THE NAIROBI HOSPITAL

RESTRICTED TENDER

PROPOSED LABOUR WARD IMPROVEMENTS.

REFERENCE NO: TNH/ITB/001/24/ENG

CLOSING DATE: WEDNESDAY, 7TH FEBRUARY 2024

CLOSING TIME: 12:00 P.M.

P. O. Box 30026 – 00100 GPO Nairobi• Kenya • Telephone: + 254 (020) 2 845 000 • e-mail: hosp@nbihosp.org • website: www.thenairobihosp.org e-mail: hosp@nairobihospital.org •website: www.nairobihospital.org

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SECTION I: INVITATION TO TENDER

TENDER NAME: PROPOSED LABOUR WARD IMPROVEMENTS.

TENDER NO: TNH/ITB/001/24/ENG

Nairobi Hospital invites sealed bids from prequalified contractors for the Proposed Labour Ward Improvements.

Complete sets of tender documents can be downloaded from The Nairobi Hospital website; https://thenairobihosp.org/tenders by interested bidders upon payment of non-refundable fee of **Ksh.3,000.00** the payment should be made through **LIPA NA MPESA Paybill Number: 998151 A/C No: Company Name** at the **hospital cashiers desk from 8:30A.M – 4:30 P.M Monday to Friday**

Candidates will then attach the original receipt to the tender documents as proof of purchase.

Prices quoted should be net inclusive of all taxes and must be expressed in Kenya shillings and shall remain valid for a period of 120 days from the closing date of the tender.

All Tenders must be accompanied by a Bid Bond in the form of a bank guarantee from a tier one bank in the amount specified in the tender document.

All Tenderers are advised to visit and examine the Site and its surroundings on **Wednesday 24th January 2024 at 10 a.m.** to obtain for himself on his own responsibility, all information that may be necessary for preparing the tender and entering into a contract. The costs of visiting the Site shall be the tenderer's own responsibility.

Completed tender documents for preliminary, technical requirements and financial are to be enclosed in a plain envelope marked with the tender reference number, tender name and addressed to:

The Chief Executive Officer
The Nairobi Hospital
P.O BOX 30026 – 00100,
Nairobi, Kenya.

Or be deposited in the Tender Box at Nairobi Hospital at the **Tender Box at Procurement Office Corporate Services Centre Second Floor** to be received on or **before 7th February 2024, at 12:00 p.m**

Electronic bidding will not be permitted. Late tenders will be rejected.

SPECIAL NOTES

The contractor is required to check the pages of these Bills of Quantities together with all collections and summaries and should he find any missing or should the contractor be in doubt of the precise meaning of any items of figures, for any reason whatsoever, he must inform The Nairobi Hospital via email tenders@nbihosp.org with a copy to the Project Manager herein PSRM Consultant email; tnhprojects@nbihosp.org in order that the correct meaning may be clarified . All clarifications should be received seven (7) days before the date for submission of Tenders.

No liability will be admitted or claim allowed in respect of errors in the contractor's tender due to mistakes in the Bills of Quantities which should have been rectified in the manner described above.

The Bills of Quantities and General Specifications shall be read and construed together and wherever descriptions in the Bills of Quantities do not agree with descriptions in the General Specifications, then the Bills of Quantities shall override.

In the event of any discrepancies arising between the Bills of Quantities and actual works the site measurements shall generally take precedence. However, such discrepancies between any contract documents shall immediately be referred to the Project Manager. The discrepancies shall then be treated as a variation and be dealt with.

SECTION II: INSTRUCTIONS TO TENDERERS

2. Instructions to Tenderers

2.1. Eligible Tenderers

2.1.1. This Invitation to tender is open to all tenderers eligible as described in the instructions to tenderers. Successful tenderers shall provide the services for the stipulated duration from the date of commencement (hereinafter referred to as the term) specified in the tender documents.

2.1.2. Tenderers involved in corrupt or fraudulent practices or debarred from participating in public procurement shall not be eligible.

2.2. Cost of Tendering

2.2.1. The Tenderer shall bear all costs associated with the preparation and submission of its tender, and The Nairobi Hospital, will in no case be responsible or liable for those costs, regardless of the conduct or outcome of the tendering process.

2.2.2. The price to be charged for the tender document shall be Kshs.3,000/=

2.2.3. Nairobi Hospital shall allow the tenderer to review the tender document free of charge before purchase.

2.3. Contents of Tender Documents

2.3.1. The tender document comprises of the documents listed below;

a) Invitation to Tender
b) Instructions to Tenderers
c) Evaluation Criteria
d) Conditions of Contract
e) Standard Forms
f) Bills of Quantities

2.3.2. The Tenderer is expected to examine all instructions, forms, terms, and specifications in the tender documents. Failure to furnish all information required by the tender documents or to submit a tender not substantially responsive to the tender documents in every respect will be at the tenderers risk and may result in the rejection of its tender.

2.4. Clarification of Documents

2.4.1. A prospective candidate making inquiries of the tender document may notify Nairobi Hospital in writing or by post, fax or email at the entity's address indicated in the Invitation for tenders. The Nairobi Hospital will respond in writing to any request for clarification of the tender documents, which it receives no later than seven (7) days prior to the deadline for the submission of tenders, prescribed by The Nairobi Hospital. Written copies of the Procuring entities response (including an explanation of the query but without identifying the source of inquiry) will be sent to all prospective tenderers who have sought out for clarifications and where need be addendum posted on The Nairobi Hospital Website.

2.4.2. Nairobi Hospital shall reply to any clarifications sought by the tenderer within 3 days of receiving the request to enable the tenderer to make timely submission of its tender

2.5. Amendment of Documents

2.5.1. At any time prior to the deadline for submission of tenders, The Nairobi Hospital, for any reason, whether at its own initiative or in response to a clarification requested by a prospective tenderer, may modify the tender documents by issuing an addendum.

2.5.2. All prospective tenderers who have obtained the tender documents will be notified of the amendment by post, fax or email and such amendment will be binding on them.

2.5.3. In order to allow prospective tenderers reasonable time in which to take the amendment into account in preparing their tenders, The Nairobi Hospital, at its discretion, may extend the deadline for the submission of tenders.

2.6. Language of Tender

2.6.1. The tender prepared by the tenderer, as well as all correspondence and documents relating to the tender exchanged by the tenderer and The Nairobi Hospital, shall be written in English language.

2.7. Documents Comprising the Tender

The tender prepared by the tenderer shall comprise the following components:

a) Completely filled BOQ
b) Documentary evidence established in accordance with Clause 2.11 that the tenderer is eligible to tender and is qualified to perform the contract if its tender is accepted.
c) Filled Standard forms.

2.8. Form of Tender

2.8.1. The tenderers shall complete the Form of Tender and the appropriate Price Schedule furnished in the tender documents, indicating the services to be performed.

2.9. Tender Prices

2.9.1. Prices quoted should be net inclusive of all taxes and must be in Kenya shillings and shall remain valid for 120 days from the closing date of the tender.

2.9.2. The Tenderer shall indicate on the form of tender and the appropriate price schedule the unit price and the total prices of the services it proposes to provide under the contract.

2.9.3. Prices quoted by the tenderer shall remain fixed during the term of the contract unless otherwise agreed by the parties. A tender submitted with an adjustable price quotation will be treated as non-responsive and will be rejected, pursuant to paragraph 2.22.

2.10. Tender Currencies

2.10.1. Prices shall be quoted in Kenya Shillings.

2.11. Tenderers Eligibility and Qualifications.

2.11.1. Pursuant to Clause 2.1 the tenderer shall furnish, as part of its tender, documents establishing the tenderers eligibility to tender and its qualifications to perform the contract if its tender is accepted.

2.11.2. The documentary evidence of the tenderers qualifications to perform the contract if its tender is accepted shall establish to The Nairobi Hospital satisfaction that the tenderer has the financial and technical capability necessary to perform the contract.

2.12. Tender Security

2.12.1. The tenderer shall furnish, as part of its tender, a tender security for the amount and form specified in the Invitation to tender.

2.12.2. The tender security shall be **Kshs. 600,000.00.**

2.12.3. The tender security is required to protect The Nairobi Hospital against the risk of Tenderer's conduct which would warrant the security's forfeiture, pursuant to paragraph 2.12.7.

2.12.4. The tender security shall be denominated in a Kenya Shillings and shall in form of a **BANK GUARANTEE from a tier one bank.**

2.12.5. Any tender not secured in accordance with paragraph 2.12.1 and 2.12.3 will be rejected by Nairobi Hospital as non-responsive, pursuant to paragraph 2.20

2.12.6. Unsuccessful tenderer's security will be discharged or returned as promptly as possible, but not later than thirty (30) days after the expiration of the period of tender validity prescribed by The Nairobi Hospital.

2.12.7. The successful tenderer's tender security will be discharged upon the tenderer signing the contract, pursuant to paragraph 2.29, and furnishing the performance security, pursuant to paragraph 2.30.

2.12.8. The tender security may be forfeited:

a) If a tenderer withdraws its tender during the period of tender validity specified by The Nairobi Hospital on the Tender Form; or

b) In the case of a successful tenderer, if the tenderer fails:

   i. To sign the contract.

   ii. To furnish performance security.

c) If the tenderer rejects, correction of an error in the tender.

2.13. Validity of Tenders

2.13.1. Tenders shall remain valid for 120 days or as specified in the invitation to tender after date of tender opening prescribed by The Nairobi Hospital, pursuant to paragraph 2.18. A tender valid for a shorter period shall be rejected by Nairobi Hospital as nonresponsive.

2.13.2. In exceptional circumstances, The Nairobi Hospital may solicit the Tenderer's consent to an extension of the period of validity. The request and the responses

thereto shall be made in writing. The tender security provided under paragraph 2.12 shall also be suitably extended. A tenderer may refuse the request without forfeiting its tender security. A tenderer granting the request will not be required nor permitted to modify its tender.

2.14. Format and Signing of Tender

2.14.1. The tenderer shall prepare one copy of the tender.

2.14.2. The copy of the tender shall be typed or written in indelible ink.

2.14.3. The final Bid bound document must be Tape Bounded and serially paginated ***(All pages in the document from top page immediately after top cover to the last page (one before back cover) including table of content, separators, brochures, receipt and any other attachments) in a continuous ascending order from the first page to the last in this format; 1,2,3……n where n is the last page).***

2.14.4. The document should be clearly arranged with **SEPARATORS AND TAPE BOUND. SPIRAL BOUND WILL NOT BE ACCEPTED.**

2.15. Sealing and Marking of Tenders

2.15.1. The tenderer shall seal the copy of the tender and the envelopes shall then be sealed in an outer envelope.

2.15.2. The inner and outer envelopes shall be addressed to:

The Chief Executive Officer
The Nairobi Hospital
P.O BOX 30026 – 00100,
Nairobi, Kenya

Bear, tender number and name in the invitation to tender and the words: **"DO NOT OPEN BEFORE" Wednesday 7th February 2024 at 12.00 p.m.**

2.15.3. If the outer envelope is not sealed and marked as required by paragraph 2.15.2, The Nairobi Hospital will assume no responsibility for the tender's misplacement or premature opening.

2.16. Deadline for Submission of Tenders

2.16.1. Tenders must be received by The Nairobi Hospital at the address specified under paragraph 2.15.2 no later than **Wednesday 7th February 2024 at 12.00 p.m.**

2.16.2. The Nairobi Hospital may, at its discretion, extend this deadline for the submission of tenders by amending the tender documents in accordance with paragraph 6, in which case all rights and obligations of The Nairobi Hospital and candidates previously subject to the deadline will thereafter be subject to the deadline as extended.

2.16.3. Bulky tenders which will not fit in the tender box shall be received by The Nairobi Hospital as provided for in the appendix.

2.17. Modification and withdrawal of tenders

2.17.1. The tenderer may modify or withdraw its tender after the tender's submission, provided that written notice of the modification, including substitution or withdrawal of the tender's is received by The Nairobi Hospital prior to the deadline prescribed for the submission of tenders.

2.17.2. The Tenderer's modification or withdrawal notice shall be prepared, sealed, marked, and dispatched in accordance with the provisions of paragraph 2.15. A withdrawal notice may also be sent by cable, but followed by a signed confirmation copy, postmarked no later than the deadline for submission of tenders.

2.17.3. No tender may be modified after the deadline for submission of tenders.

2.17.4. No tender may be withdrawn in the interval between the deadline for submission of tenders and the expiration of the period of tender validity specified by the tenderer on the Tender Form. Withdrawal of a tender during this interval may result in the Tenderer's forfeiture of its tender security, pursuant to paragraph 2.12.7.

2.17.5. Nairobi Hospital may at any time terminate procurement proceedings before contract award and shall not be liable to any person for the termination.

2.17.6. Nairobi Hospital shall give prompt notice of the termination to the tenderers and on request give its reasons for termination within 14 days of receiving the request from any tenderer.

2.18. Opening of Tenders

2.18.1. The Nairobi Hospital will open all tenders at its discretion**.**

2.18.2. Thereafter, The Nairobi Hospital will prepare minutes of the tender opening.

2.19. Clarification of tenders

2.19.1. To assist in the examination, evaluation and comparison of tenders, The Nairobi Hospital may at its discretion, ask the tenderer for a clarification of its tender. The request for clarification and the response shall be in call or writing, and no change in the prices or substance shall be sought, offered, or permitted.

2.19.2. Any effort by the tenderer to influence The Nairobi Hospital in tender evaluation, tender comparison or contract award decisions may result in the rejection of the tenderers tender. Comparison or contract award decisions may result in the rejection of the tenderers' tender.

2.20. Preliminary Examination and Responsiveness

2.20.1. The Nairobi Hospital will examine the tenders to determine whether they are complete, whether any computational errors have been made, whether required securities have been furnished whether the documents have been properly paginated, and whether the tenders are generally in order.

2.20.2. Arithmetical errors will be rectified on the following basis. If there is a discrepancy between the unit price and the total price that is obtained by multiplying the unit price and quantity, the unit price shall prevail, and the total price shall be corrected. If the candidate does not accept the correction of the errors, its tender will be rejected, and its tender security may be forfeited. If there is a discrepancy between words and figures, the amount in words will prevail.

2.20.3. The Nairobi Hospital may waive any minor informality or nonconformity or irregularity in a tender which does not constitute a material deviation, provided such waiver does not prejudice or affect the relative ranking of any tenderer.

2.20.4. Prior to the detailed evaluation, pursuant to paragraph 23, The Nairobi Hospital will determine the substantial responsiveness of each tender to the tender documents. For purposes of these paragraphs, a substantially responsive tender is one which conforms to all the terms and conditions of the tender documents without material deviations. The Nairobi Hospital's

determination of a tender's responsiveness is to be based on the contents of the tender itself without recourse to extrinsic evidence.

2.20.5. If a tender is not substantially responsive, it will be rejected by The Nairobi Hospital and may not subsequently be made responsive by the tenderer by correction of the nonconformity.

2.21. Conversion to a single currency

2.21.1. All quoted prices should be in Kenya shillings and inclusive of VAT.

2.22. Evaluation and comparison of tenders

2.22.1. The Nairobi Hospital will evaluate and compare the tenders which have been determined to be substantially responsive, pursuant to paragraph 2.20

2.22.2. The comparison shall be of the price including all costs as well as duties and taxes payable on all the materials to be used in the provision of the services.

2.22.3. The tender evaluation committee shall evaluate the tender within 30 days from the date of opening the tender.

2.22.4. To qualify for contract awards, the tenderer shall have the following: -

a) Necessary qualifications, capability experience, services, equipment and facilities to provide what is being procured.
b) Legal capacity to enter into a contract for procurement
c) Shall not be insolvent, in receivership, bankrupt or in the process of being wound up and is not the subject of legal proceedings relating to the foregoing
d) Shall not be debarred from participating in public procurement.

2.23. Contacting The Nairobi Hospital

2.23.1. Subject to paragraph 2.19, no tenderer shall contact The Nairobi Hospital on any matter relating to its tender, from the time of the tender opening to the time the contract is warded.

2.23.2. Any effort by a tenderer to influence Nairobi Hospital in its decisions on tender evaluation tender comparison or contract award may result in the rejection of the tenderers tender.

2.24. Award of Contract

(a) Post qualification

2.24.1. In the absence of pre-qualification, The Nairobi Hospital will determine to its satisfaction whether the tenderer that is selected as having submitted the lowest evaluated responsive tender is qualified to perform the contract satisfactorily.

2.24.2. The determination will take into account the tenderer's financial and technical capabilities. It will be based upon an examination of the documentary evidence of the tenderer's qualifications submitted by the tenderer, pursuant to paragraph 2.1.2, as well as such other information as The Nairobi Hospital deems necessary and appropriate.

(b) Award Criteria

2.24.3. The Nairobi Hospital will award the contract to the successful tenderer whose tender has been determined to be substantially responsive and has been determined to be the lowest evaluated tender, provided further that the tenderer is determined to be qualified to perform the contract satisfactorily.

2.24.4. The Nairobi Hospital reserves the right to accept or reject any tender and to annul the tendering process and reject all tenders at any time prior to contract award, without thereby incurring any liability to the affected tenderer or tenderers or any obligation to inform the affected tenderer or tenderers of the grounds for The Nairobi Hospital's action. If the procuring entity determines that none of the tenderers is responsive; the procuring entity shall notify each tenderer who submitted a tender.

2.24.5. A tenderer who gives false information in the tender document about its qualification or who refuses to enter into a contract after notification of contract award shall be considered for debarment from participating in future public procurement.

2.25. Notification of award

2.25.1. Prior to the expiration of the period of tender validity, the Procuring entity will notify the successful tenderer in writing that its tender has been accepted.

2.25.2. The notification of award will signify the formation of the Contract subject to the signing of the contract between the tenderer and The Nairobi Hospital

pursuant to clause 2.29. Simultaneously the other tenderers shall be notified that their tenders have not been successful.

2.25.3. Upon the successful Tenderer's furnishing of the performance security, The Nairobi Hospital will promptly notify each unsuccessful Tenderer and will discharge its tender security, pursuant to paragraph 2.12

2.26. Signing of Contract

2.26.1. At the same time as The Nairobi Hospital notifies the successful tenderer that its tender has been accepted, Nairobi Hospital will simultaneously inform the other tenderers that their tenders have not been successful.

2.26.2. Within fourteen (14) days of receipt of the Contract Form, the successful tenderer shall sign and date the contract and return it to The Nairobi Hospital.

2.26.3. The parties to the contract shall have it signed within 30 days from the date of notification of contract award unless there is an administrative review request.

2.27. Performance Security

2.27.1. Within thirty (30) days of the receipt of notification of award from The Nairobi Hospital, the successful tenderer shall furnish the performance security equivalent to 10% of the contract amount.

2.27.2. Failure of the successful tenderer to comply shall constitute sufficient grounds for the annulment of the award and forfeiture of the tender security, in which event The Nairobi Hospital may make the award to the next lowest evaluated or call for new tenders.

2.28. Corrupt or Fraudulent Practices

2.28.1. The Nairobi Hospital requires that tenderers observe the highest standard of ethics during the procurement process and execution of contracts. A tenderer shall sign a declaration that he has not and will not be involved in corrupt or fraudulent practices.

2.28.2. The Nairobi Hospital will reject a proposal for award if it determines that the tenderer recommended for award has engaged in corrupt or fraudulent practices in competing for the contract in question;

2.28.3. Further, a tenderer who is found to have indulged in corrupt or fraudulent practices risks being debarred from participating in public procurement in Kenya.

SECTION III: TECHNICAL EVALUATION

BUILDER'S WORKS EVALUATION CRITERIA

Prequalified Bidders should note that only those who meet the criteria indicated below as a minimum supported by relevant documents at submission will be considered for further evaluation.

TENDER EVALUATION CRITERIA

After tender opening, the tenders will be evaluated in 4 stages, namely:

1. Preliminary Evaluation
2. Technical Evaluation
3. Financial Evaluation
4. Due diligence

STAGE 1: BUILDER'S WORKS PRELIMINARY EVALUATION

This stage of evaluation shall involve examination of the mandatory requirements as set out in the bid document.

The mandatory requirements shall include the following:

Table 1: Mandatory Requirements

	PRELIMINARY EVALUATION OF MANDATORY REQUIREMENTS		
	Mandatory Requirements (YES/NO)		
No.	**Particulars**	**YES**	**NO**
1.	Copy of Certificate of Incorporation/Certificate of Registration		
2.	Copy of valid KRA Tax Compliance Certificate		
3.	Copy of CR12 issued within 12 months or copies of identification cards for Sole Proprietors/Partnerships. **(Must specify the shareholding)**		
4.	Must provide a copy of Valid business Trading License relevant to this tender		
5.	Must attach original receipt as proof of purchase of tender documents		
6.	Must provide tender security from a reputable bank amounting to **Kshs 600,000.00** ***(attach original letter from Tier 1 bank)***		
7.	Valid registration with National Construction Authority **(NCA 5 and above).**		
8.	Must attach dully filled, signed and stamped site visit form.		
9.	Must attach dully filled form of tender.		
10.	Must attach dully filled confidential business questionnaire.		
11.	Must submit copies of 2 audited financial reports (2021 and 2022**)** certified by audit firm registered by the Institute of Certified Public Accountants (ICPAK). **(Attach audit firm registration certificate from ICPAK) (Where there is a provision for more than one Directors, two of them must sign.)**		
12.	**ENSURE** that all pages are sequentially paginated in the format1, 2, 3 …. Starting with 1 on top page ***(see details of pagination and binding on sub-section 2.14 of the tender document).***		

Note 1*: All the above documents numbered 1 to 12 should be packaged and arranged in that order under the preliminary evaluation criteria section of the tender document.*

Note 2*: Bidders who do not attach* ***ANY*** *of the* ***MANDATORY REQUIREMENTS*** *will be considered Non-responsive and will* ***NOT*** *be evaluated further.*

STAGE 2: BUILDER'S WORKS TECHNICAL EVALUATION

	Detailed Technical Specifications/Description of requirements **Description of the works.** Scope of work covers Demolitions, new walling and partitions, service ducts, doors, windows, internal finishes, joinery fittings and builders work in connection to specialist installations.	**Maximum Points**
1.	**Key Personnel** Provide detailed company profile including CVs and Academic Certificates for; **(a)** At least 1-degree / diploma holder of key personnel in relevant field. •With over 10 years relevant experience……10 •With 5 to 10 years relevant experience……..5 •With under 5 years relevant experience……3 •No relevant certificate……..0 **(b)** At least 1 certificate holder of key personnel in relevant field. •With over 10 years relevant experience……8 •With 5 to 10 years relevant experience…….4 •With under 5 years relevant experience……...2 •No relevant certificate…….0 **(c)** At least 1 artisan (trade test certificate in relevant field) •Artisan with over 10 years relevant experience……..2 •Artisan with 1 to 10 years relevant experience……...1 •No artisan with relevant experience……0	**20 Marks**
2.	Provide at least 5 award letters/PO and companied with completion certificates for works of similar magnitude and complexity completed in the last five (5) years, i.e. from 2019 to date. **4 marks each**.	**20 Marks**
3.	Recommendation letters from clients for similar works within 5 years; • With above 5 recommendation letters…….5 marks • With 3-5 recommendation letters……..2.5 marks • With 2 and below recommendation letters……..1 marks	**5 marks**
4.	Annual volume of construction or renovation work **(certified audited financial reports for 2021 to 2022);** i. Average Annual Turn-over equal or greater than the cost of the project. **ii. (3marks)** **iii.** Average Annual Turn-over above 50% but below 100% of the cost of the project **- (1.5 marks)** iv. Average Annual Turn-over below 50% of the cost of the project **- (1 marks)**	**3 Marks**
5.	**Works Programme** Attach works program specifying the activities and duration (Gantt chart) for the work. i. Completion period provided **(2 marks)** ii. Not specified **(0 mark)**	**2 Marks**

6.	**Key Equipment** Schedule of contractor's equipment and transport **(attach proof or evidence of ownership/lease)** Relevant Transport **(at least 4No. each 2mks)** • Means of transport (Vehicle)……8 • No means of transport……...0	**16 Marks**
	Relevant Equipment **(at least 4No. each 2mks)** • Has relevant equipment for work being tendered….8 • No relevant equipment for work being tendered…...0	
7.	**Name, Address and Telephone of Contractor Main Banks (Contractor to provide) Provide letter of authorization to seek information from the bank** •Information and authorization provided……2 •No information provided……..……0	**3 Marks**
8.	**Litigation History** •Duly Filled……..1 •Not Filled……0	**1 Mark**
	TOTAL	**70 Marks**

Any bidder who scores 70% (49/70) and above shall be considered for financial evaluation.

STAGE 3: BUILDER'S WORK'S FINANCIAL EVALUATION

Upon completion of the technical evaluation a detailed financial evaluation shall follow. The evaluation shall be in three stages;

a) Determination of Arithmetic errors

b) Comparison of Rates

c) Consistency of the Rates; and

d) Deviation from the Total Cost Estimates.

a) Determination of Arithmetic Errors

Arithmetic Errors will be corrected by the Procuring Entity as follows:

i In the event of a discrepancy between the tender amount as stated in the form of Tender and the corrected tender figure in the Main summary of the Bills of Quantities, the Tender sum shall prevail.

ii Error correction factor shall be computed by expressing the difference between the tender amount and the corrected sum;

b) Comparison of rates

Items that are under-priced or overpriced may indicate potential for non-delivery and front loading respectively. The committee shall promptly write to the tenderer asking for detailed breakdown of costs for any of the quoted items, relationship between those prices, proposed construction/installation methods and schedules.

The evaluation committee shall evaluate the responses and make an appropriate recommendation to the procuring entity giving necessary evidence. Such recommendations may include but not limited to:

i Recommend no adverse action to the tenderer after a convincing response;

ii Employer requiring that the amount of the performance bond be raised at the expense of the successful tenderer to a level sufficient to protect the employer against potential financial losses;

c) Consistency of the Rates

The evaluation committee will compare the consistency of rates for similar items and note all inconsistencies of the rates for similar items.

d) Deviation from the Total Cost Estimates

The evaluation committee will analyse abnormally low tenders and abnormally high tenders by adopting the plus/minus 10% of the total cost estimates and shall reject all Tenders in this stage that will be considered to be either Abnormally Low Tender or Abnormally High.

An abnormally low tender is one where the Tender Price, in combination with other elements of the Tender, appears so low that it raises material concerns as to the capability of the Tenderer in regards to Tenderer's ability to perform the Contract for the offered Tender Price or that genuine competition between Tenderers is compromised.

Whereas Abnormally High Tender is one where the Tender Price, in combination with other constituent elements of the Tender, appears unreasonably too high to the extent that the Procuring Entity is concerned that it (the Procuring Entity) may not be getting value for money or it may be paying too high a price for the contract compared with market prices or that genuine competition between Tenderers is compromised.

STAGE 4 – DUE DILIGENCE

The Evaluation Committee shall subject shortlisted bidder(s) considered for award for due diligence check prior to award.

ELECTRICAL WORKS EVALUATION CRITERIA

Interested Bidders should note that only those who meet the criteria indicated below as a minimum supported by relevant documents at submission will be considered for further evaluation.

TENDER EVALUATION CRITERIA

After tender opening, the tenders will be evaluated in 4 stages, namely:

1. Preliminary Evaluation
2. Technical Evaluation
3. Financial Evaluation
4. Due diligence

STAGE 1: ELECTRICAL WORKS PRELIMINARY EVALUATION

This stage of evaluation shall involve examination of the mandatory requirements as set out in the bid document.

The mandatory requirements shall include the following:

Table 1: Mandatory Requirements

	PRELIMINARY EVALUATION OF MANDATORY REQUIREMENTS		
	Mandatory Requirements (YES/NO)		
No.	**Particulars**	**YES**	**NO**
1.	Copy of Certificate of Incorporation/Certificate of Registration		
2.	Copy of valid KRA Tax Compliance Certificate		
3.	Copy of CR12 issued within 12 months or copies of identification cards for Sole Proprietors/Partnerships. **(Must specify the shareholding)**		
4.	Must provide a copy of Valid business Trading License relevant to this tender		
5.	Energy and Petroleum Regulatory Authority (EPRA) License		
6.	Must attach original receipt as proof of purchase of tender document		
7.	Valid registration with National Construction Authority **(NCA 6 and above).**		
8.	Must attach dully filled, signed and stamped site visit form.		
9.	Must submit copies of 2 audited financial reports (2021 and 2022**)** certified by audit firm registered by the Institute of Certified Public Accountants (ICPAK). **(Attach audit firm registration certificate from ICPAK) (Where there is a provision for more than one Directors, two of them must sign.)**		
10.	**ENSURE** that all pages are sequentially paginated in the format1, 2, 3 …. Starting with 1 on top page ***(see details of pagination and binding on sub-section 2.14 of the tender document).***		

Note 1*: All the above documents numbered 1 to 10 should be packaged and arranged in that order under the preliminary evaluation criteria section of the tender document.*

Note 2*: Bidders who do not attach* ***ANY*** *of the* ***MANDATORY REQUIREMENTS*** *will be considered Non-responsive and will* ***NOT*** *be evaluated further.*

STAGE 2: ELECTRICAL WORKS TECHNICAL EVALUATION

	Detailed Technical Specifications/Description of requirements	Maximum Points
1.	**Key Personnel** Provide detailed company profile including CVs and Academic Certificates for; **(a)** At least 1-degree / diploma holder of key personnel in relevant field. • With over 10 years relevant experience……10 • With 5 to 10 years relevant experience……..5 • With under 5 years relevant experience……3 • No relevant certificate……..0 **(b)** At least 1 certificate holder of key personnel in relevant field. • With over 10 years relevant experience……8 • With 5 to 10 years relevant experience……..….4 • With under 5 years relevant experience……2 • No relevant certificate……..0 **(c)** At least 1 artisan (trade test certificate in relevant field) • Artisan with over 10 years relevant experience……...2 • Artisan with 1 to 10 years relevant experience……1 • No artisan with relevant experience……0	**20 Marks**
2.	Provide at least 5 award letters/PO for works of similar magnitude and complexity completed in the last five (5) years, i.e. from 2019 to date. **4 marks each**.	**20 Marks**
3.	Recommendation letters from clients for similar works within 5 years; • With above 5 recommendation letters…….5 marks • With 3-5 recommendation letters……..2.5 marks • With 2 and below recommendation letters……..1 marks	**5 Marks**
3.	Annual volume of construction or renovation work (certified audited financial reports for 2021 to 2022); i. Average Annual Turn-over equal or greater than the cost of the project. **ii. (3 marks)** **iii.** Average Annual Turn-over above 50% but below 100% of the cost of the project - **(1.5 marks)** iv. Average Annual Turn-over below 50% of the cost of the project - **(1 marks)**	**3 Marks**
4.	**Litigation History** **•Duly Filled……..2** **•Not Filled…….0**	**2 Marks**
	TOTAL	**50 Marks**

Any bidder who scores 70% (35/50) and above shall be considered for financial evaluation.

STRUCTURED CABLING INSTALLATIONS EVALUATION CRITERIA

Interested Bidders should note that only those who meet the criteria indicated below as a minimum supported by relevant documents at submission will be considered for further evaluation.

TENDER EVALUATION CRITERIA

After tender opening, the tenders will be evaluated in 4 stages, namely:

1. Preliminary Evaluation
2. Technical Evaluation
3. Financial Evaluation
4. Due diligence

STAGE 1: STRUCTURED CABLING INSTALLATIONS PRELIMINARY EVALUATION

This stage of evaluation shall involve examination of the mandatory requirements as set out in the bid document.

The mandatory requirements shall include the following:

Table 1: Mandatory Requirements

	PRELIMINARY EVALUATION OF MANDATORY REQUIREMENTS		
	Mandatory Requirements (YES/NO)		
No.	**Particulars**	**YES**	**NO**
1.	Copy of Certificate of Incorporation/Certificate of Registration		
2.	Copy of valid KRA Tax Compliance Certificate		
3.	Copy of CR12 issued within 12 months or copies of identification cards for Sole Proprietors/Partnerships. **(Must specify the shareholding)**		
4.	Must provide a copy of Valid business Trading License relevant to this tender		
5.	Communications Authority of Kenya (CAK) License		
6.	Must attach original receipt as proof of purchase of tender documents		
7.	Valid registration with National Construction Authority **(NCA 6 and above).**		
8.	Must attach dully filled, signed and stamped site visit form.		
9.	Must submit copies of 2 audited financial reports (2021 and 2022**)** certified by audit firm registered by the Institute of Certified Public Accountants (ICPAK). **(Attach audit firm registration certificate from ICPAK) (Where there is a provision for more than one Directors, two of them must sign.)**		
10.	**ENSURE** that all pages are sequentially paginated in the format1, 2, 3 …. Starting with 1 on top page ***(see details of pagination and binding on sub-section 2.14 of the tender document).***		

Note 1*: All the above documents numbered 1 to 10 should be packaged and arranged in that order under the preliminary evaluation criteria section of the tender document.*

Note 2*: Bidders who do not attach* ***ANY*** *of the* ***MANDATORY REQUIREMENTS*** *will be considered Non-responsive and will* ***NOT*** *be evaluated further.*

STAGE 2: STRUCTURED CABLING INSTALLATIONS TECHNICAL EVALUATION

	Detailed Technical Specifications/Description of requirements	Maximum Points
1.	**Key Personnel** Provide detailed company profile including CVs and Academic Certificates for; **(a)** At least 1-degree / diploma holder of key personnel in relevant field. • With over 10 years relevant experience……10 • With 5 to 10 years relevant experience……..5 • With under 5 years relevant experience……3 • No relevant certificate……..0 **(b)** At least 1 certificate holder of key personnel in relevant field. • With over 10 years relevant experience……8 • With 5 to 10 years relevant experience……..….4 • With under 5 years relevant experience……2 • No relevant certificate……..0 **(c)** At least 1 artisan (trade test certificate in relevant field) • Artisan with over 10 years relevant experience……...2 • Artisan with 1 to 10 years relevant experience……1 • No artisan with relevant experience……0	**20 Marks**
2.	Provide at least 5 award letters/PO for works of similar magnitude and complexity completed in the last five (5) years, i.e. from 2019 to date. **4 marks each**.	**20 Marks**
3.	Recommendation letters from clients for similar works within 5 years; • With above 5 recommendation letters…….5 marks • With 3-5 recommendation letters……..2.5 marks • With 2 and below recommendation letters……..1 marks	**5 Marks**
4.	Annual volume of construction or renovation work (certified audited financial reports for 2021 to 2022); i.Average Annual Turn-over equal or greater than the cost of the project. **ii. (3 marks)** **iii.** Average Annual Turn-over above 50% but below 100% of the cost of the project **- (1.5 marks)** iv. Average Annual Turn-over below 50% of the cost of the project - **(1 marks)**	**3 Marks**
5.	**Litigation History** **•Duly Filled……..2** **•Not Filled……0**	**2 Marks**
	TOTAL	**50 Marks**

Any bidder who scores 70% (35/50) and above shall be considered for financial evaluation

SECURITY INSTALLATIONS EVALUATION CRITERIA

Interested Bidders should note that only those who meet the criteria indicated below as a minimum supported by relevant documents at submission will be considered for further evaluation.

TENDER EVALUATION CRITERIA

After tender opening, the tenders will be evaluated in 4 stages, namely:

1. Preliminary Evaluation
2. Technical Evaluation
3. Financial Evaluation
4. Due diligence

STAGE 1: SECURITY INSTALLATIONS PRELIMINARY EVALUATION

This stage of evaluation shall involve examination of the mandatory requirements as set out in the bid document.

The mandatory requirements shall include the following:

Table 1: Mandatory Requirements

	PRELIMINARY EVALUATION OF MANDATORY REQUIREMENTS		
	Mandatory Requirements (YES/NO)		
No.	**Particulars**	**YES**	**NO**
1.	Copy of Certificate of Incorporation/Certificate of Registration		
2.	Copy of valid KRA Tax Compliance Certificate		
3.	Copy of CR12 issued within 12 months or copies of identification cards for Sole Proprietors/Partnerships. **(Must specify the shareholding)**		
4.	Must provide a copy of Valid business Trading License relevant to this tender		
5.	Communications Authority of Kenya (CAK) License		
6.	Must attach original receipt as proof of purchase of tender documents		
7.	Valid registration with National Construction Authority **(NCA 6 and above).**		
8.	Must attach dully filled, signed and stamped site visit form.		
9.	Must submit copies of 2 audited financial reports (2021 and 2022**)** certified by audit firm registered by the Institute of Certified Public Accountants (ICPAK). **(Attach audit firm registration certificate from ICPAK) (Where there is a provision for more than one Directors, two of them must sign.)**		
10.	**ENSURE** that all pages are sequentially paginated in the format1, 2, 3 …. Starting with 1 on top page ***(see details of pagination and binding on sub-section 2.14 of the tender document).***		

Note 1*: All the above documents numbered 1 to 10 should be packaged and arranged in that order under the preliminary evaluation criteria section of the tender document.*

Note 2*: Bidders who do not attach* ***ANY*** *of the* ***MANDATORY REQUIREMENTS*** *will be considered Non-responsive and will* ***NOT*** *be evaluated further.*

STAGE 2: SECURITY INSTALLATIONS TECHNICAL EVALUATION

	Detailed Technical Specifications/Description of requirements	Maximum Points
1.	**Key Personnel** Provide detailed company profile including CVs and Academic Certificates for; **(a)** At least 1-degree / diploma holder of key personnel in relevant field. • With over 10 years relevant experience……10 • With 5 to 10 years relevant experience……..5 • With under 5 years relevant experience……3 • No relevant certificate……..0 **(b)** At least 1 certificate holder of key personnel in relevant field. • With over 10 years relevant experience……8 • With 5 to 10 years relevant experience……..….4 • With under 5 years relevant experience……2 • No relevant certificate……..0 **(c)** At least 1 artisan (trade test certificate in relevant field) • Artisan with over 10 years relevant experience……...2 • Artisan with 1 to 10 years relevant experience……1 • No artisan with relevant experience……0	**20 Marks**
2.	Provide at least 5 award letters/PO for works of similar magnitude and complexity completed in the last five (5) years, i.e. from 2019 to date. **4 marks each**.	**20 Marks**
3.	Recommendation letters from clients for similar works within 5 years; • With above 5 recommendation letters…….5 marks • With 3-5 recommendation letters……..2.5 marks • With 2 and below recommendation letters……..1 marks	**5 Marks**
4.	Annual volume of construction or renovation work (certified audited financial reports for 2021 to 2022); **i.**Average Annual Turn-over equal or greater than the cost of the project. **ii. (3 marks)** **iii.** Average Annual Turn-over above 50% but below 100% of the cost of the project - **(1.5 marks)** **iv.** Average Annual Turn-over below 50% of the cost of the project - **(1 marks)**	**3 Marks**
5.	**Litigation History** **•Duly Filled……..2** **•Not Filled…….0**	**2 Marks**
	TOTAL	**50 Marks**

Any bidder who scores 70% (35/50) and above shall be considered for financial evaluation

NURSE CALL INSTALLATIONS EVALUATION CRITERIA

Interested Bidders should note that only those who meet the criteria indicated below as a minimum supported by relevant documents at submission will be considered for further evaluation.

TENDER EVALUATION CRITERIA

After tender opening, the tenders will be evaluated in 4 stages, namely:

1. Preliminary Evaluation
2. Technical Evaluation
3. Financial Evaluation
4. Due diligence

STAGE 1: NURSE CALL INSTALLATIONS PRELIMINARY EVALUATION

This stage of evaluation shall involve examination of the mandatory requirements as set out in the bid document.

The mandatory requirements shall include the following:

Table 1: Mandatory Requirements

	PRELIMINARY EVALUATION OF MANDATORY REQUIREMENTS		
	Mandatory Requirements (YES/NO)		
No.	**Particulars**	**YES**	**NO**
1.	Copy of Certificate of Incorporation/Certificate of Registration		
2.	Copy of valid KRA Tax Compliance Certificate		
3.	Copy of CR12 issued within 12 months or copies of identification cards for Sole Proprietors/Partnerships. **(Must specify the shareholding)**		
4.	Must provide a copy of Valid business Trading License relevant to this tender		
5.	Energy and Petroleum Regulatory Authority (EPRA) License		
6.	Must attach original receipt as proof of purchase of tender documents		
7.	Valid registration with National Construction Authority **(NCA 6 and above).**		
8.	Must attach dully filled, signed and stamped site visit form.		
9.	Must submit copies of 2 audited financial reports (2021 and 2022**)** certified by audit firm registered by the Institute of Certified Public Accountants (ICPAK). **(Attach audit firm registration certificate from ICPAK) (Where there is a provision for more than one Directors, two of them must sign.)**		
10.	**ENSURE** that all pages are sequentially paginated in the format1, 2, 3 …. Starting with 1 on top page ***(see details of pagination and binding on sub-section 2.14 of the tender document).***		

Note 1*: All the above documents numbered 1 to 10 should be packaged and arranged in that order under the preliminary evaluation criteria section of the tender document.*

Note 2*: Bidders who do not attach* ***ANY*** *of the* ***MANDATORY REQUIREMENTS*** *will be considered Non-responsive and will* ***NOT*** *be evaluated further.*

STAGE 2: NURSE CALL INSTALLATIONS TECHNICAL EVALUATION

Detailed Technical Specifications/Description of requirements		Maximum Points
1.	**Key Personnel** Provide detailed company profile including CVs and Academic Certificates for; **(a)** At least 1-degree / diploma holder of key personnel in relevant field. • With over 10 years relevant experience……10 • With 5 to 10 years relevant experience……..5 • With under 5 years relevant experience……3 • No relevant certificate……..0 **(b)** At least 1 certificate holder of key personnel in relevant field. • With over 10 years relevant experience……8 • With 5 to 10 years relevant experience……..….4 • With under 5 years relevant experience……2 • No relevant certificate……..0 **(c)** At least 1 artisan (trade test certificate in relevant field) • Artisan with over 10 years relevant experience……...2 • Artisan with 1 to 10 years relevant experience……1 • No artisan with relevant experience…….0	**20 Marks**
2.	Provide at least 5 award letters/PO for works of similar magnitude and complexity completed in the last five (5) years, i.e. from 2019 to date. **4 marks each**.	**20 Marks**
3.	Recommendation letters from clients for similar works within 5 years; • With above 5 recommendation letters…….5 marks • With 3-5 recommendation letters……..2.5 marks • With 2 and below recommendation letters……..1 marks	**5 Marks**
4.	Annual volume of construction or renovation work (certified audited financial reports for 2021 to 2022); **i.** Average Annual Turn-over equal or greater than the cost of the project. **ii. (3 marks)** **iii.** Average Annual Turn-over above 50% but below 100% of the cost of the project - **(1.5 marks)** **iv.** Average Annual Turn-over below 50% of the cost of the project - **(1 marks)**	**3 Marks**
5.	**Litigation History** **•Duly Filled……..2** **•Not Filled……0**	**2 Marks**
	TOTAL	**50 Marks**

Any bidder who scores 70% (35/50) and above shall be considered for financial evaluation.

PLUMBING & DRAINAGE INSTALLATIONS EVALUATION CRITERIA

Interested Bidders should note that only those who meet the criteria indicated below as a minimum supported by relevant documents at submission will be considered for further evaluation.

TENDER EVALUATION CRITERIA

After tender opening, the tenders will be evaluated in 4 stages, namely:

1. Preliminary Evaluation
2. Technical Evaluation
3. Financial Evaluation
4. Due diligence

STAGE 1: PLUMBING & DRAINAGE INSTALLATIONS PRELIMINARY EVALUATION

This stage of evaluation shall involve examination of the mandatory requirements as set out in the bid document.

The mandatory requirements shall include the following:

Table 1: Mandatory Requirements

	PRELIMINARY EVALUATION OF MANDATORY REQUIREMENTS		
	Mandatory Requirements (YES/NO)		
No.	**Particulars**	**YES**	**NO**
1.	Copy of Certificate of Incorporation/Certificate of Registration		
2.	Copy of valid KRA Tax Compliance Certificate		
3.	Copy of CR12 issued within 12 months or copies of identification cards for Sole Proprietors/Partnerships. **(Must specify the shareholding)**		
4.	Must provide a copy of Valid business Trading License relevant to this tender		
5.	Plumbers License		
6.	Must attach original receipt as proof of purchase of tender documents		
7.	Valid registration with National Construction Authority **(NCA 6 and above).**		
8.	Must attach dully filled, signed and stamped site visit form.		
9.	Must submit copies of 2 audited financial reports (2021 and 2022**)** certified by audit firm registered by the Institute of Certified Public Accountants (ICPAK). **(Attach audit firm registration certificate from ICPAK) (Where there is a provision for more than one Directors, two of them must sign.)**		
10.	**ENSURE** that all pages are sequentially paginated in the format1, 2, 3 …. Starting with 1 on top page ***(see details of pagination and binding on sub-section 2.14 of the tender document).***		

Note 1*: All the above documents numbered 1 to 10 should be packaged and arranged in that order under the preliminary evaluation criteria section of the tender document.*

Note 2*: Bidders who do not attach* ***ANY*** *of the* ***MANDATORY REQUIREMENTS*** *will be considered Non-responsive and will* ***NOT*** *be evaluated further.*

STAGE 2 PLUMBING & DRAINAGE INSTALLATIONS TECHNICAL EVALUATION

Detailed Technical Specifications/Description of requirements		Maximum Points
1.	**Key Personnel** Provide detailed company profile including CVs and Academic Certificates for; **(a)** At least 1-degree / diploma holder of key personnel in relevant field. • With over 10 years relevant experience……10 • With 5 to 10 years relevant experience……..5 • With under 5 years relevant experience……3 • No relevant certificate……..0 **(b)** At least 1 certificate holder of key personnel in relevant field. • With over 10 years relevant experience……8 • With 5 to 10 years relevant experience……..….4 • With under 5 years relevant experience……2 • No relevant certificate……..0 **(c)** At least 1 artisan (trade test certificate in relevant field) • Artisan with over 10 years relevant experience……...2 • Artisan with 1 to 10 years relevant experience……1 • No artisan with relevant experience…….0	**20 Marks**
2.	Provide at least 5 award letters/PO for works of similar magnitude and complexity completed in the last five (5) years, i.e. from 2019 to date. **4 marks each**.	**20 Marks**
3.	Recommendation letters from clients for similar works within 5 years; • With above 5 recommendation letters…….5 marks • With 3-5 recommendation letters……..2.5 marks • With 2 and below recommendation letters……..1 marks	**5 Marks**
4.	Annual volume of construction or renovation work (certified audited financial reports for 2021 to 2022); **v.** Average Annual Turn-over equal or greater than the cost of the project. **vi. (3 marks)** **vii.** Average Annual Turn-over above 50% but below 100% of the cost of the project - **(1.5 marks)** **viii.** Average Annual Turn-over below 50% of the cost of the project - **(1 marks)**	**3 Marks**
5.	**Litigation History** **•Duly Filled……..2** **•Not Filled…….0**	**2 Marks**
	TOTAL	**50 Marks**

Any bidder who scores 70% (35/50) and above shall be considered for financial evaluation.

HVAC INSTALLATIONS EVALUATION CRITERIA

Interested Bidders should note that only those who meet the criteria indicated below as a minimum supported by relevant documents at submission will be considered for further evaluation.

TENDER EVALUATION CRITERIA

After tender opening, the tenders will be evaluated in 4 stages, namely:

1. Preliminary Evaluation
2. Technical Evaluation
3. Financial Evaluation
4. Due diligence

STAGE 1: HVAC INSTALLATIONS PRELIMINARY EVALUATION

This stage of evaluation shall involve examination of the mandatory requirements as set out in the bid document.

The mandatory requirements shall include the following:

Table 1: Mandatory Requirements

	PRELIMINARY EVALUATION OF MANDATORY REQUIREMENTS		
	Mandatory Requirements (YES/NO)		
No.	**Particulars**	**YES**	**NO**
1.	Copy of Certificate of Incorporation/Certificate of Registration		
2.	Copy of valid KRA Tax Compliance Certificate		
3.	Copy of CR12 issued within 12 months or copies of identification cards for Sole Proprietors/Partnerships. **(Must specify the shareholding)**		
4.	Must provide a copy of Valid business Trading License relevant to this tender		
5.	Must attach original receipt as proof of purchase of tender documents		
6.	Valid registration with National Construction Authority **(NCA 6 and above).**		
7.	Must attach dully filled, signed and stamped site visit form.		
8.	Must submit copies of 2 audited financial reports (2021 and 2022**)** certified by audit firm registered by the Institute of Certified Public Accountants (ICPAK). **(Attach audit firm registration certificate from ICPAK) (Where there is a provision for more than one Directors, two of them must sign.)**		
9.	**ENSURE** that all pages are sequentially paginated in the format1, 2, 3 …. Starting with 1 on top page ***(see details of pagination and binding on sub-section 2.14 of the tender document).***		

Note 1*: All the above documents numbered 1 to 9 should be packaged and arranged in that order under the preliminary evaluation criteria section of the tender document.*

Note 2*: Bidders who do not attach* ***ANY*** *of the* ***MANDATORY REQUIREMENTS*** *will be considered Non-responsive and will* ***NOT*** *be evaluated further.*

STAGE 2: HVAC INSTALLATIONS TECHNICAL EVALUATION

Detailed Technical Specifications/Description of requirements		Maximum Points
1.	**Key Personnel** Provide detailed company profile including CVs and Academic Certificates for; **(a)** At least 1-degree / diploma holder of key personnel in relevant field. • With over 10 years relevant experience……10 • With 5 to 10 years relevant experience……..5 • With under 5 years relevant experience……3 • No relevant certificate……..0 **(b)** At least 1 certificate holder of key personnel in relevant field. • With over 10 years relevant experience……8 • With 5 to 10 years relevant experience……..….4 • With under 5 years relevant experience……2 • No relevant certificate……..0 **(c)** At least 1 artisan (trade test certificate in relevant field) • Artisan with over 10 years relevant experience……...2 • Artisan with 1 to 10 years relevant experience……1 • No artisan with relevant experience……0	**20 Marks**
2.	Provide at least 5 award letters/PO for works of similar magnitude and complexity completed in the last five (5) years, i.e. from 2019 to date. **4 marks each**.	**20 Marks**
3.	Recommendation letters from clients for similar works within 5 years; • With above 5 recommendation letters…….5 marks • With 3-5 recommendation letters……..2.5 marks • With 2 and below recommendation letters……..1 marks	**5 Marks**
4.	Annual volume of construction or renovation work (certified audited financial reports for 2021 to 2022); **i.** Average Annual Turn-over equal or greater than the cost of the project. **ii. (3 marks)** **iii.** Average Annual Turn-over above 50% but below 100% of the cost of the project - **(1.5 marks)** **iv.** Average Annual Turn-over below 50% of the cost of the project - **(1 marks)**	**3 Marks**
5.	**Litigation History** **•Duly Filled……..2** **•Not Filled……0**	**2 Marks**
	TOTAL	**50 Marks**

Any bidder who scores 70% (35/50) and above shall be considered for financial evaluation.

MEDICAL GASES INSTALLATIONS EVALUATION CRITERIA

Interested Bidders should note that only those who meet the criteria indicated below as a minimum supported by relevant documents at submission will be considered for further evaluation.

TENDER EVALUATION CRITERIA

After tender opening, the tenders will be evaluated in 4 stages, namely:

1. Preliminary Evaluation
2. Technical Evaluation
3. Financial Evaluation
4. Due diligence

STAGE 1: MEDICAL GASES INSTALLATIONS PRELIMINARY EVALUATION

This stage of evaluation shall involve examination of the mandatory requirements as set out in the bid document.

The mandatory requirements shall include the following:

Table 1: Mandatory Requirements

	PRELIMINARY EVALUATION OF MANDATORY REQUIREMENTS		
	Mandatory Requirements (YES/NO)		
No.	**Particulars**	**YES**	**NO**
1.	Copy of Certificate of Incorporation/Certificate of Registration		
2.	Copy of valid KRA Tax Compliance Certificate		
3.	Copy of CR12 issued within 12 months or copies of identification cards for Sole Proprietors/Partnerships. **(Must specify the shareholding)**		
4.	Must provide a copy of Valid business Trading License relevant to this tender		
5.	Must attach original receipt as proof of purchase of tender documents		
6.	Valid registration with National Construction Authority **(NCA 6 and above).**		
7.	Must attach dully filled, signed and stamped site visit form.		
8.	Must submit copies of 2 audited financial reports (2021 and 2022**)** certified by audit firm registered by the Institute of Certified Public Accountants (ICPAK). **(Attach audit firm registration certificate from ICPAK) (Where there is a provision for more than one Directors, two of them must sign.)**		
9.	**ENSURE** that all pages are sequentially paginated in the format1, 2, 3 …. Starting with 1 on top page ***(see details of pagination and binding on sub-section 2.14 of the tender document).***		

Note 1*: All the above documents numbered 1 to 9 should be packaged and arranged in that order under the preliminary evaluation criteria section of the tender document.*

Note 2*: Bidders who do not attach* ***ANY*** *of the* ***MANDATORY REQUIREMENTS*** *will be considered Non-responsive and will* ***NOT*** *be evaluated further.*

STAGE 2: MEDICAL GASES INSTALLATIONS TECHNICAL EVALUATION

	Detailed Technical Specifications/Description of requirements	Maximum Points
1.	**Key Personnel** Provide detailed company profile including CVs and Academic Certificates for; **(a)** At least 1-degree / diploma holder of key personnel in relevant field. • With over 10 years relevant experience……10 • With 5 to 10 years relevant experience……..5 • With under 5 years relevant experience……3 • No relevant certificate……..0 **(b)** At least 1 certificate holder of key personnel in relevant field. • With over 10 years relevant experience……8 • With 5 to 10 years relevant experience……..….4 • With under 5 years relevant experience……2 • No relevant certificate……..0 **(c)** At least 1 artisan (trade test certificate in relevant field) • Artisan with over 10 years relevant experience……...2 • Artisan with 1 to 10 years relevant experience……1 • No artisan with relevant experience…….0	**20 Marks**
2.	Provide at least 5 award letters/PO for works of similar magnitude and complexity completed in the last five (5) years, i.e. from 2019 to date. **4 marks each**.	**20 Marks**
3.	Recommendation letters from clients for similar works within 5 years; • With above 5 recommendation letters…….5 marks • With 3-5 recommendation letters……..2.5 marks • With 2 and below recommendation letters……..1 marks	**5 Marks**
4.	Annual volume of construction or renovation work (certified audited financial reports for 2021 to 2022); **i.** Average Annual Turn-over equal or greater than the cost of the project. **ii. (3 marks)** **iii.** Average Annual Turn-over above 50% but below 100% of the cost of the project - **(1.5 marks)** **iv.** Average Annual Turn-over below 50% of the cost of the project - **(1 marks)**	**3 Marks**
5.	**Litigation History** **•Duly Filled……..2** **•Not Filled……0**	**2 Marks**
	TOTAL	**50 Marks**

Any bidder who scores 70% (35/50) and above shall be considered for financial evaluation

SECTION IV: CONDITIONS OF CONTRACT

4.1. Examination of Tender Document

The Tenderer is required to check the numbers of the pages of this document and should he find any missing or indistinct, he must inform the Services Consulting Engineer at once and have the same rectified.

All tenderers shall be deemed to have carefully examined the following: -

a) Work detailed in the Specification and in the Contract Drawings.
b) The "General Conditions of Main Works".
c) Other documents to which reference is made.

The Tenderer shall also be deemed to have included for any expenditure which may be incurred in conforming with the above items (a), (b) and (c) and observe this expense as being attached to the Contract placed for the whole or any part of the work.

The tenderer shall ensure that all ambiguities, doubts or obscure points of detail are clarified with the Project Manager before submission of his tender, as no claims for alleged deficiencies in the information given shall be considered after this date.

4.2. Discrepancies

The Contractor shall include all work either shown on the Contract Drawings or detailed in the Specification. No claim nor extra cost shall be considered for work which has been shown on the drawings or in the specification alone.

Should the drawing and the specification appear to conflict, the Contractor shall query the points at the time of tendering and be satisfied that all work intended is included as no claim for extra payment on this account shall be considered after the Contract is awarded.

4.3. Statement of Compliance

At the commencement of the works, the Contractor shall investigate and report to the Project Manager if all materials and equipment to be used in the work and not specified as supply by others are available locally. If these materials and equipment are not available locally, the Contractor shall at this stage place orders for the materials in question and copy the orders to the Project Manager. Failure to do so shall in no way relieve the Contractor from supplying the specified materials and equipment in time.

Materials supplied by others for installation and/or connection by the Contractor shall be carefully examined in the presence of the supplier before installation and connection. Any defects noted shall be reported to the Engineer.

The Contractor shall be responsible for verifying all dimensions relative to his work by actual measurements taken on the site.

The Contractor shall mark accurately on one set of drawings and indicate all alterations and/or modifications carried out to the designed systems during the construction period. This information must be made available on site for inspection by the Engineer.

4.4. Conditions of Contract Agreement

The subcontractors shall be domestic. The MC shall be required to enter into domestic agreements with the sub-contractors.

The Conditions of the Contract between the Main Contractor and the Client as hereinafter defined shall the current Conditions of Contract for Construction for Building and Engineering Works Designed by the Employer (Second Edition 2017) published by International Federation of Consulting Engineers (FIDIC) or as may have been reprinted thereafter. For the purpose of this Contract, the Agreement and Schedule of Conditions and any such modifications and amendments shall be read and construed together. In the event of discrepancy, the modifications and amendments shall prevail.

4.5. Definition of Terms

Throughout these Contract Documents units of measurements and terms are abbreviated, and wherever used hereinafter and in all other documents they shall be interpreted as follows:- Employer/Purchaser: - The term "Employer shall mean The Nairobi Hospital, P.O. Box 30026 – 00100, Nairobi.

Main Contractor: - The term "Contractor" shall mean the person or persons, firms or company whose tender for this work has been accepted, and who has entered into a contract agreement with the Client for the execution of the Contract Works and shall include his or their heirs, executors, administrators, assigns, successors, and duly appointed representatives.

Sub-Contractor: - The term "Sub-Contractor" shall mean the person or persons, firms or company who's tender for this work has been accepted, and who has entered into a contract agreement with the Main Contractor for the execution of the Contract Works and shall include his or their heirs, executors,

Administrators, assigns, successors, and duly appointed representatives.

Project Manager: - The term "Project Manager" shall mean PSRM Consultants, P. O. Box 60824- 00200, Nairobi.

Architect: - The term "Architect" shall mean Mutiso Menezes International, P. O. Box 44934 –00100, Nairobi.

Quantity Surveyor: - The term "Quantity Surveyor" shall mean Linear Projects Ltd., P. O. Box 106188– 00100, Nairobi.

Civil/Structural Engineers: - The term "Civil/Structural Engineers" shall mean Nat Consult Engineers, P.O. Box 3975 – 00506, Nairobi.

Mechanical, Electrical and Electronic Engineers: - The term "Electrical & Mechanical Engineers" shall mean Geomax Consulting Engineers Ltd., P. O. Box 53748 – 00200, Nairobi.

Working Drawings: - The term "Working Drawings" shall mean those drawings required to be prepared by the Sub- Contractor as hereinafter described.

Record Drawings: - The term "Record Drawings" shall mean those drawings required to be prepared by the Sub- Contractor showing "as installed" and other records for the Sub-Contract Works.

Abbreviations:

Cm: Shall mean cubic meters Sm: Shall mean square meters

Lm: Shall mean linear meters Mm: Shall mean millimetres No: Shall mean number

Kg: Shall mean kilograms

BS: Shall mean the current standard British Standard Specification published by the British Standard Institution, 2 Part Street, London W1, England.

4.6. Site Location

The site of the proposed Sub-Contract works shall be at The Nairobi Hospital, along Argwings Kodhek Road.

The tenderer is recommended to visit the site and shall be deemed to have satisfied himself with regard to access, possible conditions, and the risk of injury or damage to property on or adjacent to the site and the conditions under which the Contract Works shall have to be carried out.

A climatic study of the site shall be undertaken by the Contractor. Unless otherwise stated, all ratings of plant, equipment and apparatus shall be interpreted as site ratings and not sea level or other ratings.

4.7. Duration of the Contract

Possession of the site will be given immediately upon the issue of letter accepting the tender unless otherwise stated. The works are to commence forthwith and the time of completion is to be calculated from the date of commencement. The tenderer in submitting his tender shall be deemed to have included for commencing any necessary works on site immediately.

The Contractor shall be required to phase his work. The programme is to be agreed with the project Architect /Engineer.

4.8. Scope of Contract Works

The project comprises of proposed maternity room improvements at the Nairobi hospital.

The Contractor shall supply, deliver, unload, hoist, fix, test, commission and hand over in satisfactory working order the complete installation detailed in the specification and accompanying Drawings, including all items of plant and equipment under other contracts. The Sub-Contractor shall supply all accessories, whether described in this Specification or not essential to the completion of the work to the satisfaction of the Engineer and in accordance with all local and Government Regulations.

The Contractor shall be responsible for receiving of items or equipment supplied by other Contractors but to be fixed and commissioned under this Contract.

The Client may choose to supply some of the imported materials specified in the Contract. Nevertheless, the Tenderer is required to quote for the supply and installation of all materials specified.

4.9. Extent of the Sub-Contractor's Duties

At the commencement of the works, the Contractor shall investigate and report to the Project Manager if all materials and equipment to be used in the work and not specified as supply by others are available locally. If these materials and equipment are not available locally, the Contractor shall at this stage place orders for the materials in question and copy the orders to the Engineer. Failure to do so shall in no way relieve the Contractor from supplying the specified materials and equipment in time.

Materials supplied by others for installation and/or connection by the Contractor shall be carefully examined in the presence of the supplier before installation and connection. Any defects noted shall be reported to the Engineer.

The Contractor shall be responsible for verifying all dimensions relative to his work by actual measurements taken on the site.

The Contractor shall mark accurately on one set of drawings and indicate all alterations and/or modifications carried out to the designed systems during the construction period. This information must be made available on site for inspection by the Project Manager.

4.10. Execution of the Works

The works shall be carried out strictly in accordance with all the relevant statutory instruments and regulations which include the following: -

a) All relevant British Standards Specification and Codes of Practice (hereinafter referred to as B.S. and C.P. respectively), I.E.T. Regulations, Electric Power Act and By-Laws of KP& L Co. Ltd.
b) IEC & ISO Standards.
c) By-laws of the Local Authority.
d) The Building Code.
e) Regulations under the Factories Act.
f) The I.E.E. Regulations for Electrical Installations.
g) Any special requirements of the Local Electricity, Water undertakings and Fire Authority.
h) The Architect's and/or Engineer's Instructions.
i) This Specification and Sub-Contract Drawings.

The Contract Drawings and Specifications shall be read and construed together.

4.11. Validity of Tender

The tender shall remain valid for acceptance within 120 days from the final date of submission of the tender, and this has to be confirmed by signing the Tender Bond. The Tenderer shall be exempted from this Bond if the tender was previously withdrawn in writing to the Employer before the official tender opening.

4.12. Firm Price Contract

Unless specifically stated in the documents or the invitation to tender, this is a firm-price Contract must allow in his tender for any increase in the cost of labour and/or material, or currency fluctuations during the duration of the Contract.

No claims will be allowed for day-to-day currency fluctuations. The Sub- Contractor will be deemed to have allowed in his tender for any increase in the cost of materials which may arise as a result of currency fluctuation during the Sub-Contract period.

4.13. Variations

No alteration to the Contract Works shall be carried out until receipt by the Contractor of written instructions from the Engineer/Architect/PM.

Any variation from the Contract price in respect of any extra work, alterations or omissions requested or sanctioned by the Architect or Engineer shall be agreed and confirmed in writing at the time such variations are decided and shall not affect the validity of the Contract. Unit Rates shall be used to assess the value of such variations. No allowance shall be made for loss of profit on omitted works.

4.14. Bond

All tenderers will submit the name of an approved Surety who will be willing to be bound to the Employer in an amount equal to 10% of the Contract amount.

4.15. Government Legislation and Regulations

The Contractor must acquaint himself with current legislation and any Government Regulations regarding the movement, housing, security and control of labour, labour camps, passes for transport, etc. The Contractor shall allow for providing holidays and transport for work people, and for complying with Legislation Regulations and Union Agreements.

The Contractor will be required to pay full Import Duty and other Government Taxes on all items of equipment, fittings and plant whether imported or locally manufactured items as required whether imported directly for this Contract or not. The tenderer shall therefore make full allowance in his tender for all such duty and tax. No advance payment will be made to the Contractor by the Employer for the purpose of opening a Letter of Credit for the items to be imported or purchased locally. The Contractor will therefore be expected to make his own arrangements for the opening of letters of credit and payment of taxes.

4.16. Import Duty and Value Added Taxes

The Contractor shall be required to pay full Import Duty and Value Added Tax on all items of equipment, fittings and plant whether imported or locally manufactured items as required whether imported directly for this Contract or not. The tenderer shall therefore make full allowance in his tender for all such Duty and Tax. No advance payment will be made to the Contractor by the Client for the purpose of opening a letter of Credit for the items to be imported or purchased locally. The Contractor will therefore be expected to make his own arrangements for the opening of Letters of Credit and payments of taxes.

4.17. Insurance Company Fees

The attention is drawn to the Tenderers to allow for all necessary fees, where known, that may be payable in respect of fees imposed by Insurance Companies or statutory authorities for testing or inspection. No allowance shall be made to the Contractor with respect to fees should these have been omitted by the Tenderer due to his negligence in this respect.

4.18. Storage of Materials on Site

The Contractor shall submit the names of any approved suppliers for the materials to be incorporated to the PM for approval. The information regarding the names of the suppliers may be submitted at different times, as may be convenient, but no sources of supply will be changed without prior approval.

Each supplier must be willing to admit the Engineer or his representative to this premises during working hours for the purpose of examining or obtaining samples of the materials in question.

4.19. Samples and Materials Generally

Contractor shall, when required, provide for approval at no extra cost, samples of all materials to be incorporated in the works. Such samples when approved shall be retained by the Engineer and shall form the standard for all such materials incorporated.

No materials of any description shall be used or delivered to site without prior sanction by the Engineer, and any condemned materials as unit for use in the works, must be removed immediately from the site without any recompense to the Contractor.

All materials for the permanent works shall be new and shall, where no other specification is given, be of first-class quality and suitable for the purpose intended.

Where trade names or manufacturer's catalogue numbers are mentioned, the reference is intended as a guide to the type or article or quality of material required. The Contractor may use any article or material equal in type or quality to those described, subject to prior approval by the Engineer. The Sub- Contractor shall be responsible for proving equivalence in quality.

4.20. Administrative Procedure and Contractual Responsibility

Wherever within the Specification it is mentioned or implied that the Contractor shall deal with the employer or Engineer it shall mean "through the Contractor" who is responsible to the Employer for the whole of the works including Contract Works.

4.21. Bills of Quantities

The Bills of Quantities have been prepared in accordance with the Standard Method of Measurement of Building Works for East Africa, First Edition, Metric 1970. All the Quantities are based on the tender drawings and are provisional and they shall not be held to gauge or to limit the amount or description of the work to be executed by the Contractor but the value thereof shall be deducted from the Contract sum and the value of the work ordered by the Engineer in accordance with the conditions of the Contract.

All work liable to adjustment under this Contract shall be left uncovered for a reasonable time to allow measurements needed for such adjustment to be taken by the Quantity Surveyor. Immediately the work is ready for measuring the Contractor shall

give notice to the Quantity Surveyor to carry out the measurements before covering up. If the Contractor shall make default in these respects he shall, if the Architect so directs, uncover the work to enable the necessary measurements to be taken and afterwards reinstate at his own expense.

4.22. Sub-Contractor's Office in Kenya

The Contractor shall maintain (after first establishing if necessary) in Kenya an office staffed with a competent Engineer Manager and such supporting technical and clerical staff as are necessary to control and co- ordinate the execution and completion of the Contract Works.

The Project Manager and his staff shall be empowered by the Contractor to represent him at meetings and in discussions with the Contractor, the Engineer and other parties who may be concerned and any liaison with the Contractor's Head Office on matters relating to the design, execution and completion of the Contract Works shall be effected through his office in Kenya.

It shall be the Contractor's responsibility to procure work permits, entry permits, licenses, registration, etc. in respect of all expatriate staff. The Contractor shall prepare a substantial proportion of his Working Drawings and Record Drawings at his office in Kenya. No reasons for delays in the preparation or submission for approval or otherwise of such drawings or proposals will be accepted on the grounds that the Contractor's Head Office is remote from his office in Nairobi or the site of the Contract works or otherwise.

4.23. Structural Provision for the Works

Preliminary major structural provision has been made for the Sub-Contract works based on outline information ascertained during the preparation of the specification.

The preliminary major structural provision made will be deemed as adequate unless the Contractor stated otherwise when submitting his tender.

Any minor structural provision or alteration to major structural provisions required by the Contractor shall be shown on working drawings to be submitted to the Engineer within 30 days of being appointed.

No requests for alterations to preliminary major structural provision will be approved except where they considered unavoidable by the Engineer. In no case will they be

approved if building work is so far advanced as to cause additional costs or delays in the work of the Contractor.

4.24. Provision of Services, Plant, Equipment, Fitting and Apparatus

The Contract Drawings give a general indication of the intended layout. The position of the equipment and appliances, and also the exact routes of the ducts, mains and distribution pipework shall be confirmed before installation is commenced. The exact sitting of appliances, pipework etc., may vary from that indicated.

The routes of services and positions of apparatus shall be determined by approved dimensions details on Working Drawings or on site by the Engineer in consultation with the Contractor or the Contractors.

Services through the ducts shall be arranged to allow maximum access along the ducts and services shall be readily accessible for maintenance. Any work which has to be re-done due to negligence in this respect shall be the Sub- Contractor's responsibility.

The Contractor shall be deemed to have allowed in his Contract sum for locating terminal points of services (e.g. lighting, switches, socket outlets, lighting points, control switches, thermostats and other initiating devices, taps, stop cocks) in positions plus or minus 1.2m horizontally and vertically from the locations shown on Contract Drawings. Within these limits no variations in the contract sum will be made unless this work has already been executed in accordance with previously approved working drawings and with the approval of the Engineer.

4.25. Checking of Work

The Contractor shall satisfy himself as to the correctness of the connections he makes to all items of equipment supplied under the contract agreement and equipment supplied under other contracts before it is put into operation.

Details of operation, working pressures, temperatures, voltages, phases, power rating, etc. shall be confirmed to others and confirmation received before the system is first operated.

4.26. Setting to Work and Regulating System

The Contractor shall carry out such tests of the Contract Works as are required by British Standard Specifications, or equal and approved codes as specified hereinafter and are customary.

No testing or commissioning shall be undertaken except in the presence of and to the satisfaction of the Engineer unless otherwise stated by him (Contractor's own preliminary and proving tests accepted).

It will be deemed that the Contractor has included in the tender sum for the costs of all fuel, power, water and the like, for testing and commissioning as required as part of the Contract Works. He shall submit for approval to the Engineer a suitable programme for testing and commissioning. The Engineer and the Employer shall be given ample warning in writing, as to the dates on which testing and commissioning will take place.

The Contractor shall commission the contract works and provide attendance during the commissioning of all services, plant and apparatus connected under the Contract Agreement or other sub-contract agreements related to the project.

4.27. Working Drawings

The Contractor shall prepare such working drawings as may be necessary. The working drawings shall be complete in such detail not only that the Contract Works can be executed on site but also that the Engineer can approve the Contractor's proposals, detailed designs and intentions in the execution of the Contract Works.

If the Contractor requires any further instructions, details, contract drawings or information drawings to enable him to prepare his working drawings or proposals, the Contractor shall supply in writing to the Engineer for information at a time which is neither unreasonably distant from nor unreasonably close to the date when it is needed.

All working drawings shall be submitted to the Engineer for approval. If not so submitted the contract shall accept at his own cost, risk that any work commenced or which he intends to commence at site may be rejected.

The Engineer in giving his approval to the working drawings, will pressure that any necessary action has been, or shall be taken by the Contractors whose installations and works might be affected.

If the Contractor submits his working drawings to the Engineer without first liaising and obtaining clearance for his installations from the Contractor and the other Contractors whose installations and works might be affected, then he shall be liable to

pay for any alteration or modification to his own, the Contractor's installation and works, which are incurred, notwithstanding any technical or other approval which the Contractor's working drawings may have been received from the Engineer.

Working drawings to be prepared by Contractor shall include but not restricted to the following: -

a) Any drawings required by the Contractor, or the Engineer to enable structural provision to be made including Builder's Work Drawings or Schedules and those for the detailing of holes, chases, fixing, foundations cables and pipework ducting whether below or above ground or in or outside or below buildings.
b) General arrangement drawings of all plant, control boards, fittings and apparatus or any part thereof and of installation layout arrangement of such plant and apparatus.
c) Schematic layout drawings of services and of control equipment.
d) Layout drawings of all embedded and non-embedded electrical conduit.
e) Complete circuit drawings of the equipment, together with associated circuit descriptions.
f) Such other drawings as are called for in the text of the specification or schedules or as the Engineer may reasonably require.

Approved working drawings shall not be departed from except as may be approved or directed by the Engineer.

Approval by the Engineer of working drawings shall neither relieve the Contractor of any of his obligations under the Contract Agreement nor relieve him from correcting any errors found subsequently in the approved working drawings or other working drawings and in the contract works on site or elsewhere associated therewith.

The Contractor shall ensure that his working drawings are submitted to the Engineer for approval at a time not unreasonably close to the date when such approval is required. Late submission of his working drawings will not relieve the Contractor of his obligations to complete the Contractor Works within the agreed contract period and in a manner that would receive the approval of the Engineer.

4.28. Disclosure of Contract and Publications

The Contractor shall treat the details of the Contract as private and confidential, save in so far as may be necessary for the purposes thereof, and shall not publish or disclose the same or any particulars thereof the previous consent in writing of the Employer or the Consultants. If any dispute arises as to the necessity of any publication or disclosure for the purposes of the contract the same shall be referred to the decision of the Employer whose award shall be final.

4.29. Payment

Payments shall be made through certificates to the Main Contractor unless he specifically forgoes this right, in which case direct payments shall be made to the Sub-Contractor. All payments shall be less retention as specified in the Main Contract Agreement. No payments will become due until materials are delivered on the site.

4.30. Final Account

On completion of the works the Contractor shall agree with the Engineer the value of any variations outstanding as soon as possible thereafter to submit to the Engineer his final statement of account showing the total sum claimed sub-divided as follows:-

Statement A: Detailing the tender amounts less the Prime Cost and Provisional Sums, included therein.

Statement B: Detailing all the variation orders issued on the contract.

Statement C: Summarizing statement A and B and giving the net grand total due to the Sub- Contract.

4.31. Fair Wages

The Contractor shall comply in all respects with Clause 7, 'fair wages' contained in the Ministry of Public Works Contract Agreement (1970 edition).

4.32. Supervision

During the progress of the works, the Contractor shall provide and keep constantly available for consultant on site an experienced English-speaking Supervisor and shall provide reasonable office facilities, attendance, etc., for the supervisor.

In addition, during the whole of the time the works are under construction, the Contractor shall maintain on site one experienced foreman or charge- hand and an adequate number of fitters, etc., for the work covered by the specification. The number

of this staff shall not be reduced without the prior written approval of the Architect/Engineer.

a) Working drawings amended as necessary but titled "record drawings" and certified as a true record of the "as installed" Contract Works. Subject to the approval of the Engineer such working drawings as may be inappropriate may be omitted.
b) Fully dimensioned drawings of all plant and apparatus.
c) General arrangement drawings of equipment, other areas containing plant forming part of the Contract works and the like, indicating the accurate site of location of plant and apparatus suitably cross- referenced to the drawings mentioned in (b) above and hereinafter.
d) Route, types, sites and arrangement of all conduit and ductwork including date of installation of underground ducts.
e) Relay adjustment charts and manuals.
f) Routes, types, sites and arrangement of all electric cables, conduits, ducts and wiring including the date of installation of buried work.
g) System schematic and trunking diagrams showing all salient information relating to control and instrumentation.
h) Schematic diagrams of individual plant, apparatus and switch and control boards. These diagrams to include those peculiar to individual plant or apparatus and also those applicable to system and also those applicable to system operation as a whole.
i) Operating Instructions
j) Schematic and wiring diagrams shall not be manufacturer's multi- purpose general issue drawings, they shall be prepared specially for the Contractor Works and shall contain no spurious or irrelevant information.

Marked-up drawings of the installation of the Contract Works shall be kept up to date and completed by the date of practical or section completion. Two copies of the Record Drawings of the Contract Works and two sets of the relay adjustments and grading charts and schematic diagrams on stiff backing shall be provided not later than one month later.

The Contractor shall supply for fixing in sub-stations switch rooms, plant rooms, pump houses, the office of the Maintenance Engineer and other like places, suitable instructions charts, schematic diagrams of instrumentation and of the electrical reticulation as may be requested by the Engineer providing that the charts, diagrams, etc. relate to installations forming part of the sub- contract works. All such charts and diagrams shall be of suitable plastic material on a stiff backing and must be approved by the Engineer before final printing. Notwithstanding the Sub-Contractor's obligations referred to above, if the Contractor fails to produce, to the Engineer's approval, either: -

a) The marked-up drawings during the execution of the Contract Works.

b) The record drawings, etc. within one month of section or Practical Completion.

The Engineer shall have these drawings produced by others. The cost of obtaining the necessary information and preparing such drawings etc. will be recovered from the Contractor.

Any instructions given to the supervisor on site shall be deemed to have been given to the Contractor.

One copy of this specification and one copy of each of the Contract Drawings (latest issue) must be retained on site at all times, and available for reference by the Engineer or Sub- Contractor.

4.33. Labour Camps

The Contractor shall provide the necessary temporary workshop and mess room in positions to be approved by the Architect.

The people employed by the Contractor shall occupy only that part of the site necessary for the performance of the work and the Contractor shall instruct his employees accordingly.

If practicable, w.c. accommodation shall be allocated for the sole use of the Contractor's workmen and the Contractor will be required to keep the same clean and distended to make good any damage thereto and leave in good condition.

4.34. Storage of Materials

The Contractor shall be liable for the cost of materials but the Contractor will be responsible for the provision of any lock-up sheds or stores required.

4.35. Labour

The Contractor shall provide skilled and unskilled labour as may be necessary for the successful completion of the contract.

Nominated Sub-Contractors are to be made liable for the cost of any storage accommodation provided especially for their use. No materials shall be stored or stacked on suspended slabs with the prior approval of the Architect.

4.36. Water and Electricity for the Works

These will be made available by the Main Contractor. The Contractor shall be liable for the cost of any water or electric current used and for any installation provided especially for their own use.

4.37. Protection

The Contractor shall adequately cover up and protect his own work to prevent injury and also to cover up and protect from damage all parts of the building or premises where work is performed by him under the Contract.

4.38. Test Certificates

The Contractor shall provide the Engineer with three copies of all test reports or certificates that are or may be required by this specification.

4.39. Taxation

The Contractor and his staff shall be liable to pay all income and other taxes required by the Laws of the Republic of Kenya which may be in force during the currency of the Contract.

4.40. Corrupt Gifts, Bribes and Payment of Commission

If the Contractor or any of his staff, agents, servants offers to give or agrees to offer or give to any person any bribe, gift or commission as an inducement or reward for doing or fore bearing to do any action in relation to the Contract or any other Contract with employer, then the employer may enter upon the site and the works and terminate the employment of the Contractor; and the employer shall be entitled to recover from the Contractor the amount or value of any such gift, bribe, gratuity or commission.

4.41. Damages for Delay

Liquidated and Ascertained damages as stated in the Main Contract Agreement will be claimed against the Main Contract for any unauthorized delay in completion.

4.42. Testing and Inspection – Manufactured Plant

The Engineer reserves the right to inspect and test or witness of all manufactured plant, equipment and materials.

The rights of the Engineer relating to the inspection examination and testing of plant during manufacture shall be applicable to Insurance Companies and Inspection Authorities so nominated by the Engineer.

The Contractor shall give two weeks' notice to the Engineer of his intention to carry out any inspection or tests and the Engineer or his representative shall be entitled to witness such tests and inspections.

Six copies of all test certificates and performance curves shall be submitted as soon as possible after the completion of such tests, to the Engineer for his approval.

Plant of equipment which is shipped before the relevant test certificates has been approved by the Engineer shall be shipped at the Contractor's own risk and should the test certificate not be approved new tests may be ordered by the Engineer at the Contractor's expense. The foregoing provisions relate to tests as manufacturer's works and as appropriate to those carried out at site.

4.43. Testing and Inspection – Installation

Allow for testing each section of the Contract works installation as described hereinafter to the satisfaction of the Engineer.

4.44. Record Drawings (as installed) and Instructions

During the execution of the Contract Works the Contractor shall, in a manner approved by the Engineer record on working or other drawings of the installed Contract Works. Marked up working or other drawings and other documents shall be made available to the Engineer as he may require for inspection and checking.

Record Drawings may, subject to the approval of the Engineer, include approved working drawings adjusted as necessary and certified by the Contractor as a correct record of the installation of the Contract Works.

They shall include but not be restricted to the following drawings or information:-

4.45. Hand-Over

The Contract Works shall be considered complete and the maintenance and defects liability period shall commence only when the Contract Works and supporting

services have been tested, commissioned and operated to the satisfaction of the Engineer and officially approved and accepted by the Employer, provided always that the handing over of the Contract Works shall be coincident with the handing over of the Main Contract Works. The procedure to be followed will be as follows:-

a) On completion of the Contract Works to the satisfaction of the Engineer and the Employer, the Contractor shall request the Engineer to arrange for handing over.
b) The Engineer shall arrange a Hand over meeting or a series thereof, at site.
c) The Contractor shall arrange with the Engineer and the Employer for a complete demonstration of each and every service to be carried out for instruction to be representative of the employer.
d) In the presence of the Employer and the Engineer, handover will take place, subject to agreement of the Hand over Certificates and associated check lists.

The hand-over documents shall include Manufacturer's guarantee of equipment which shall
extend beyond the 6 months defects liability period.

4.46. Maintenance Manual

Upon practical completion of the Contract Works, the Contractor shall furnish to the Engineer with four copies of a Maintenance Manual relating to the installation forming part or of the Contract Works. The manual shall be loose-leaf type, International A4 size with stiff covers and cloth bound. It may be in several volumes and shall be sub-divided into sections, each section covering one Engineering Service system. It shall have a ready means of reference and a detailed index.

4.47. Guarantee

Contractor shall guarantee workmanship, equipment and materials installed under his contract for a period of not less than one (1) year from the date of substantial completion. Should any defects occur during this period, the Contractor shall promptly repair or replace the defective item and any other damage caused to the building free of charge to the owner, including cost of labour and materials.

This Clause shall not in any way invalidate any Manufacturer's guarantee on equipment which may extend for periods longer than the Engineer's certificate of completion.

The manuals are to be specially prepared for the sub-contract works and manufacturer's standard descriptive literature and plant operating instruction cards will not be accepted for inclusion unless exceptionally approved by the Engineer. The Contractor shall, affix such cards, if suitable, adjacent to plant and apparatus. One spare set of all such cards shall be furnished to the Engineer.

4.48. Clear Away on Completion

The Contractor shall, upon completion of the works at his own expense remove and clear away all plant, equipment, rubbish and unused materials, and shall leave the whole of the works in a clean and tidy state, to the satisfaction of the Engineer. On completion the whole of the works shall be delivered up clean, complete and perfect in every respect to the satisfaction of the Engineer.

4.49. Training

The tenderer shall allow for the training of three of the Client's technicians to a level where they are sufficiently confident and proficient in managing, trouble- shooting and maintenance of the installed systems and programming of the devices as necessary.

4.50. Initial Maintenance

The Contractor shall make routine maintenance inspection once a month during the Liability for the Defects Period and shall carry out all necessary adjustments and repairs, cleaning and oiling of moving parts. A monthly report or the inspection and any work done upon the installation shall be supplied to the Engineer.

The Contractor shall also provide a 24-hour breakdown service to attend to faults on or malfunctioning of the installation between the routine visits of inspection.

The Contractor shall allow in the Contract Sum for the initial maintenance, inspection and breakdown service and shall provide for all tools, instruments, plant and scaffolding and the transportation thereof, as required for the correct and full execution of these obligations and the provision, use or installation of all materials as oils, greases, sandpaper, etc. or parts which are faulty for any reason whatsoever expecting always Acts of God such as storm, tempest, flood, earthquake and civil revolt, acts of war and vandalism.

4.51. Maintenance and Servicing After Completion of the Initial Maintenance

The Contractor shall, if required, enter into a maintenance and service agreement with the Employer for the installation for a period of up to five years from the day following the last day of the liability for defects period which offers the same facilities as specified in Clause 1.56.

The Contractor shall submit with his tender for the works, a firm quotation for the maintenance and service of agreement for other similar installation.

The Contractor shall submit with his tender for the works, a firm quotation for the maintenance and service of the installation as specified herein, which shall be based upon present day costs and may be varied only to take into account increases in material and labour unit rate costs between the time of tendering and the signing of the formal maintenance and service agreement and which shall remain valid and open for acceptance by the employer up to and including the last day of the fifth complete calendar month following the end of the liability for Defects Period.

4.52. Defects after Completion

The defects liability period will be six months from the date of completion of the Main Contract as certified by the Engineer.

SECTION V: STANDARD FORMS

1. Form of Invitation for Tenders
2. Form of Tender
3. Form of Tender Security
4. Qualification Information
5. Tender Questionnaire
6. Confidential Business Questionnaire
7. Details of Sub-Contractors
8. Litigation History Declaration Form

1. FORM OF INVITATION FOR TENDERS

_____*[date]*

To: _____*[Name of Contractor]*
_____*[Address]*
_____

Dear Sirs:

*Reference:*_____*[Contract Name]*

You have been prequalified to tender for the above project.

We hereby invite you and other prequalified tenderers to submit a tender for the execution and completion of the above Contract.

A complete set of tender documents may be purchased by you from _____

_____
[m ailing address, cable/telex/facsimile numbers].

Upon payment of a non-refundable fee of Kshs_____

All tenders must be accompanied by_____number of copies of the same and

a security in the form and amount specified in the tendering documents, and must be delivered to

_____

[address and location] at or before_____*(time and date).* Tenders will be opened

Immediately thereafter, in the presence of tenderers' representatives who choose to attend.

Please confirm receipt of this letter immediately in writing by cable/facsimile or telex.

Yours faithfully,
_____Authorized Signature
_____*Name and Title*

2. FORM OF TENDER

THE NAIROBI HOSPITAL
P.O BOX 30026 - 00100,
NAIROBI KENYA

Dear Sir,

PROPOSED MATERNITY ROOMS IMPROVEMENT AT THE NAIROBI HOSPITAL

We the undersigned hereby are willing to enter a contract to perform fully (within the time stated below) the whole of the works in erecting, completing and maintain the works named above in accordance with the conditions if the Contract all the entire satisfaction of the Architect.

Tender sum.....

(Words)

Kshs.....

(Figures)

Time for completion ….....

(Weeks) (Attach program of works with cash flow projections).

Further we the undersigned, agree to complete the whole of the works as per the Completion Time, from the date of possession of the site as defined within the Conditions of Contract.

If our tender is accepted, we agree to enter into a Bond for due performance of the contract with the Guarantor described herein. The Guarantor shall be a licensed bank, such a guarantor shall be to the approval of the client.

Further, we agree that until a formal agreement is signed, the tender and your acceptance do not form a binding contract between us and that this tender is valid for ninety days from the date stated for delivery.

We have visited the site of the works and we have examined all the documents mentioned as forming part of this contract together with instruction tenders and we fully understand their requirements.

Our tender is complete and we have considered our entire obligation on matters necessary for total execution of this contract.

We understand that the lowest or any tender will not necessarily be accepted and that the clients shall not allow any claims we incur in preparing this tender.

TENDERER

Signature of Tenderer.....
(Company stamp).....
Name of Tenderer.....
Address of Tenderer.....
Telephone Number (office).....
Mobile.....
E-mail Address.....

WITNESSED BY:

Signature of Witness.....
Name of witness.....
Address of witness.....
Telephone Number.....

3. TENDER SECURITY

WHEREAS

……..
(Hereinafter called "the Tenderer") has submitted his tender dated…….
for the construction of ……
……... (Name of Contract)
KNOW ALL PEOPLE by these presents that WE …… having our registered office at …… (hereinafter called "the Bank"), are bound unto …….. (Hereinafter called "the Employer") in the sum of Kshs.…… for which payment well and truly to be made to the said Employer, the Bank binds itself, its successors and assigns by these presents sealed with the Common Seal of the said Bank this …… ……. Day of……. 20……

THE CONDITIONS of this obligation are:

If after tender opening the tenderer withdraws his tender during the period of tender validity specified in the instructions to tenderers Or

If the tenderer, having been notified of the acceptance of his tender by the Employer during the period of tender validity:

a) fails or refuses to execute the form of Agreement in accordance with the Instructions to Tenderers, if required; or
b) fails or refuses to furnish the Performance Security, in accordance with the Instructions to Tenderers.

We undertake to pay to the Employer up to the above amount upon receipt of his first written demand, without the Employer having to substantiate his demand, provided that in his demand the Employer will note that the amount claimed by him is due to him, owing to the occurrence of one or both of the two conditions, specifying the occurred condition or conditions.

This guarantee will remain in force up to and including thirty (30) days after the period of tender validity, and any demand in respect thereof should reach the Bank not later than the said date.

_____
_____
[Date] [Signature of the Bank]

_____
_____
[Witness] [Seal]

4. QUALIFICATION INFORMATION

Individual Tenderers or Individual Members of Joint Ventures

1.1. Constitution or legal status of tenderer (attach copy or Incorporation Certificate);

Place of registration: _____

Principal place of business _____

Power of attorney of signatory of tender _____

1.2. Total annual volume of construction work performed in the last five years Year

Year	**Volume**	
	Currency	**Value**

1.3. Work performed as Main Contractor on works of a similar nature and volume over the last five years. Also list details of work under way or committed, including expected completion date.

Project name	**Name of Client and Contact Person**	**Type of Work Performed and Year of Completion**	**Value of Contract**

1.4. Major items of Contractor's Equipment proposed for carrying out the Works. List all information requested below

Item of Equipment	**Description Make and Age (years)**	**Condition (new, good, poor) and number available**	**Owned, leased (from whom?), or to be purchased (from whom?)**

1.5. Qualifications and experience of key personnel proposed for administration and execution of the Contract. Attach biographical data.

Position	**Name**	**Years of Experience (general)**	**Years of Experience in proposed position**
Project Manager			

1.6. Financial reports for the last TWO years: balance sheets, profit and loss statements, auditor's reports, etc. List below and attach copies.

_____

_____

_____

1.7. Evidence of access to financial resources to meet the qualification requirements: cash in hand, lines of credit, etc. List below and attach copies of supportive documents.

_____

_____

_____

1.8. Name, address and telephone, telex and facsimile numbers of banks that may provide reference if contacted by the Employer.

_____

_____

_____

1.9. Statement of compliance with the requirements of Clause 1.2 of the Instructions to Tenderers.

_____

_____

_____

1.10. Proposed program (work method and schedule) for the whole of the Works.

5. TENDER QUESTIONNAIRE

Please fill in block letters.

a) Full names of tenderer ……....

b) Full address of tenderer to which tender correspondence is to be sent (unless an agent has been appointed below)

……

……

c) Telephone number (s) of tenderer

……

……

d) Email Address

……

……

e) Name of tenderer's representative to be contacted on matters of the tender during the tender period

……..

……..

f) Details of tenderer's nominated agent (if any) to receive tender notices. This is essential if the tenderer does not have his registered address in Kenya (name, address, telephone, telex)

……

……

_____

Signature of Tenderer

Make copy and deliver to:_____*(Name of Client)*

6. CONFIDENTIAL BUSINESS QUESTIONNAIRE

You are requested to give the particulars indicated in Part 1 and either Part 2 (a), 2 (b) or 2 (c) and 2 (d) whichever applies to your type of business.

You are advised that it is a serious offence to give false information on this Form.

Part 1 – General

Business Name ……

Location of business premises; Country/Town……

Plot No…… Street/Road ……

Postal Address…… Tel No……

Email Address……

Nature of Business……...

Current Valid Trade License No…… Expiring date……

Maximum value of business which you can handle at any time:

Kshs…….

Name of your bankers……..

Branch……

Part 2 (a) – Sole Proprietor

Your name in full…….....Age……

Nationality…… Country of Origin……

*Citizenship details ……

Part 2 (b) – Partnership

Give details of partners as follows:

Name in full	Nationality Citizenship	Details Shares
1……	……	……
2……	……	……
3……	……	……
4……	……	……

Part 2(c) – Registered Company:

Private or public…….

State the nominal and issued capital of the Company

Nominal Kshs……

Issued Kshs……

Give details of all directors as follows:

Name in full	Nationality Citizenship Details*	Shares.
1……	……	……
2……	……	……
3……	……	……
4……	……	……

Part 2(d) – Interest in the Firm:

Is there any person/persons in …… *(Name of Client*) who has interest in this firm? Yes/No…… (Delete as necessary)

I certify that the information given above is correct.

…… ……

(Title) (Signature) (Date)

Attach proof of citizenship

7. DETAILS OF SUB-CONTRACTORS

The Tenderer must give below details of the sub-contractors he intends to employ for each portion.

Failure to comply with this requirement may invalidate the tender.

(i) Portion of Works to be sublet……..

(ii) Full name of Sub-contractor and address of head office

……

……

Sub-contractor's experience of similar works carried out in the last 3 years with Contract

value……..……

……

Portion of Works to be sublet……....…

(i) Full name of Sub-contractor and address of head office ……

……

(ii) Sub-contractor's experience of similar works carried out in the last 3 years with Contract value……

……..

……

_____ _____

[Signature of Tenderer] Date

(Use this format for all domestic subcontractor proposed)

8. LITIGATION HISTORY DECLARATION FORM

Name of Applicant or partner of a joint venture

Applicants, including each of the partners of a joint venture, should provide information of any history of litigation or arbitration resulting from contracts executed in the last five years or currently under execution. A separate sheet should be used for each partner of a joint venture.

Year	Award FOR or AGAINST Applicant	Name of client, cause of litigation, and matter in dispute	Disputed amount (current value Kshs.)

Note: Litigation History Form should be stamped and signed by an advocate

APPENDIX

1) MAIN WORKS – TECHNICAL SPECIFICATIONS AND BOQ

2) SERVICES – TECHNICAL SPECIFICATIONS AND BOQ

3) DRAWINGS

BILL NO. 1 : PRELIMINARIES

Item	Description	Amount
	PRELIMINARIES:	
	PRELIMINARY PARTICULARS OF CONTRACT	
A	Parties to the Contract:	
	The 'Employer' is **THE NAIROBI HOSPITAL,** P.O. BOX 30026-00100, NAIROBI, KENYA.	
	The 'Project Manager' is **PSRM CONSULTANTS,** P.O BOX 60824-00200, NAIROBI, KENYA.	
	The 'Architect' is **MUTISO MENEZES INTERNATIONAL,** P.O BOX 44934-00100, NAIROBI, KENYA.	
	The 'Quantity Surveyor' is **LINEAR PROJECTS LTD,** P.O. BOX 106188-00101, NAIROBI, KENYA.	
	The 'Structural/Civil Engineer' is **NATCONSULT CONSULTING ENGINEERS LTD,** P.O BOX 3975 - 00506, NAIROBI, KENYA.	
	The 'Services Engineer' is **GEOMAX CONSULTING ENGINEERS,** P.O BOX 53748 - 00200, NAIROBI, KENYA.	
	The Consultants above, when performing their respective duties are deemed to be invested with such duties and representative of the Project Manager.	
	The 'Contractor' is the person or persons, partnership, firm or company whose tender for this work has been accepted, and who has or have signed this contract and shall include his or their heirs, executors, successors and duly appointed representatives.	
	Carried to Collection Kshs	

Item	Description	Amount
A	Location of site: The site is located along in Argwings Kodhek, Kilimani area Nairobi and can be accessed from Nairobi Hospital gate 1 or 2 or any other gate that the client may designate for purposes of carrying out these works	
B	Site Visit: The contractor shall visit the site to acquaint himself with the nature and position; nature of ground substrata and other supplies; access roads or any other limitations. If the contractor is unable to locate the site he can seek guidance and information from the Project Manager. No claims whatsoever for extras on account of lack of knowledge in this respect will be considered.	
C	Drawings: The drawings used in preparing these Bills of Quantities are as in Appendix 'A' at the end of these Bills of Quantities. Further drawings may be inspected at the office of the Project Manager or Quantity Surveyor by prior appointment.	
D	Scope of work: The scope of works : a) Demolitions - Wall, Finishes,Joinery, Window and Door demolitions b) New Scope - New walls, Partitions, Doors, Windows and Finishes	
	Carried to Collection Kshs	

Item	Description	Amount
	GENERAL DESCRIPTION OF THE WORKS	
A	Approximate areas	
	The approximate total area is:	
	Maternity Rooms 340 sm	
	Total Area 340 sm	
	The areas are given without warranty and for the tenderer's guidance only	
B	Construction programme of works:	
	The bidders shall provide a proposed programme of works together with their bid documents and the successful bidder will submit a detailed programme of works at the time of signing the contract.	
	Carried to Collection Kshs	

Item	Description	Amount
	CONTRACT PARTICULARS:	
A	Form of Contract:	
	The Contractor will be required to enter into a contract which will be the current Conditions of Contract for Construction for Building and Engineering Works Designed by the Employer (Second Edition 2017) published by International Federation of Consulting Engineers (FIDIC) or as may have been reprinted thereafter (With Quantities), except in so far as varied hereafter. The Form of Contract can be inspected at the offices of the Quantity Surveyors.	
B	The Contractor's attention is drawn to the following Clauses of the Conditions of Contract which shall be read as incorporated herein and shall allow any sums which he considers necessary for the carrying out and observance of such Conditions.	
C	Clause 1 General Provisions	
	The Defects Notification Period (DNP) IS 180 days.	
	The Time for completion shall mean the time agreed in weeks from the from Commencement Date	
	The Agreed methods of electronic transmission All communication shall be in writing and delivered by hand (against receipt), sent by mail or courier. In addition copies of all communication shall be sent by email from the originator to each of the recipients of the original communication using email addresses agreed between contractor, engineer and employer following contract signing. Such email copies shall be for the convenience of the parties only and the contractual version of any communication shall be the version in writing and the date and time of delivery shall be the date and time of the delivery of the version in writing.	
	The governing law shall be the laws of the Republic of Kenya with the ruling language and language for communications being English (UK)	
	Notwithstanding the foregoing, the employer reserves the right to remove any part of the work from the main contractor and have the same executed by a nominated contractor. The Main Contractor shall not be entitled to any claim for loss of profit but will be entitled to profit (2%) and attendance (2%)	
D	Clause 2 The Employer	
E	Clause 3 The Engineer	
	The term Engineer shall collectively mean the Project Manager and any other Professional Consultants engaged by the Employer for their respective roles.	
	All instructions with a cost implication or materially change the nature and scope of the works must be approved by the Employer prior to execution through a variation order. Full justification for such changes shall be provided by the Contractor and the respective Consultants.	
	Carried to Collection Kshs	

Item	Description	Amount
A	Clause 3 The Engineer cnt'd Replacement of the Engineer clause 3.6 Paragraph 3 is **Deleted** and replaced with "The Employer shall have the right to replace the Engineer at any time with or without the consent of the Contractor on the choice of the Engineer".	
B	Clause 4 The Contractor **Highlights to;** **Performance Bond / Security** The performance security will be in the form of an irrevocable and unconditional guarantee from a tier one or tier two Bank approved by the employer The performance security shall remain valid for 180 days from the commencement date and shall be extended should the completion time be extended beyond its validity period. Training to Employer's employees to be provided at the end of the contract and is deemed included within the Contractors tender price. Daily progress reports to be issued complete with progress photos at the Contractor's cost. Before the commencement of the construction, the Contractor shall avail a comprehensive site security plan to the Employer. The Employer, together with any other third party as authorized by the Employer, reserves rights to examine procedures, methods and facilities used by the Contractor to provide security.	
C	Clause 5 Subcontracting	
D	Clause 6 Staff and Labour Before the commencement of the construction, the Contractor shall avail a comprehensive health and safety plan to the Employer. The Employer, together with any other third party as authorized by the Employer, reserves rights to examine procedures, methods and facilities used by the Contractor to provide health and safety to personnel.	
E	Clause 7 Plant Materials and Workmanship	
F	Clause 8 Commencement, Delays and Suspension Extension of Time for Completion; the word 'epidemic' is **Deleted** Maximum amount of delay damages 10% of the Final Contract Price. The damages will automatically be chargeable from expiry of the contract period or extended time of the contract and will be recovered from any amounts due to the Contractor including retention and the performance security. Employer's Suspension **clause 8.9** the first paragraph is **Deleted** and replaced with: "The Employer may issue the Engineer with a notice of suspension instructing the Engineer to suspend the works." Consequences of Employer's Suspension **clause 8.10** the first paragraph is **Deleted**. Payment for Plant and Materials after Employer's Suspension **clause 8.11** is **Deleted**	
	Carried to Collection Kshs	

Item	Description	Amount
A	Clause 9 Tests on Completion	
B	Clause 10 Employer's Taking Over	
C	Clause 11 Defects After Taking Over	
D	Clause 12 Measurement and Valuation Standard Method of Measurements of Building and Associated Civil Works for Eastern Africa, Second Edition 2008, published by the Architectural Association of Kenya. Percentage profit **clause 12.3** shall be a maximum of 15%	
E	Clause 13 Variations and Adjustments Percentage rate to be applied to provisional sums for Overhead charges and profit **clause 13.4(b)** is **Deleted**	
F	Clause 14 Contract Price and Payment Total amount of advance payment (as a percentage of accepted contract amount) **clause 14.2** 18% shall be the maximum percentage of accepted contract sum payable as an advance payment and shall be payable in the currencies and proportions in which the accepted contract amount is payable upon presentation of an irrevocable and unconditional performance guarantee from a bank approved by the employer and presentation of an irrevocable and unconditional advance payment guarantee from a bank approved by the employer. Currency or currencies of advance payment **clause 14.2** shall be Kenya Shillings (Kshs) Repayment of the Advance Payment **clause 14.2.3** The Advance Payment Guarantee shall be provided at the cost of the contractor from a Tier (1) or Tier (2) bank and will be equivalent to the advance payment in value. Period of payment **clause 14.3** When payments are 10% of the accepted contract amount less provisional sums. Number of additional paper copies of statements **clause 14.3(b)** shall be 6no. Percentage of retention **clause 14.3(iii)** shall be 10% of each Interim certificate Limit of retention money (as a percentage of accepted contract amount) **clause 14.3(iii)** shall be 10% of the Accepted Contract Price or Provisional Final Account Whichever is higher. Plant and materials for payment when shipped **clause 14.5 (b) (i)** is N/A	
	Carried to Collection Kshs	

Item	Description	Amount
A	Clause 14 Contract Price and Payment cnt'd	
	Plant and materials for payment **clause 14.5 (c)** (i) All permanent materials shall be payable as materials on site as at when they are delivered on site and upon confirmation on their suitability by the Engineer.	
	Period for payment of advance payment to the Contractor **clause 14.7(a)** shall be 14 days	
	Period for the employer to make interim payments to the Contractor [Interim Certificate] **clause 14.7(b)(i)** shall be 21 days	
	Period for the employer to make interim payments to the Contractor [Final Certificate] **clause 14.7(b)(ii)** shall be 28 days	
	Period for the employer to make final payment to the Contractor **clause 14.7(c)** shall be 28 days	
	Financing charges for delayed payment **clause 14.8** Central Bank of Kenya base lending rate plus 3 percentage points.	
	Number of additional paper copies of draft final statement **clause 14.11.1(b)** shall 6 No	
	Currencies for payment of contract price **clause 14.15** shall be Kenya Shillings (Kshs.)	
	Proportions or amounts of local and foreign currencies **clause 14.15(a)(i)** is N/A	
	Rates of exchange **clause 14.15(f)** is N/A	
G	Clause 15 Termination by Employer	
	Notice to Correct **clause 15.1** The Engineer shall consult with the Employer before issuing Notice to Correct to the Contractor.	
	Termination for Contractor's Default **clause 15.2.2** the days of receiving the Notice have been reduced from 14 days to 7 days	
H	Clause 16 Suspension and Termination By Contractor	
J	Clause 17 Care of the Works and Indemnities	
	Forces of nature, the risks of which are allocated to the Contractor clause **17.2(d)** Supply chain risks, availability of labour and weather	
K	Clause 18 Exceptional Events	
	Carried to Collection Kshs	

Item	Description	Amount
A	Clause 19 Insurance Permitted deductible limits: **clause 19.1** is 100% of the total contract sum Contractors All risk: • Insurance required for the works-Insurance required for goods- • Insurance required for liability for breach of professional duty • Insurance required against liability for fitness for purpose(if any is required) • Insurance required for injury to employees **clause 19.1** Kenya Shillings Five Million (Kshs. 5,000,000.00) per occurrence with unlimited occurrences. • Minimum amount for insurance of the employers risks **clause 19.1** Kenya Shillings Five (Kshs. 5,000,000.00) per occurrence with unlimited occurrences.	
B	Clause 20 Employer's and Construction's Claims	
C	Clause 21 Disputes and Arbitration Time for appointment of dispute avoidance/adjudication board (DAAB) **clause 21.1** An Ad hoc board to be constituted as when required within 5no. Days after notice by either party The DAAB shall comprise **clause 21.1** one member List of proposed members of DAAB **clause 21.1** -proposed by employer -proposed by contractor Both Parties to agree on the list of possible members to be appointed to DAAB at the time of signing the contract. Appointing entity (official) for DAAB members **clause 21.2** shall be : 1. Chartered Institute of Arbitrators 2. Architectural Association of Kenya 3. Institute of Quantity Surveyors of Kenya 4. Institution of Engineers of Kenya 5. Association of Consulting Engineers of Kenya The appointed members of the DAAB or Arbitrator as the case may be shall meet the following qualifications and experience: - Registered Consulting Engineer of 15+ years of experience Registered Architect of 15+ years of experience Registered Quantity Surveyor of 15+ years of experience On the request of the applying party. The entity written to first by the aggrieved party shall take precedence over all other institutions and no further reference shall be made to the other entities by either party including for any subsequent disputes on this contract. Clause 21.6 Delete "The rules of the International Chamber of Commerce and replace with "The current rules of The Chattered Institute of Arbitrators Kenya Branch".	
	Carried to Collection Kshs	

Item	Description	Amount
	GENERAL MATTERS OF CONTRACT	
A	Sufficiency of Tender The Contractor shall be deemed to have satisfied himself before tendering as to the correctness and sufficiency of this tender for the works and of the rates and prices stated in the Priced Bills of Quantities, which rates and prices shall cover all his obligations under the Contract and all matters that are necessary for the proper completion and maintenance of the works.	
B	Stamp Charges and Registration of the Contract. The Contractor shall allow for the payment of all stamp charges and registration in connection with the Contract Agreement. The contractor will also be responsible for registration of project with the National Construction Authority (NCA) which must happen within the 7 days from signing of the contract.	
C	Definitions and Abbreviations The terms used in the Bills of Quantities shall be interpreted as follows: “Approved” shall mean approved by the Project Manager and the Employer in writing. “As directed” shall mean as directed by the Project Manager and the Employer in writing. “B.S.” shall mean the current British Standard Specification published by the British Standards Institution, 2 Park street, London, W.I., England. "K.S" shall mean the current Kenya Standard specification published by the Kenya Bureau of Standards, P.O. Box 54974, NAIROBI, Kenya. “C.M.” Shall mean Cubic Metre. “S.M” Shall mean Square Metre. “L.M.” Shall mean Linear Metre. “mm” Shall mean Millimetre. “No.” Shall mean Number. “Kg.” Shall mean Kilogramme. “DO” or Ditto” shall mean the whole of the preceding description except as qualified in the description in which it occurs. “As described” shall mean as described previously in a foregoing Bill or Trade Preambles of in the Ministry of Public Works, General specification for Building Works 1976 Edition or any subsequent revision thereof.	
	Carried to Collection Kshs	

Item	Description	Amount
A	Progress Schedule The Contractor shall upon receiving instructions to proceed with the work, draw up a time and progress schedule setting out the order in which the works are to be carried out and stating the appropriate dates. This Time and Progress Schedule is to be agreed with the Project Manager and the Employer, and no deviation from the order set out in this schedule will be permitted without the written consent of the Project Manager and the Employer. The Main Contractor will be responsible for agreeing the above programme with all sub-Contractors including the Nominated Sub-Contractors and Nominated Suppliers.	
B	Figured Dimensions: Figured dimensions are to be followed in preference to dimensions scaled from the drawings, but whenever possible dimensions are to be taken on the site or from the buildings. Before any work is commenced by sub-contractors or specialist firms, dimensions must be checked on the site and/or building and agreed with the Contractor, irrespective of the comparable dimensions shown on the drawings. The contractor shall be responsible for the accuracy of such dimensions.	
C	Provisional Work: All "provisional" and other work liable to adjust under this Contract shall be left uncovered for a reasonable time to allow all measurements needed for such adjustment to be taken by the Quantity Surveyor. Immediately the work is ready for measurement the contractor shall give notice to the Quantity Surveyor. If the Contractor makes default in these respects, he shall, if the Project Manager so directs, uncover the work at his own expense to enable measurements to be taken.	
	Carried to Collection Kshs	

Item	Description	Amount
A	Existing Services Prior to commencement of any work the contractor is to ascertain from the relevant authorities the exact position, depth and level of existing electric cables, water pipes or other services in the area and he shall make whatever provisions may be required by the authorities concerned for the support and protection of such services. Any damage or disturbance caused to any service shall be reported immediately to the Project Manager and the relevant authority and shall be made good to their satisfaction at the Contractor's expense.	
B	Transport to and from the site The Contractor shall include in his prices for the transport of materials, workmen, etc. to and from the site of the proposed works, at such hours and by such routes as are permitted by the authorities.	
C	Labour camps No labour camps will be allowed on site. The Contractor may however liaise with adjacent property owners and locate his camp within good distance from the site.	
D	Public and Private Roads, Pavements, etc. The Contractor will be required to make good, at his own expense, any damage he may cause to the present road surfaces and pavements during the period of the works. In particular, all existing lawns, gardens, paths, storm water channels, hedges, fences, etc., which may be destroyed or damaged during the progress of the works are to be made good by the Contractor to the satisfaction & approval of the Project Manager.	
E	Government Acts regarding Workplace, etc. Allow for complying with all Government Acts, Orders and Regulations in connection with the Employment of labour and other matters related to the execution of the works. In particular the Contractor's attention is drawn to the provision of the Factory Act 1950 and his tender must include for all costs arising or resulting from compliance with any Act, Order or Regulation relating to insurance, pension and Holidays for workplace or to the safety, health or welfare of work people. The Contractor must make himself fully acquainted with current Acts and Regulations, including police regulations regarding the movement, housing, security and control of labour, labour camps, passes for transport, etc. It is important that the contractor, before tendering, shall obtain from the relevant authority the fullest information regarding all such regulations and/or restrictions which may affect the organization of the works, supply and control of labour, etc. and allow accordingly in his tender. The Contractor is especially drawn to the requirement to provide workers with protective clothing which shall include but not limited to safety helmet, protective overalls and safety boots. The Employer will enforce this requirement. No claim in respect of want of knowledge in this connection will be entertained. Particular attention is drawn to the Rules published in Legal Notice 179, dated 02 June 1978 (Building operations and Work of Engineering Construction)	
	Carried to Collection Kshs	

Item	Description	Amount
A	Overtime Working The Working hours shall be those generally worked by good employers in the Building and Civil Engineering Trades in Kenya. The contractor shall be responsible for any extra costs for overtime working he considers will be necessary in order to complete the works within the contract period or time for completion apart from overtime working which may be ordered by the Project Manager. If overtime is worked out in accordance with a written instruction issued by the Project Manager, the contractor will be reimbursed in respect of such overtime to the unproductive time payable over and above the basic hourly rates as laid down by the Regulation of wages and Conditions of Employment Act, Building and Construction Industry Wages Council and excluding any bonuses, profits and overheads.	
B	Firm Price Contract Unless otherwise specifically stated no claim for increased costs will be entertained excepting only increased costs arising from fluctuation clause as defined in the Conditions of Contract.	
	MATERIALS AND WORKMANSHIP	
C	Generally: All materials shall be new unless otherwise directed or permitted by the Project Manager and the Employer and in all cases where the quality of goods or materials is not described or otherwise specified, is to be the best quality obtainable in the ordinary meaning of the word "best" and not merely a trade signification of the word. All materials and workmanship shall unless otherwise specified or described conform to the appropriate British Standard Institution Specification current at the date of Tender. The Contractor shall order all materials to be obtained from overseas immediately after the Contract is signed and shall also order materials to be obtained from local sources as early as necessary to ensure that such materials are on site **WHEN REQUIRED** for use in the works. The Contractor shall be responsible for and shall replace or make good at his own expense any materials lost or damaged. The works shall be executed by skilled workmen well versed in their respective trades. The Bills of Quantities shall not be used for the purpose of ordering materials.	
	Carried to Collection Kshs	

Item	Description	Amount
A	Rejected Workmanship or Materials Any workmanship or materials not complying with the specific requirements or approved samples or which have been damaged, contaminated or have deteriorated, must be immediately removed from the site and replaced at the Contractor's expense as required.	
B	Proprietary Materials Where proprietary materials are specified hereinafter the contractor may propose the use of materials of other manufacturer but equal quality for approval by the Project Manager. All materials and goods, where specified to be obtained from a particular manufacturer or supplier, are to be used or fixed strictly in accordance with their instructions.	
C	Samples: The Contractor shall furnish at the earliest possible opportunity before work commences and at his own cost, any samples of materials or workmanship that may be called for by the Project Manager for his approval or rejection and any further samples in the case of rejection until such samples are approved by the Project Manager and such samples when approved shall be the minimum standard for the work to which they apply.	
D	Concrete Tests Concrete test cubes, i.e. per set of three as later described including testing fee, labour and material, mould, transport and handling etc. successful tests only (PROVISIONAL) Sets of three: No. 20 @ Kshs *_____ The cube tests will be done at an approved laboratory. The Structural Engineer reserve the right to conduct non destructive tests at any single time. TEMPORARY WORKS	
E	Areas to be occupied by the Contractor: The Contractor shall obtain the Project Manager's approval for the siting of all temporary buildings; spoil heaps, temporary roads, paths and storage areas for materials.	
	Carried to Collection Kshs	

Item	Description	Amount
A	Telephone: The Contractor shall provide a dedicated mobile/wireless phone for the site which shall be attended at all times, for the period of the works and shall pay all fees and rentals for the same.	
B	Plant, Tools and Scaffolding: The Contractor shall provide all necessary hoists, tackle, plant, vehicles, tools and appliances of every description for the due and satisfactory completion of the works and shall remove the same on completion. The contractor shall provide, erect and maintain all temporary scaffolding, sufficiently strong and efficient for the due and satisfactory performance of the works, alter and adopt all scaffolding as and when required during the works and remove on completion and make good. No timber used for scaffolding, formwork or similar purpose shall be used afterwards in the permanent works. All such plant, tools and scaffolding shall comply with all regulations whether general or local in force throughout the period of the Contract and shall be altered or adapted during the Contract as may be necessary to comply with any amendments in or additions to such regulations. Scaffolding is not measured hereinafter, and the Contractor must allow here or in his rates for the above.	
C	Watching and lighting: The Contractor shall provide at his own expense and risk all watching and lighting as necessary to safeguard the works, plant and materials against damage and theft.	
D	Temporary Roads: The Contractor is to allow for providing where directed, all execution of the works including making good when no longer required.	
	Carried to Collection Kshs	

Item	Description	Amount
A	Existing and Adjacent Property: The Contractor must take all steps necessary to safeguard existing and adjacent property, make good at his own expense any damage to persons or property caused thereon, and hold the Employer indemnified against any claim arising. The Contractor will be held fully responsible for the safety of the existing and adjacent building and for any damage caused in consequence of these works. He must reinstate all damages at his own expense and indemnify the Employer against any loss.	
B	Nuisance: The Contractor must take such steps and exercise such care and diligence so as to minimize nuisance from dust, noise or any other cause, to the occupiers of adjacent properties.	
C	Ordering of Materials: The Contractor must assist in alleviating the effects of possible shortages of materials by advance ordering of materials in order to maintain a continuous supply. Early delivery of materials will be permitted and included in interim certificates and upon request by the Project Manager, the Contractor will be required to produce copies of order forms and invoices to establish that materials have been ordered in sufficient time and to check on material deliveries.	
	DOMESTIC SUB-CONTRACTORS.	
D	Domestic Sub-contractors. The Contractor shall be responsible for domestic sub-contractors in every respect and, in particular, it shall be the Contractor's responsibility to ensure that each sub-contractor commences and completes the work in such a manner and is ready on the site with his materials, labour and special plant at such times also as to conform with the progress schedule, as specified previously and to ensure satisfactory progress. The Contractor shall also accept liability for and bear cost of general attendance on the sub-contractors which he shall be deemed to include for:	
	Carried to Collection Kshs	

Item	Description	Amount
	Allowing the use of standing scaffolding, maintenance and alteration of all scaffolding until such time as all relevant sub-contractor's work are complete, and removal of all scaffolding on completion. Providing space for office accommodation and for storage of plant and materials; allowing use of sanitary accommodation; the supply of necessary water, power, lighting and watching; and clearing away all rubbish. The items for "Attendance" given hereinafter following prime cost sums in respect of subcontractor's work shall be deemed to include all the above. The cutting away for and making good after the work of sub-contractors as may be required will be measured and valued separately by the Quantity Surveyor. The Main Contractor shall choose the domestic sub-contractors from the provided guidance list. However, the main contractor will be at the liberty to choose his own preferred sub-contractors in which case he must first seek approval from the project team.	
A	Nominated Suppliers The cost of (Fix Only) materials to be obtained from nominated suppliers which are covered by prime cost or provisional sums shall include for taking delivery on site, checking with invoices or indents, reporting and claiming damages for shortages and damaged goods, defraying demurrage, signing for as having been received in good order unloading, storing, covering and protecting until the time of fixing, unpacking, replacing anything lost or damaged, sorting assembling, hoisting to required levels and fixing as described. Before placing any order with Nominated suppliers the Contractor must ascertain that the terms and conditions of the quotations and the dates of delivery of materials or execution of work comply with the terms of the contract, and the progress schedule.	
B	Prime Cost Sum Where description of items includes a P.C. rate per unit, this rate is to cover the Net supply cost of the unit only. The Contractor's price must include for the cost of the unit at the rate stated plus waste, taking delivery, storage, fixing in position, profit and overheads. The net cost per unit will be adjusted within the final account against the P.C rate stated.	
	Carried to Collection Kshs	

Item	Description	Amount
	PROTECTION AND CLEANING	
A	Protection of Completed Works The Contractor shall cover up and protect from damage, including damage from inclement rainy weather, all finished work, and unfixed materials including that of sub-contractors, etc. to the satisfaction of the Project Manager until the completion of the Contract. No claim for pumping rain water in basements or other damages occasioned by the above will be allowed.	
B	Protection of Trees The Contractor shall in the course of construction take all necessary precautions to preserve any existing trees. The contractor will not cut down any tree(s) without express authority or written instruction by the Project Manager and relevant authorities. He must at all times liaise with the Project Manager in this regard. The cost of obtaining any necessary permits will be borne by the Contractor.	
C	Materials on site All materials for incorporation in the works must be stored on or adjacent to the site before payment is effected unless specifically exempted by the Project Manager.	
D	Cleaning: The Contractor shall upon completion of the works, at his own expense, remove and clear away all surplus excavated materials, plant, rubbish and unused materials including clearing away and making good all traces of dirt and shall leave the whole of the site and works in a clean and tidy state to the satisfaction of the Project Manager. Particular care shall be taken to leave clean all floors and windows and remove all paint and cement stains. He shall also, at the discretion of the Project Manager, remove all rubbish and dirt as it accumulates. The contractor is to find his own dump and shall pay all charges in connection therewith.	
	Carried to Collection Kshs	

Item	Description	Amount
A	Training Levy The Contractor's attention is drawn to Legal Notice No. 237 of October 1971 which requires payments by the Contractor of a Training Levy at the rate of ¼% of the Contract sum on all contracts of more than Kshs 50,000 in value and his Tender must include for all costs arising or resulting therefrom.	
B	Value Added Tax (VAT) and other taxes The Contractor's attention is drawn to V.A.T Public Notice No. 6 of 5th August 1993 regarding the Finance Bill 1993 which expanded the V.A.T base to cover construction services amongst other items. The Contractor is required to acquaint himself with such notices and allow in his Bills of Quantities rates (excluding P.C and Provisional Sums) for the net tax (i.e. less input tax where applicable) as required by law. The Contractor may seek further direction and assistance regarding the application of this law to the Commissioner of Domestic Tax.	
C	Timely payment for labourers The Contractor shall ensure that his workers are paid their wages promptly and on time. If such payments are effected weekly the Contractor shall ensure that workers are paid on the appointed day to avoid any disruption of work occasioned by the failure of the Contractor to pay workers on time and shall be required to furnish proof to that effect.	
D	Extended Preliminaries In case the Contractor suffers costs due to extended preliminaries as a result of excusable delays. Then the Employer shall compensate the Contractor the **ACTUAL COST** of such extended preliminaries plus 10% administrative costs. Such costs will be proven with payment receipts, payroll etc. No further claims shall be allowed with respect to the same.	
E	Additional Items Any additional items(s) which the Tenderer may wish to price separately and which he considers has not been included in the foregoing conditions, specifications and/or Bills of Quantities. Description: …… …… ……	
	Carried to Collection Kshs	

Item	Description			Amount
	PRELIMINARIES (SUMMARY)			
	COLLECTION			
	From Page	Sec 1, Page 1	Kshs	
	From Page	Sec 1, Page 2	Kshs	
	From Page	Sec 1, Page 3	Kshs	
	From Page	Sec 1, Page 4	Kshs	
	From Page	Sec 1, Page 5	Kshs	
	From Page	Sec 1, Page 6	Kshs	
	From Page	Sec 1, Page 7	Kshs	
	From Page	Sec 1, Page 8	Kshs	
	From Page	Sec 1, Page 9	Kshs	
	From Page	Sec 1, Page 10	Kshs	
	From Page	Sec 1, Page 11	Kshs	
	From Page	Sec 1, Page 12	Kshs	
	From Page	Sec 1, Page 13	Kshs	
	From Page	Sec 1, Page 14	Kshs	
	From Page	Sec 1, Page 15	Kshs	
	From Page	Sec 1, Page 16	Kshs	
	From Page	Sec 1, Page 17	Kshs	
	From Page	Sec 1, Page 18	Kshs	
	Total Amount Carried to Main Summary		**Kshs**	

BILL NO. 2 : MATERNITY ROOMS

ITEM	DESCRIPTION	QTY	UNIT	RATE	AMOUNT
	ELEMENT NO. 1 : DEMOLITIONS (ALL PROVISIONAL) **NOTE : The Contractor is strongly advised to visit the site and fully ascertain the nature and scope of structures hereafter described as for demolition before pricing and is requested to raise any queries that appertain to the structures to be demolished that may affect or influence the pricing, Such queries should be addressed to the project engineer before the tender closing date.** No claims arising from the tenderers failure to fulfil the above requirement shall be considered. The contractor is to allow for all temporary protection required during the works including ordinary and special dust screens, hoarding, barriers, warning signs etc. as directed by the Architect and as necessary for the protection of the existing structure and finishings, workmen employed upon the site and the general public. All protective devices are to be removed on completion of the works and any necessary making good consequent upon this is to be executed to the satisfaction of the Architect. The works shall be executed in such order and sequence as the architect may direct and with as little disruption and inconvenience as possible and shall be caused to the normal functioning of the employer, the staff and the public including the adjacent property occupiers. Demolitions work shall be carefully executed with particular aim of minimizing damage to adjacent finishes, structure or components not measured herewith. All existing works shall be propped, strutted and supported as necessary before the demolition work is commenced. Prices shall include for all necessary preparatory work to structure and finishings and all making good to finishings on completion whether or not specifically described. Unless otherwise described, all arisings, debris and surplus materials resulting from the demolitions shall be set aside for client's use or carted away from the site and prices shall be deemed to include all credit allowances, unless an additional credit is offered by means of a lump sum deduction on the collection page of this bill. All existing work shall be made good up to new surface and cleaned to the entire satisfaction of the Project Manager				
	Total Carried to Collection.				

ITEM	DESCRIPTION	QTY	UNIT	RATE	AMOUNT
	Amounts and rates for demolitions shall include the following in addition to what is described in the particular item. a) Making good i.e. reinstatement of any finishes and structures affected by the demolition work to the original state. b) Clearing debris with speed on daily basis as they arise, cleaning of affected surfaces, and removal of the debris from site to approved dumping sites. Accumulation of debris within the site premises shall not be allowed. c) Allowance for all notices, statutory or otherwise required to be issued before commencement shall be deemed to be included in the pricing. d) The amounts quoted shall be deemed to be inclusive of all handling of the removed items and their removal from the site. e) Materials deemed by the Engineer as reusable shall be salvaged, cleaned down, made good as necessary, stored securely and transported to the premises of the client at a designated area as directed. The contractor shall allow for proper and neat stacking of the materials. f) The Contractor to carefully inspect and demolish the following structures including breaking up foundations with and including reinforced concrete structures, walls, roof and carefully disconnecting and removing all sanitary, electrical or other fixed fittings, joinery, windows and doors, service pipes and conduits. **Demolitions (Including cart away of any debris arising).** **Floor Finishes**				
A	Carefully hack existing ceramic / porcelain floor tile finish including screed & skirting (Approximately 175 SM) and set aside/ cart away as directed.	1	ITEM		
	Masonry walls				
B	Carefully demolish existing 2.7m high masonry walls (Approximately 74 LM) including all wall finishes and cart away debris arising there of as directed.	1	ITEM		
	Dwarf walls				
C	Carefully demolish existing 0.7m high masonry walls complete with timber coping (Approximately 52 LM) including all wall finishes and cart away debris arising there of as directed.	1	ITEM		
	Total Carried to Collection.				

ITEM	DESCRIPTION	QTY	UNIT	RATE	AMOUNT
	Ceiling				
A	Carefully demolish existing gypsum and acoustic ceiling including brandering in all the rooms and set aside for re-use as directed. (Approximately 175 SM)	1	ITEM		
	Doors				
B	Carefully remove existing 4 No. timber size 1100 x 2100mm high including door frame and set aside/ cart away as directed.	1	ITEM		
C	Ditto 6 No. timber size 1000 x 2000mm high including door frame and set aside/ cart away as directed.	1	ITEM		
D	Ditto 1 No. timber size 800 x 1900mm high including door frame and set aside/ cart away as directed.	1	ITEM		
E	Ditto 1 No. aluminium size 600 x 1700mm high including door frame and set aside/ cart away as directed.	1	ITEM		
	Windows				
F	Carefully remove existing 1 No. aluminium window size 2000 x 1500mm high including frame and set aside/ cart away as directed.	1	ITEM		
G	Ditto existing 1 No. aluminium window size 1500 x 1500mm high including frame and set aside/ cart away as directed.	1	ITEM		
H	Ditto existing 1 No. aluminium window size 500 x 1500mm high including frame and set aside/ cart away as directed.	1	ITEM		
I	Ditto existing 2 No. aluminium window size 1300 x 1050mm high including frame and set aside/ cart away as directed.	1	ITEM		
	Wall Tiles				
F	Carefully remove and hack existing wall tiles including cement sand backing (Approximately 55sm) and cart away arising debris as directed.	1	ITEM		
	Shelving				
G	Carefully remove existing high level shelving (Approximately 13 LM) and set aside re use as directed	1	ITEM		
H	Carefully remove existing wardrobe (Approximately 2 LM) and set aside re use as directed	1	ITEM		
	Total Carried to Collection.				

ITEM	DESCRIPTION	QTY	UNIT	RATE	AMOUNT
	Floor Slab				
A	Carefully cut existing 150mm slab for1500 x 1500mm hole into existing slab and cart away debris arising thereof as directed to allow for concrete columns.	4	NO		
	Crash Rail				
B	Carefully remove existing timber crash rail (Approximately 127LM) and set aside re use as directed	1	ITEM		
	Total Carried to Collection.				
	COLLECTION				
	Brought forward from Page 2				
	Brought forward from Page 3				
	Brought forward from Above				
	Total for Demolitions Carried to Main Summary				

ITEM	DESCRIPTION	QTY	UNIT	RATE	AMOUNT
	ELEMENT NO. 02 : SUBSTRUCTURES (ALL PROVISIONAL)				
	Excavations & Disposal including maintaining & supporting sides & keeping free from water, mud etc. and disposal				
	Note : **(1). The Tolerances for excavation works shall be +-10mm, any over excavation shall be corrected with mass concrete class 20 at the contractor's expense.**				
	(2). Excavations for column bases and strip foundations are measured net. No working space is allowed, tenderers allow for working space within their rates.				
	NOTE : Classes of Rock				
	(1) Class 1: Class 1 Rock shall be with compressive strength exceeding 15KN/mm^2 This type of rock contains stones and boulders of untethered or incompletely weathered Tuff, trachyte, black trap or lava with compressive strength exceeding 15N/mm2 in a formation which is massive and geologically homogeneous. A boulder or outcrop with such compressive strength will be deemed to be class 2 rock or Hard rock. The opinion of the Engineer in classifying rock shall be final and binding. Explosives must not be used without the prior written approval of the Engineer. Blasting operations are carried out at the contractor's sole risk and all blasting must be carried out in accordance with government regulations and approval.				
	(2) Class 2: Soft rock of the type know locally as "tuff" or "malady" which in the opinion of the Engineer cannot be considered as hard rock shall be known as rock Class 1 rock. Soft rock shall be rock with compressive strength not exceeding 15N/mm^2. Murram and Kunken are specifically excluded and will be deemed as normal excavation. Extremely weathered and weak tuff shall also be considered as normal excavation.				
	Excavations				
A	Excavation in hard compacted material and hardcore up to a level not exceeding 1.5m from cut level	14	CM		
	Total Carried to Collection Page				

ITEM	DESCRIPTION	QTY	UNIT	RATE	AMOUNT
	Excavations (Continued)				
A	Return, fill, ram selected excavated material around foundations.	5	CM		
B	Dispose surplus excavated material from site.	9	CM		
	Imported Filling & Surface Treatment				
C	300mm thick approved imported hardcore filling spread, levelled, well rammed and consolidated in layers to receive concrete surface bed (m.s).	9	SM		
D	Murram or quarry dust layer to hardcore prepared to receive surface bed 50 mm thick.	9	SM		
	Damp-proof membranes				
E	Damp proof membrane over blinded hardcore including 300mm end & side laps 1000 gauge.	9	SM		
	Anti-Termite Treatment				
F	Chemical anti-termite treatment, executed complete by an approved specialist under a ten-year guarantee, to surfaces of hard-core.	9	SM		
	Concrete Work				
G	Plain concrete class 15; 50mm thick blinding under column bases	9	SM		
	Vibrated reinforced concrete class 25 (20mm aggregate) to:				
H	Column bases	3	CM		
I	Columns	1	CM		
J	150mm thick floor bed	9	SM		
	Steel Reinforcement (All Provisional)				
	High yield deformed steel bar reinforcement to B.S. 4461 including cutting and bending, hoisting into position, tying, stools, spacer blocks and any other accessories all in accordance with the Structural Engineers Details and approval.				
K	Assorted bars	400	KG		
	Total Carried to Collection Page				

ITEM	DESCRIPTION	QTY	UNIT	RATE	AMOUNT
	Mesh fabric reinforcement to B.S 4483 and setting in concrete bed including end laps Ref. A142 weighing 2.22kg/m2 to;				
A	Ground floor slab	9	SM		
	Formwork				
	Formwork finish type II to:				
B	Vertical sides of column bases	7	SM		
C	Vertical sides of columns	7	SM		
	Total Carried to Collection				
	COLLECTION				
	Total Brought forward from Page 5				
	Total Brought forward from Page 6				
	Total Brought forward from Above				
	Total for Substructures carried to Bill Summary				

ITEM	DESCRIPTION	QTY	UNIT	RATE	AMOUNT
	ELEMENT NO. 03: STRUCTURAL STEEL WORKS ***Structural Steelworks complete with all welding and accessories as described in BS 449 Part 2.*** The following in framed structural Steel works complete with and including welded and bolted connections; delivery to site and erection with and including on shop coat red / grey oxide primer; hoisting and fixing in position average height 9,000mm high from ground level and finishing with 3 coats zinc chromate enamel paint or other equal and approved to all exposed surfaces. ***Steel Fabrication Notes*** All Materials shall be tested for thorough thickness properties to the specified Class BS 5920-2001,21.2 Manufacturers Certificate of test and inspection shall be issued conforming to BS EN 10204 stating the process of manufacture and product grade. Preloaded fasteners shall generally be HSFG BOLTS with associated NUTS & WASHERS. Steel casing and forgings shall conform to BS3100. Bedding material for steel bases on concrete foundation shall be done to Engineer's Approval. Structural steel members shall be positively be identified by a marking scheme Cutting shall be by sawing, shearing, cropping or thermal cutting (if permitted). Hand held cutting shall be used only where it is impractical to use machine cutting Cut edges shall be true to profile and free from major notches and cutting serrations. Round hole for pines shall be drills, plasma or laser cut. All weld, boltings and cuttings shall be approved on site before fabrication (prepare sample for erection) All measurements shall be done accurately at all stages. Support to be provided for roof frame units until they are adequately fixed in the position as shown.				
	Total Carried to Collection				

ITEM	DESCRIPTION	QTY	UNIT	RATE	AMOUNT
	Columns & Beams				
A	UC 203 x 203 x 46kg/m	552	KG		
B	UB 254 x 146 x 31kg/m	570	KG		
	Mild Steel Plates				
C	350 x 350 x 3mm base plate, with 8 No holes 22mm holes for M20 bolts	4	NO		
D	150 x 100 x 10mm stiffener plate	16	NO		
E	160 x 405 x 18mm thick end plate welded to UB and UC; with 8 no holes for M16 bolts	18	NO		
	Mild Steel Bolts				
H	600mm long M20 grade 8.8 anchor bolts drilled into the slab with chemical anchor or equivalent	32	NO		
I	65mm long M16 grade 8.8 anchor bolts drilled into masonry wall with chemical anchor or equivalent	64	NO		
	Total Carried to collection				
	Total Brought forward from Page 8				
	Total Brought forward from Above				
	Total for Canopy Carried to Summary				

ITEM	DESCRIPTION	QTY	UNIT	RATE	AMOUNT
	ELEMENT NO. 04: LINTELS AND WALLING				
	Vibrated reinforced concrete class 25 (20mm aggregate) in:				
A	Lintel beams	1	CM		
	Reinforcement (Provisional)				
	High yield deformed steel bar reinforcement to B.S. 4461 including cutting and bending, hoisting into position, tying, stools, spacer blocks and any other accessories all in accordance with the Structural Engineers Details and approval.				
B	Assorted reinforcement bar sizes	100	KG		
	Formwork				
	Formwork finish type II to:				
C	Vertical sides and soffits of beams	8	SM		
	MASONRY WALLING				
	Internal Walling				
	Machine cut natural coursed stone walling obtained from an approved quarry bedded and jointed in gauged mortar (1:3); include hoop iron at every course;				
D	150mm thick	125	SM		
E	100mm thick	31	SM		
	Total for Lintels & Walling Carried to Section Summary.				

ITEM	DESCRIPTION	QTY	UNIT	RATE	AMOUNT
	ELEMENT NO. 05: DOORS				
	Hardwood Timber doors				
	Supply and fix 45mm hardwood door; faced with 3mm thick hardwood veneer on both sides; hardwood lipping on all edges; including all planted mouldings;				
A	Single Leaf, one way swing overall size 1500 x 2700mm high	7	NO		
B	Single Leaf, one way swing overall size 900 x 2700mm high	7	NO		
	Mahogany or other equal and approved hardwood timber as described in:				
C	200 x 50mm rebated door frame with one labour, plugged to wall/beam	84	LM		
D	50 x 25mm splayed architrave	84	LM		
E	25mm diameter quadrant beading	84	LM		
	Ironmongery				
	Supply and fix 'UNION' (made in ENGLAND) or other equal approved ironmongery with matching screws; to architects approval				
F	Stainless steel ball bearing hinges 'HN 2BB-403030'	28	PRS		
G	Cylinder stainless steel floor mounted door stop 'DH005 SS'	14	NO		
H	Stainless steel heavy duty door closer as 'Union 8247 SS'	14	NO		
I	150X150mm aluminium sign plate with room symbol engrave	14	NO		
K	900x 200mm SS kick plates 'KP-800-200 SS'	14	NO		
L	400x 200mm SS push plate	14	NO		
M	Stainless steel coat and hat hook 'DCH0560 SS'	7	NO		
N	Indicator bolt 'Vacant/Engaged' satin steel '80941 SC'	7	NO		
	Prepare and apply one coat wood preservative to woodwork before fixing				
O	Over 100mm but not exceeding 200mm girth	84	LM		
	Prepare and apply three coats of gloss oil paint on timber surfaces				
P	Over 100 but not exceeding 200mm girth	84	LM		
Q	Generally on doors	66	SM		
	Total for Doors Carried to Section Summary.				

ITEM	DESCRIPTION	QTY	UNIT	RATE	AMOUNT
	ELEMENT NO. 06 : WINDOWS				
	Sliding Aluminium Windows				
	Supply and Install Purpose made powder coated aluminium glazed window frame size 50x40x2mm, complete with 6mm one way glass, all ironmongery including, Fasteners, stays and hinges to manufacturer's specifications, mosquito gauze, sample to approval and all to Architect's instructions.				
A	Aluminium sliding window overall size 2000 x 1500mm high	3	NO		
B	Ditto but 1400 x 1500mm high	4	NO		
C	Ditto but 1000 x 1500mm high	1	NO		
	Total for Windows Carried to Section Summary.				

ITEM	DESCRIPTION	QTY	UNIT	RATE	AMOUNT
	ELEMENT NO. 07 : INTERNAL FINISHES				
	Wall Finishes				
	Cement and sand (1:1:6) lime plaster:				
A	12mm thick two coat plaster to masonry surfaces to receive paint (ms)	188	SM		
	Painting and Decoration				
B	Prepare and apply 3 coats vinyl antimicrobial paint to plastered surfaces.	188	SM		
C	Dust, Clean, prepare and apply 2 coats quality matt emulsion antimicrobial paint to existing plastered wall surfaces.	304	SM		
	Cement and sand (1:4) backing as described, finished to receive wall finishes.				
D	12mm thick backing to walls to receive tiles(ms)	138	SM		
	The following ceramic tiles .				
F	600 x 300 x 8mm thick coloured glazed ceramic wall tiles bedded and pointed using an approved tile adhesive and jointed with colour matching water-proof cement grout in kitchenette.	138	SM		
E	Dust and Clean 600 x 300mm existing wall tiles to Architect's instructions	27	SM		
F	Replace any broken ceramic tiles with 600 x 300mm thick ceramic wall tiles including 32mm thick cement sand backing, to match existing wall tile colour, pattern and specifications all to Architect's detailed instructions	15	SM		
	Floor Finishes				
	Cement and Sand Screed				
G	32mm thick cement and sand (1:4) self levelling screed with hardener, finished smooth to receive Gerflor floor (m.s)	167	SM		
H	32mm thick cement and sand (1:4) screed as described, finished to receive porcelain floor tiles (m.s)	30	SM		
	Gerflor Vinyl Flooring				
I	Supply and fix including all accessories and fittings X-tech Gerflor floor finish, homogeneous, Antistatic, Antibacterial, Antiskid Gerflor floor, to floors internally complete with coved junctions between the walls and the floors including coved junction between the wall and the floor all to manufacturer's instructions and Architect's approval.	167	SM		
	Total Carried to Collection				

ITEM	DESCRIPTION	QTY	UNIT	RATE	AMOUNT
A	Supply and fix 600 x 300mm floor tiles laid on backing (m.s),with an appropriate and approved tile adhesive and jointed with colour matching water-proof cement grout.	30	SM		
	Ceiling Finishes				
	Gypsum Ceiling				
B	Supply and fix 9mm thick gypsum board ceiling on 50mm steel studwork complete with metal edge floor and ceiling trims in horizontal suspended ceiling and scheming with 'crown covermatt' or any equal and approved.	162	SM		
C	Supply and fix 9mm thick moisture proof gypsum board ceiling on 50mm steel studwork complete with metal edge floor and ceiling trims in horizontal suspended ceiling and scheming with 'crown covermatt' or any equal and approved.	29	SM		
D	Extra Over for 300mm bulkhead at the boardroom and Reception Area	39	LM		
	Painting and Decoration				
E	Prepare and apply 3 coats silk vinyl antimicrobial paint to gypsum board ceiling	191	SM		
	Crash Rail				
F	1.8mm thick continuous natural aluminium retainer screwed to wall with 2mm high impact PVC customised rail cover to approval including all accessories and fittings	153	LM		
	Total Carried to Collection				
	COLLECTION				
	Total Carried from page 13				
	Total Carried from above				
	Total for Internal Finishes Carried to Section Summary				

ITEM	DESCRIPTION	QTY	UNIT	RATE	AMOUNT
	ELEMENT NO. 7: BUILDER'S WORK IN CONNECTION TO SPECIALIST INSTALLATIONS				
	Electrical Installations (Provisional)				
A	Inspect all drawings and bills of quantities for Electrical Installation works and allow for all Builder's work associated with Electrical Installations, including cutting away for and making good after Electrician installing a concealed conduit system including cutting or leaving all holes, notches, sinkings and chases in both the structure, covering and infills.	1	ITEM		
	Mechanical Installations (Provisional)				
B	Inspect all drawings and bills of quantities for Plumbing, Drainage and Mechanical Installation works and allow for all Builder's work associated with the Installations, including cutting away for and making good after installing a concealed drainage system including cutting or leaving all holes, notches, mortices, sinkings and chases in both the structure and its covering; including but not limited to forming recess in masonry.	1	ITEM		
	Total for Builder's Work in Connection to Specialist Installations Carried to Section Summary.				

ITEM	DESCRIPTION	QTY	UNIT	RATE	AMOUNT
	SECTION SUMMARY				
1	Demolitions				
2	Substructure				
3	Structural Steelworks				
4	Lintels and Walling				
5	Doors				
6	Windows				
7	Internal Finishes				
8	Builder's Work in Connection to Specialist Installations				
	TOTAL FOR MATERNITY ROOM IMPROVEMENTS CARRIED TO BILL SUMMARY				

BILL NO. 3 : SPECIALIST WORKS

ITEM	DESCRIPTION	QTY	UNIT	RATE	AMOUNT
	SPECIALIST WORKS - *ALL Sub-contractors are domestic*				
	Electrical Installations				
A	Allow a Prime Cost sum for General Electrical Installations		SUM		
	Allow a percentage for profit		%		
B	Allow a Prime Cost sum for Structured Cabling Installations		SUM		
	Allow a percentage for profit		%		
C	Allow a Prime Cost sum for Structured Cabling and Security Installations		SUM		
	Allow a percentage for profit		%		
D	Allow a Prime Cost sum for Nurse Call Installations		SUM		
	Allow a percentage for profit		%		
	Mechanical Installations				
E	Allow a Prime Cost sum for General Plumbing, Drainage Installations		SUM		
	Allow a percentage for profit		%		
F	Allow a Prime Cost sum for Heating, Ventilation & Air Conditioning (HVAC) Installations		SUM		
	Allow a percentage for profit		%		
G	Allow a Prime Cost sum for Medical Gases Installations		SUM		
	Allow a percentage for profit		%		
	Total for Specialist Works Carried to Grand Summary				

BILL NO. 4 : PROVISIONAL SUMS

ITEM	DESCRIPTION	QTY	UNIT	RATE	AMOUNT
	PROVISIONAL SUMS				
	Signage				
A	Allow a Provisional sum for all signage and way finding installations			SUM	100,000.00
	Joinery Works				
B	Allow a Provisional sum for joinery works			SUM	1,000,000.00
	Contingency				
C	Allow a provisional sum for contingency to be expedited at the express authority of the Client.			SUM	3,000,000.00
	Total for Provisional Sums Carried to Section Summary				**4,100,000.00**

MAIN SUMMARY

PROPOSED LABOUR WARD IMPROVEMENTS

MAIN SUMMARY

	DESCRIPTION	BILL NO.	TOTAL (KES)
	GRAND SUMMARY		
1	PRELIMINARIES	Bill No. 1	
2	MATERNITY ROOMS	Bill No. 2	
3	PROVISIONAL SUMS	Bill No. 3	
4	SPECIALIST WORKS	Bill No. 4	
	GRAND SUMMARY CARRIED TO FORM OF TENDER (INCLUSIVE OF VAT)		

TENDERER

Signature of Tenderer.....(Company stamp).....

Name of Tenderer.....

Address of Tenderer.....

Telephone no(office).....Mobile.....

E-mail Address.....

BUILDING AND CIVIL WORKS SPECIFICATIONS

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SECTION 2.1

Building and Civil Work Specifications

2.1 BUILDING AND CIVIL WORK SPECIFICATIONS

2.1.1 GENERAL REQUIREMENTS

2.1.1.1 General

2.1.1.1.1 Definitions

(a) '**Architect'** means the person or other entity engaged by the Employer to perform architectural, engineering, design and other services related to the works as provided for in the contract. Where the specifications refer to the 'Engineer', the terms **'Architect'** and

'Engineer' shall be synonymous. The Architect shall serve as a technical representative of the Employer.

2.1.1.1.2 Standards

(a) All materials, equipment and testing apparatus etc. to be furnished and Works to be executed by the Contractor in this Contract shall conform to the requirements of the latest Kenya Standards, International Standards Organisation (ISO) Standards, British Standards, European Standards, or other approved applicable Standard in Kenya, unless otherwise specifically stated.

(b) All materials and equipment to be purchased shall be from well-recognised manufacturers whose products are standardised and controlled by any recognised Standard Organisation. All dimensions and measurement units shall be S.I. units.

(c) The Contractor may propose to the Engineer an alternative Standard other than specified, in which case he shall submit six (6) copies of English translation of the proposed Standard and all other information for the materials, equipment and testing, together with the written proof that the proposed Standard is equivalent in all significant respects to the Standard specified.

2.1.1.1.3 Equipment

(a) The equipment to be employed by the Contractor shall have sufficient performance capacity and durability as to secure the completion of the Works within the construction period stipulated under the Contract.

(b) All materials and equipment shall be subject to inspections or tests by the Engineer at any time and in any state of completion both off-site and on-site, as he deems necessary.

(c) The Contractor shall furnish promptly, without additional charge, all facilities, labour and materials reasonably needed for performing such inspections and tests as may be required by the Engineer.

2.1.1.1.4 Substitutes

(a) The Contractor shall make diligent efforts to procure the specified materials, but when the materials specified are unavailable, for reasons beyond the control of the Contractor, substitutes may be used with prior written approval of the Engineer.

2.1.1.2 Supervision and Labour

The Contractor will be required to maintain a competent Site Agent and staff on site throughout the construction period until the completion of the Works, and thereafter as may be required during the period of maintenance. The Engineer shall give prior authority to the appointment of the Site Agent and reserves the right to call for his withdrawal. The Site Agent must speak English.

2.1.1.3 Specialist Sub-Contractors

Where sub-contractors are not nominated, the Contractor shall appoint approved specialist sub-contractors for any sections of the works described herein for which he is not himself an experienced and approved operator. The Contractor shall co-ordinate his programmes with those of the sub-contractors.

2.1.1.4 Site

2.1.1.4.1 Definition of the site

The Site shall include all those areas of land which, being public or private:

- Are being provided by the Employer for the purposes of constructing the permanent Works;
- Are being provided by the Employer for Temporary Works, including camps, offices and stores;

2.1.1.4.2 Use of the Site

(a) The lands and other places outside the Site, which are the property or under the control of the Employer, shall not be used except with the approval of the Engineer.

i. The Contractor shall at any time remove any vehicle or vessel or any other obstruction under his control that may be required to be removed by the Engineer for any purpose. The Contractor shall move such obstruction promptly on being given instruction to do so.

ii. The Contractor shall maintain access for the inspection, operation and maintenance of any of the Employer's plant or works, which lies within the site or elsewhere.

iii. The Contractor shall not use any portion of the Site for any purpose not connected with the Works without the written consent of the Engineer.

iv. Except with the written consent of the Employer, to be given when necessary for the execution of the Works, the Contractor's employees will not be permitted to enter any of the Employer's buildings or lands or sites under the control of other contractors or the Engineer. The Contractor shall warn his employees that any person found within such buildings or sites without authority is liable to be removed from the Works in accordance with the Conditions of Contract.

2.1.1.5 Possession of Site

The Contractor shall restrict his activities to areas for which possession has been given and shall avoid any encroachment upon lands outside these areas. Any trespass or damage arising from such encroachment shall be the Contractor's sole responsibility and he shall hold the Employer indemnified against all claims arising from such trespass or damage.

2.1.1.6 Interference with the Works

The Contractor shall not interfere in any way with any existing works, whether the property of the Employer or of a third party, whether or not the position of such works is indicated to the Contractor by the Engineer, except where such interference is specifically described as part of the Works, either in the Contract or in an instruction from the Engineer.

2.1.1.7 Security

The Contractor at his own expense shall provide watching of the Works. If the Engineer considers it necessary, he will order in writing that additional watchmen be provided all at the Contractor's expense. Watch dogs shall be confined to the Site, be kept under control and properly inoculated and licenced (if necessary).

2.1.1.8 Material for the Works

2.1.1.8.1 Materials and equipment provided by the Employer

(a) Materials and equipment which are to be provided by the Employer will be as stated in the Contract.

(b) Materials and equipment provided by the Employer shall be collected by the Contractor from the locations stated in Contract and delivered by the Contractor to the Site. The Contractor shall inspect the materials and equipment before taking receipt and shall immediately inform the Engineer of any shortage or damage.

(c) Materials or equipment provided by the Employer which are damaged after collection shall be repaired by the Contractor and submitted to the Engineer for approval. Materials or equipment which are lost or which in the opinion of the Engineer are not capable of being or have not been repaired satisfactorily shall be replaced by the Contractor.

(d) Crates and containers for materials or equipment provided by the Employer shall be disposed of by the Contractor.

(e) Equipment and materials provided by the Employer which are surplus to the requirements of the Works shall be returned to the locations stated in the Contract.

(f) The Contractor shall protect and maintain equipment provided by the Employer while it is on the Site and shall provide operatives, fuel and other consumables required to operate the equipment.

2.1.1.8.2 Materials

(a) Materials for inclusion in the permanent work shall be new or other material as stated in the Contract or approved by the Engineer.

(b) Certificates of tests by manufacturers which are submitted to the Engineer shall relate to the material delivered to the Site. Certified true copies of certificates may be submitted if the original certificates cannot be obtained from the manufacturer. A letter from the supplier stating that the certificates relate to the material delivered to the Site shall be submitted with the certificates.

(c) Materials which are specified by means of trade or proprietary names may be substituted by materials from a different manufacturer approved by the Engineer provided that the materials are of the same or better quality and comply with the specified requirements.

(d) Samples of materials submitted to the Engineer for information or approval shall be kept on the Site and shall not be returned to the Contractor or used in the permanent work unless permitted by the Engineer.

2.1.1.9 Inspection by Engineer during Defects Liability Period

The Engineer will give the Contractor 7 days' notice of his intention to carry out any inspection during the defect's liability period. The Contractor shall, upon receipt of such notice, arrange for a responsible representative to be present at the times and dates named by the Engineer.

2.1.1.10 Pollution

The Contractor shall take all reasonable steps to protect the environment on and off the site and to avoid damage or nuisance to persons or to property of the republic or others resulting from pollution, noise or other causes arising as a consequence of his methods of operation.

2.1.1.11 Fences

2.1.1.11.1 Fences

The Contractor shall not interfere with existing fences and should give prior notice to the Engineer whenever the Works necessitate breaching of fences. In such instances, the Contractor will make good the fence on completion of that section of the Works at his own expense.

Hoardings, fences, gates and signs on the Site shall be maintained in a clean, stable and secure condition.

Project signboards stated in the Contract shall be erected not more than 2 weeks, or such other period agreed by the Engineer, after the date for commencement of the Works. Other advertising signs shall not be erected on the Site unless permitted by the Engineer.

The permission of the Engineer shall be obtained before hoardings, fences, gates or signs are removed. Hoardings, fences, gates and signs which are to be left in position after completion of the Works shall be repaired and repainted as instructed by the Engineer.

2.1.1.12 Contractor's Activities in Respect of Property outside the Site of the Works and of Services Moved, Damaged or Altered

2.1.1.12.1 Location of Services

(a) The Contractor shall acquaint themselves with the position of all existing services, such as drains, underground and overhead telephone and electricity lines, ducts, poles, water mains, fittings, railway lines, etc. before any excavation or other work likely to affect the existing services is commenced.

(b) The Contractor shall check and determine on the site the position of any services shown on the Drawings. This shall be done by consultation with owners of services, visual inspections, using detecting apparatus and by making excavations as required to expose the position of the services. The positions of all services so detected shall be marked carefully and then drawn in on the Drawings. These services will then be defined as known services.

2.1.1.12.2 Damage to Services

(a) The Contractor shall take all reasonable precautions to protect existing services during construction and during the relocation of such services. Where protective measures involve the construction of permanent work, the Contractor shall execute the work in accordance with the Engineer's instructions.

(b) All pipes, cables, conduits or other known services of any nature whatsoever damaged as a result of the Contractor's operations shall be repaired and reinstated forthwith by the Contractor or by the Authority concerned, to the satisfaction of the Engineer, all at the expense of the Contractor.

(c) The Contractor shall inform the Engineer immediately if any existing works or services are exposed, located or damaged. All costs which may be incurred by the Contractor as a result of programming and coordinating work to enable any alterations to the services to be carried out and the cost of any safety precautions which shall be deemed necessary shall be at the Contractor's expense.

2.1.1.12.3 Safety by Overhead Power Lines

(a) Where work is to be carried out in the vicinity of overhead power lines, the Contractor shall ensure that all persons working in such areas are aware of the relatively large distance that high voltage electricity can "short" to earth when cranes, or other large masses of steel, are in the vicinity of power lines. The Contractor shall be required to work outside the clearances stated in **BS END 61439:1-2, BS END 62271-200:2012** and **BS 7354** which give safe clearance for the various voltages.

2.1.1.12.4 Relocation of Services

(a) It shall be clearly understood that, in certain instances, existing services can be relocated only after the Contractor has advanced sufficiently on or has completed certain sections of earthworks or certain structures. Whenever services are encountered which interfere with the execution of the Works and which require to be moved and relocated, the Contractor shall advise the Engineer, who will determine the extent of work, if any, to be undertaken by the Contractor in moving, relocating and reinstating or protecting such services. The Contractor shall be responsible for arranging the removal or alteration of such services in conjunction with and to the specifications of the relevant statutory authority subject to the prior agreement of the Engineer and were necessitated by the Works.

(b) A Provisional Sum for this work has been included in the Bill of Quantities. Subject to prior agreement of the Engineer, and upon production of receipts, the Contractor will be reimbursed the net cost of such work plus the percentage inserted by the Contractor in the Bill of Quantities for his overheads and costs, in making the arrangement, for co-ordinating the work and effecting payment.

2.1.1.12.5 Negotiations with Owners of Services

(a) The Contractor shall work in close co-operation with private owners or public authorities controlling services, which have to be protected, moved or relocated. Details regarding the state of negotiations concluded between the Employer and the owner at the time of bidding in respect of the time when either the owner is prepared to start moving such services or

when the Contractor is required to or will be allowed to start moving the services, and the duration of such operations, will either be stated in the bid documents or be made available to bidders.

(b) Further such consultations and negotiations with private owners or public authorities shall be carried out as required by the Contractor. Should the owners of services refuse to co-operate with the Contractor in a reasonable manner in connection with the protection or moving of services belonging to them, the Contractor shall refer the matter to the Engineer.

2.1.1.12.6 Use of Land outside Provided Area

(a) Should the Contractor wish to use land outside the area provided by the Employer for storing or keeping material or equipment required for the construction of the permanent works, it will be subject to the following:
- That the Engineer approves any area selected for this purpose;
- That such land be physically separated from any production plant or activities and suitably fenced in;
- That the area used for the aforesaid purpose be surveyed, and, where the land does not belong to the Contractor, he shall enter into a contract of lease with the owner of such land in respect of the full period for which such land shall be used for such purpose;
- That the contract shall stipulate that the owner shall not have any right whatsoever to any material stockpiled on such land during the currency of the contract of lease;
- That suitable, permanent reference beacons, approved by the Engineer, be placed next to the area, at the cost of the Contractor, for use by the Engineer with a view to, if applicable, taking cross-sections for determining quantities;
- That only material intended for use on this contract shall be stored on such land.

2.1.1.13 Programme of Works and Temporary Works

2.1.1.13.1 Programme of Works

(a) In accordance with relevant clauses of the Conditions of Contract and the Particular Conditions of Contract and prior to commencement of permanent works, the Contractor shall submit a fully detailed and time related programme showing the order of procedure and method in which the Contractor proposes to carry out the Works.

(b) The programme shall be in form of a gant chart only and show clearly the anticipated quantities of work to be performed each month, as well as the anticipated earnings for the various sections of work. Further it shall show the critical path of activities. The Contractor shall supply together with his programme an expenditure chart superimposed on it showing his monthly anticipated expenditure.

(c) The breakdown of the work to be shown for each Section of the Works on the programme submitted in accordance with Clauses 2.1.1.13.1(1) shall be comprehensive.

- work to be carried out, including testing and commissioning,
- fabrication, delivery and installation of materials to be fabricated off the Site,
- Delivery of critical materials originating from outside Kenya.
- activities for which the Employer or Engineer is responsible, including the issue of critical drawings and other information,
- provision of materials by the Employer, nomination and approval of Nominated Sub-contractors and consideration and approval of drawings and proposals, and

- Work to be carried out by Government departments, utility undertakings and other contractors.

(d) The Contractor shall be responsible for arranging, co-ordinating and agreeing with the utility undertakings a programme for their works. The Contractor shall make full allowance for time and provision of facilities for the utility undertakings in the preparation of his programmes.

(e) The Works shall be carried out so as to achieve a continuous and consecutive output of fully completed elements of construction. The order of execution of the Works shall be subject to reasonable adjustment as requested by the Engineer.

(f) Should the Contractor fall behind with the programme submitted by him in terms of the relevant clause of the Conditions of Contract, which programme has been approved by the Engineer, or if the sequence of operations is altered, or if the programme is deviated from in any other way, the Engineer may, without prejudice to the Employer's rights in terms of the relevant clause of the Conditions of Contract, require the Contractor to submit, within seven days of the date on which he has received a notice to this effect, a revised programme in terms of this Clause, which indicates the manner in which the Contractor undertakes to complete the Works within the required time.

(g) Any proposal in the revised programme to accelerate the rate of progress shall be accompanied by positive steps to increase production by more and / or better labour and equipment being provided on the site or by the available labour and equipment being utilised more effectively. Failure on the part of Contractor to work according to the programme or revised programmes shall be sufficient reason for the Employer to take steps as provided in the Conditions of Contract and shall be construed, as not executing the Works in accordance with the Contract.

(h) The approval by the Engineer of any programme shall have no contractual significance other than that the Engineer would be satisfied if the work is carried out in accordance with such programme and that the Contractor undertakes to carry out the work in accordance with the programme.

2.1.1.13.2 Temporary Works

(a) The Contractor shall supply the Engineer with drawings for approval showing the layout and general arrangement of all Temporary Works he proposes to construct for the purpose of the Contract including, but not limited to:

- Site Offices
- Stores
- Concrete batching plants
- Temporary access roads

2.1.1.14 Workmanship and Quality Control

2.1.1.14.1 Workmanship and quality control

(a) The onus rests with the Contractor to produce work which conforms in quality and accuracy of detail to all the requirements of the Specifications and Drawings, and the Contractor shall, at his own expense, institute a quality control system and provide experienced engineers, foremen, surveyors, materials technicians, other technicians and

other technical staff, together with all transport, instruments and equipment, to ensure adequate supervision and positive control of the Works at all times.

(b) The Contractor shall provide chainmen and labourers as necessary for the Engineer to carry out checks on the Works. The Contractor shall conduct tests or have them conducted continually on a regular basis, to check the properties of natural materials and processed natural materials and of products manufactured on the site, such as concrete.

(c) Although not a requirement for the Contractor to conduct regular tests on any commercially manufactured products such as cement, bitumen, steel and pipes, the Contractor shall remain fully responsible for any defective material or equipment provided by him. Similarly, the quality of all elements of the Works shall be checked on a regular basis so as to ensure compliance with the specified requirements.

(d) The intensity of control and of tests to be conducted by the Contractor in terms of these obligations is not specified but shall be adequate to ensure that proper control is being exercised. Where any natural materials or products made from natural materials are supplied, and upon completion of each element of the construction work, the Contractor shall test and check such materials, products and / or elements for compliance with the specified requirements and shall submit his results to the Engineer for approval. Such submission shall include all his measurements and test results and shall furnish adequate proof of compliance with the specified requirements.

(e) The Contractor's attention is also drawn to the provisions of the various sections of the Specifications regarding the minimum frequency of testing that will be required to undertake process control. The Contractor shall at his own discretion increase this frequency where necessary to ensure adequate control. The Contractor shall submit to the Engineer for examination, the results of all relevant tests, measurements and levels indicating compliance with the Specifications on completion of every part of the Work.

2.1.1.15 The Setting Out of Work and Protection of Beacons

2.1.1.15.1 Setting out

(a) The Contractor’s attention is drawn to the requirements of the relevant clauses of the Conditions of Contract, and he shall also comply with all legal provisions in regard to surveying and setting out work. The Contractor shall be responsible for the proper and accurate setting out of the works as required in the Contract documents. The Contractor shall provide all survey and measuring equipment and instruments necessary for his use in the execution of the scheduled Works.

(b) The Engineer will provide sufficient basic survey information to enable the contractor to set out the Works and the Contractor shall be responsible for setting out all necessary reference points and for the maintenance thereof.

(c) The Contractor shall satisfy himself as to the accuracy in line, level and dimension of the basic survey and setting out details provided and should the Contractor discover any error in the information provided by the Engineer, he should at once notify the Engineer. If the information is confirmed to be in error the Engineer will issue amended drawings or instructions regarding the correction of the error.

2.1.1.15.2 Beacons

(d) The Contractor shall not remove, damage, alter or destroy in any way plot beacons or survey beacons of the Kenya Government. Should the Contractor consider that any beacon

will be interfered with by the Works he shall notify the Engineer who, if he considers necessary, will make arrangements for the removal and replacement of the beacon.

(e) If the Contractor removes or disturbs a beacon without permission of the Engineer, he shall be liable for the full cost of its replacement.

(f) The Contractor shall allow in his bid rates for being unable to use up to 30% of the Engineer's control points where such are provided in the Contract, through loss or damage occasioned prior to the commencement date. When the Contractor requires the establishment of a new control point or points due to the above-mentioned loss or damage, he shall advise the Engineer who will, if he deems it necessary, arrange for the establishment of a new control point or points. Control points not affected by the works shall be protected and preserved by the Contractor. In the case of negligence on the part of the Contractor, or his employees, resulting in the destruction of control points, an amount equal to the cost of replacing the same may be deducted from subsequent payments due to the Contractor. Control points affected by the works shall be offset by the Contractor to the satisfaction of the Engineer.

(g) The Contractor shall, prior to any setting out, submit to the Engineer for his approval, the method of setting out he proposes to employ. The plan shall include the accuracy, positions of the various types of stakes, method of marking stakes, and methods to be used for protecting stakes, etc. No survey work shall proceed prior to the Engineer's approval of the Contractor's plan. At least 24 hours before he intends to survey any portion of the Works, the Contractor shall give written notice to the Engineer. Such notice shall include time, location and type of Works to be set out. The Contractor shall set out the Works and obtain approval of his setting out before proceeding with construction.

(h) In general, the Contractor shall check for the existence of original marks, lines and levels of reference not less than one month prior to commencing works in any section, to allow sufficient time for reinstatement of markings, and checking of lines and levels. Any discrepancies encountered shall be immediately reported to the Engineer, for instruction and coordination.

(i) The Contractor shall be deemed to have allowed in his bid price for checking and reinstatement of original markings. Special care shall be exercised during construction not to damage, displace or disturb property and trigonometrical survey beacons. If such beacons are disturbed or destroyed by the Contractor, they shall be replaced without delay by a registered land surveyor at the Contractor's expense. In cases where displacement of or damage to such beacons is unavoidable the Contractor shall also be responsible for relocation or suitably referencing for later reinstatement of such beacon at his own cost. The Engineer may if he deems it necessary, revise the line and grade and will require the Contractor to adjust the stake-out accordingly.

2.1.1.16 Information Furnished by the Employer

2.1.1.16.1 Information

(a) Certain information contained in these contract documents or provided separately is being offered in good faith, but in the circumstances pertaining to the type of information furnished, no guarantee can be given that all the information is necessarily correct or representative of the in-situ condition. This applies more specifically to all soil tests, soil mapping, drilling results, geophysical survey, geological reports, borrow-pit information, material surveys and reports, and similar information, the accuracy of which is necessarily subject to the limitations of testing, sampling, the natural variation of material or formations being investigated and the measure of certainty with which conclusions can be

drawn from any investigations made. It also applies to any materials utilisation plan provided, as the diagram may be subject to major alterations during the progress of the work, depending on site conditions.

(b) The Employer will not accept any liability for the correctness or otherwise of the information furnished or for any resulting damage, whether direct or consequential, should it appear, during the course of the Contract, that the information supplied is either incorrect or not representative.

2.1.1.17 Protection of the Works and Requirements to be Met Before Construction of Work

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2.1.1.17.1 Nature of Ground and Condition of Work

(a) The Contractor must satisfy himself as to the general circumstances at the site of the Works and the construction thereon, the surface of the ground and nature of the materials to be excavated, the possibility of subsidence from soft ground and bad and broken materials, and falls of rock in or arising out of the Works, and the possibility of floods and landslides, and the rates and prices in the Bill of Quantities will be held to cover all such contingencies.

(b) In order to minimise the possible adverse effects of flooding, the drainage of the natural ground in the vicinity of the earthworks and the drainage works generally shall be carried out in advance of the rest of the Works.

2.1.1.17.2 Drainage

(a) The contractor shall provide temporary drainage works such as drains, open channels, banks, etc and provide and operate temporary pumps and such other equipment as may be necessary for adequately protecting, draining and de-watering the Works and temporary works. This will be in addition to any permanent drainage works specified and installed, and in addition to any temporary drainage works specifically paid for separately.

2.1.1.17.3 Excavations

(a) Excavations for pipe drains, culverts, service ducts and similar structures shall be adequately protected against the possible ingress of water during rainstorms.

2.1.1.17.4 Completed Layer Work

(a) All completed layer work shall be protected and maintained until the following layer is constructed. Maintenance shall include immediate repairs to any damage or defects which may occur and shall be repeated as often as may be necessary to keep the layer continuously intact and in good condition.

2.1.1.17.5 Preparation of Layer Work

(a) Before any completed layer is primed or a succeeding layer is constructed thereon, any damage to the existing layer shall be repaired, so that, after repair or reconstruction, if necessary, it will conform in all respects to the requirements specified for that layer. All repair work other than minor surface damage repairs shall be submitted to the Engineer for inspection before it is covered up.

(b) The previously constructed layer shall be thoroughly cleaned by the removal of all foreign material before construction of a succeeding layer or application of a prime coat, surfacing or surface treatment. In the case of all bituminous work in particular, the existing layer

shall be thoroughly broomed and all dung, clay, mud and other deleterious material completely removed.

(c) Where necessary, the surface shall be sprayed with water before, during and after brooming to remove all foreign material.

(d) Work performed as part of the above obligations shall not be measured and paid for separately, and the cost thereof shall be included in the rates bid for the various items of work requiring protection and the items for the Contractor's establishment on the site, as specified in Section 2.1.2.

2.1.1.18 Faulty Work and Remedial Work

2.1.1.18.1 General

(a) Any work which fails to comply with the Specifications shall be rejected and the Contractor shall, at his own expense, make good any defects, as directed by and to the satisfaction of the Engineer.

(b) When any part of the Works or any equipment or material is found, upon examination by the Engineer, not to conform to the requirements or at any stage before final acceptance is damaged so that it no longer conforms to the requirements of the Specifications, the Engineer may order its complete removal and replacement, at the Contractor's expense, with satisfactory work, equipment or material, or he may permit the Contractor to apply remedial measures in order to make good any such defects or damage.

(c) The actual remedial measures taken shall at all times be entirely at the Contractor's own initiative, risk and costs, but subject to the Engineer's approval regarding the details thereof. In particular, remedial measures shall ensure full compliance with the requirements of the Specifications of the final product, shall not endanger or damage any other part of the Works, and shall be carefully controlled and submitted to the Engineer for examination when completed or at any intermediate stage as may be required.

(d) For the guidance of the Contractor, an indication is given below of what would normally be required in the more common cases of defects or damage, but the Engineer will in no way be bound to accept or approve the measures given below, as the actual remedial measures will be dictated by the circumstances of each particular case.

2.1.1.19 Water

2.1.1.19.1 Supply

(a) It is the Contractor's responsibility to provide clean and sufficient supply of fresh water for both construction purposes and also for all the offices, workshops, laboratories, etc.

(b) The construction water shall be clean, free from suspended solids and undesirable concentrations of deleterious salts and from any matter in quantities considered by the Engineer to be unsuitable for the proposed work. The water shall be applied at the location, in the amounts, and during the hours, including nights, as directed by the Engineer. The distributors used for watering shall be equipped with spray bar and shall be of ample capacity and of such design as to ensure uniform application of water in the amounts directed by the Engineer. Water supplied to the Resident Engineer's offices, laboratories

and camps shall be drinkable to the satisfaction of the Medical Officer of the Area and the Engineer. The water for drinking and cooking purposes shall be filtered, boiled or treated as necessary for human consumption. Water for the Engineer and Employer shall be approved bottled water. All water sources used shall be approved by the Engineer.

2.1.1.20 Drawings Provided by the Contractor

2.1.1.20.1 Preparation

(a) Where the Contractor is required to prepare any drawings for the purpose of this Contract, they shall be prepared as specified below and in accordance with any further requirements specified by the Engineer. The Contractor shall be provided with one transparent polyester standard drawing sheet and one steel schedule sheet, which shall be used as masters for all drawings prepared by him and submitted to the Engineer for consideration.

(b) The Contractor shall submit to the Engineer for his adjudication one transparent polyester print, 0.05mm thick, of each drawing prepared by him. The standard of detailing and quality of print shall be the same as those of the Drawings supplied to the Contractor under the Contract. The Drawings shall be compiled in the English language and shall comply in all respects with the requirements of the Employer.

2.1.1.20.2 Accepted drawings

(a) Accepted Drawings shall form an integral part of the Contract documents, and any drawing not accepted and signed will not be permitted on the site of the Works for construction purposes and / or used for the manufacture of any item. Notwithstanding the approval and / or acceptance and signing of the Drawings, the Contractor shall take full responsibility for all details, discrepancies, omissions, errors, etc, in respect of the said Drawings as well as for the consequences thereof.

(b) The Contractor shall submit only fully complete Drawings in accordance with this specification and shall not be entitled to claim for delays resulting from the submission of incomplete drawings. The Engineer will require a period of four to eight weeks, depending on circumstances, for reviewing the complete drawings.

(c) No direct payment for design, preparation and submission of Drawings will be made and all costs shall be included in the rates bid for the relevant pay items as provided in the Bill of Quantities.

2.1.1.21 Blasting

(a) No blasting shall be allowed.

2.1.1.22 Demolitions

2.1.1.22.1 General

(a) Prior to permitting employees to start demolition operations, an engineering survey shall be performed, by a Competent Person, of the structure to determine structural integrity and the possibility of unplanned collapse of any portion of the structure. Any adjacent

structure where workers may be exposed shall also be similarly checked. The employer shall have, in writing, evidence that such a survey has been performed.

2.1.1.22.2 Demolition plan

In addition, the Contractor shall submit for acceptance, a demolition plan to the Engineer that as a minimum addresses the following:

(a) Worker Safety.

(b) Protection of the public in areas surrounding the demolition site.

(c) Protection of the existing structures not to be demolished.

(d) Emergency procedures and fire protection.

(e) Work sequence.

(f) Protection of the environment.

(g) Means and methods to minimize waste and maximize salvage.

(h) Disposal procedures.

2.1.1.22.3 Demolition guidelines

(a) Before any demolition begins all utilities such as electric, gas, water, steam, sewer, and other service lines shall be de-energized, shut off, capped, or otherwise controlled.

(b) A survey shall be performed to determine whether asbestos, hazardous materials, gases, explosives, flammable materials, or similarly dangerous substances are present at the work site. When the presence of any such substance is apparent or suspected, testing and removal or purging shall be performed and the hazard eliminated before demolition is started. A copy of the survey shall be kept on the project.

(c) Demolition of all buildings and structures shall be conducted under the supervision of a Competent Person. The Competent Person shall conduct field inspections as the work progresses, to ensure that the demolition plan is being implemented and adhered to by the Contractor and to detect hazards that may have developed during the course of the demolition process. A daily inspection shall be documented and any deficiencies corrected immediately.

(d) Prior to concrete cutting operations where energized utilities may be present, the employer shall ascertain by inquiry or direct observation, or by instruments, whether any part of an energized electrical power circuit, exposed or concealed, is so located that the performance of the work may bring a person, tool, or machine into physical or electrical contact with the electrical power circuit and marked.

(e) The Contractor shall implement and follow their submitted dust control plan throughout the demolition process as required.

(f) All floor and wall opening created during the course of demolition shall be guarded and posted according requirements set forth in this program.

(g) All protruding nails or other sharp objects shall be pulled, bent over, or rendered harmless.

(h) No demolition debris shall be dumped from heights greater than 10 feet without the use of enclosed debris chutes.

(i) All stairways, passageway, and ladders being used for access and egress shall be positively identified. All others shall be barricaded and closed entirely.

(j) Housekeeping shall be maintained at all times. Walkways and passages shall be kept clear and defined.

(k) The Contractor shall have a Fire Protection/Hot Work (i.e., welding) policy in place.

(l) Additional fire protection requirements may be required when direct area suppression systems have been deactivated.

2.1.1.23 Access to Contractor's Records, Monthly Site Meetings and Progress Photographs

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2.1.1.23.1 Access

(a) The Engineer shall at all times have full access to all files, drawings, documents, records and whatsoever in connection with the execution of the Works. The Contractor or his authorised representative shall attend meetings on the site with representatives of the Employer and Engineer, at dates and times to be determined by the Engineer. Such meetings will be held for evaluating the progress of the Contract which any of the parties represented may wish to raise.

2.1.1.24 Legal Provisions

2.1.1.24.1 Legal provisions

(a) The Contractor shall keep himself fully conversant with the latest enactment, provisions and regulations of all legislative and statutory bodies and in all respects and at all time shall comply with such enactment, provisions and regulations in regard to executing the Contract.

2.1.1.25 Final Clearance

(a) Upon completion of the Works, the Contractor shall clean up the site and remove all temporary buildings, plant and debris. He shall level off and fine grade all excavated material which is surplus to requirements. The whole of the site shall be left in a clean and workmanlike condition to the satisfaction of the Engineer.

2.1.1.26 Electricity Supply

2.1.1.26.1 Power supply

(a) The Contractor shall provide and maintain at his own expense his own electricity supply. This supply must be adequate to supply the area set aside for his own and the Engineer's office as well as stores and workshops as necessary.

2.1.1.26.2 Apparatus

(a) The Contractor shall provide and maintain all necessary temporary power and lighting and all associated apparatus for the duration of the Contract at his own expense. He must make allowances for the use of the said supplies and equipment by all sub-contractors. Once equipment becomes redundant and having received the approval from the Engineer, the Contractor shall disconnect and remove said equipment and make good any works disturbed at his own expense.

2.1.1.27 Roads and Site to be Kept Tidy

2.1.1.27.1 Roads

(a) The Contractor shall take all necessary care and precautions to ensure that roads and thoroughfares used by him either for the construction of the Works or for the transport of equipment, labour and materials are kept in good repair and condition and not damaged or made untidy as a result of such construction or transport.

(b) In the event of their becoming thus dirtied in the opinion of the Engineer, the Contractor shall immediately take all necessary steps to rectify as required by the Engineer.

(c) Materials, including materials required for Temporary Works, shall be stored in an orderly manner. Rubbish and debris shall be disposed of at least once a week.

(d) Measures shall be taken to prevent mosquito breeding on the Site. The measures to be taken shall include the following:

i. Empty cans, oil drums, packings and other receptacles which may retain water shall be deposited at a central collection point and those not required for future use shall be removed from the Site regularly.

ii. Standing water shall be treated at least once every week with an oil which will prevent mosquito breeding.

2.1.1.28 Safety

2.1.1.28.1 Safety management

(a) The Contractor is responsible for accident prevention and job site safety. This responsibility cannot be delegated to Subcontractors, suppliers, the Employer, or other persons. To this end, the Contractor shall:

i. Promote a safe and healthy work environment.
ii. Provide an accident prevention program.
iii. Promote training programs to improve the skill and competency of all employees in the field of occupational safety and health.
iv. Instruct all employees of safe work methods and practices when assigning work.
v. Ensure that employees have and use the proper protective equipment and tools for the Site. The job.
vi. Ensure that all heavy equipment operators (i.e., cranes, loaders and forklifts) are properly qualified and trained on the specific piece of equipment in use.

vii. Plan and execute all work to comply with the stated objectives and safety requirements contained in the contract provisions, local laws and regulations, and industry standards.
viii. Maintain an orientation program for new employees that includes at a minimum, a review of:
- Potential hazards in the work areas
- Required personal protective equipment and apparel

ix. Hold a minimum of one weekly scheduled safety meetings with its employees.
x. Such meetings shall include a discussion of all observed unsafe work practices or conditions, a review of the accident experience and all corrective actions. The Contractor shall encourage safety suggestions from employees.
xi. Ensure prompt medical treatment is administered to any injured employee.
xii. Undertake a complete investigation of all accidents and implement corrective action to prevent a recurrence.

2.1.1.28.2 Accidents

(a) The Engineer shall be notified by the Contractor immediately any accident occurs whether on Site or off Site in which the Contractor is directly involved which results in any injury to any person whether directly concerned with the Site or whether a third party. Such initial notification may be verbal and shall be followed by a written comprehensive report within 24 hours of the accident.

2.1.1.28.3 Emergency procedures

(a) The Contractor shall have in place written Site-Specific Emergency Procedures and site evacuation plans. These plans shall include how the Contractor and their personnel will deal with severe weather conditions, natural disasters such as earthquakes or a higher security alert status, and construction related emergencies. The plan shall include primary and secondary location/assembly points where Contractor personnel will meet following such conditions, and how personnel will be accounted for.

(b) The Contractor shall advise employees of these assembly points at their initial safety orientation. This information shall be posted at the project site and updated as conditions change.

2.1.1.28.4 Subcontractors

(a) The Contractor shall insure that all Subcontractors and sub-tier contractors working under their direction comply with all applicable laws, regulations, ordinances, conditions of the contract, or orders of any public authority having jurisdiction relating to the safety of persons or property.

2.1.1.28.5 Protective equipment

(a) Personal Protective Equipment (PPE) shall be provided to employees, used where required, and maintained in proper condition.

2.1.1.28.6 Storage and handling of hazardous materials

(a) The Contractor shall train employees in the proper storage and handling of hazardous materials (i.e., flammable, combustible, toxic) and hazardous wastes.

(b) Transportation of any material by the Contractor shall be in suitable vehicles which when loaded does not cause spillage and all loads shall be suitably secured. Any vehicle which does not comply with this requirement or any of the local traffic regulations and laws shall be removed from the Site. Arrangement shall be made with

the appropriate Authority before entering in or working on existing and associated works.

2.1.1.29 Working platforms/Scaffolding

2.1.1.29.1 Scaffolding

(a) Working platforms are to be provided to enable the work to be safely and effectively carried out.

(b) Ensure that standing scaffolding is erected early enough and/or dismantled late enough to suit the programmes of all sub-contractors. The Contractor shall comply with the need to prevent unauthorised access to the scaffolding, other parts of the building or adjoining buildings.

(c) Scaffolding shall comply with **BS END 74:1-3, BS END 12810-2:2003 & BS END 12811-1:2003.**

2.1.1.30 Tests of Materials and Manufactured Articles before Use

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2.1.1.30.1 Tests

(a) Any or all of the materials and manufactured articles supplied by the Contractor for use on any of the Works throughout this Contract shall be subject in advance to tests as may be specified in the relevant Standard Specification as may from time to time be deemed necessary by the Engineer.

(b) Samples of all such materials and manufactured articles, together with all the necessary labour, materials, plant and apparatus for sampling and for carrying out of tests on the site on all such materials and manufactured articles shall be supplied by the Contractor at his own expense.

(c) The cost of special tests ordered by the Engineer to be carried out by an independent person at a place other than the site or place of manufacture or fabrication shall be borne by the Contractor.

2.1.1.31 Operation and Maintenance Materials

2.1.1.31.1 O & M manuals

(a) The Contractor is required to provide in triplicate and in English, details of all the different manufactured plant and components incorporated in the Works including but not limited to all pertinent manufacturer's brochures.

(b) Substantial completion of the scheme will not be considered until such detailed information as is required has been submitted to and accepted by the Engineer.

2.1.1.32 Abbreviations

1. The abbreviations herein, together with others in general use, are applicable to the Contract Drawings and the Contract Documents, including General Conditions, General Requirements and Technical Specifications.

2. Common Usage: Whenever the following abbreviations are used, they shall have the meanings indicated:

°C	degrees Celsius
g	gram
g/mL	gram per millilitre
g/m^2	gram per square metre
ha	hectare
hr	hour
Hz	hertz
J	joule
Kg	kilogram
kHz	kilohertz
kJ	kilojoule
km	kilometre
km/hr	kilometre per hour
kN	kilonewton
kPa	kilopascal
kV	kilovolt
kW	kilowatt
L	litre
L/min	litre per minute
L/s	litre per second
m	metre
m^2	square metre
m^3	cubic metre
m/s	metre per second
Mg	megagram
Mg/m^3	megagram per cubic metre
Min	minute
mL	millilitre
mm	millimetre
mm^2	square millimetre
mm^3	cubic millimetre
mm/s	millimetre per second
MPa	megapascal
N	newton
N/mm	newton per millimetre
N/m2	newton per square metre
No.	number
Pa.s :	pascal second
r/min :	revolution per minute
r/s :	revolution per second
s :	second
t :	tonne
µm :	micrometre
% :	percentage
DN	nominal bore
PN	pressure rating in bar
max	maximum
min	minimum
ch	chainage (distance in metres)
eo	extra over

ne	not exceeding
P. Sum	Provisional Sum
P.C.	Prime Cost
fob	free on board
cif	cost, insurance and freight
wt	weight
HYS	high yield steel
PCC	precast concrete
uPVC	unplasticized polyvinyl chloride
GMS	galvanised mild steel
DI	ductile iron
GRP	glass reinforced plastic
HDPE	high density polyethylene
SV	sluice valve
AV	air valve
WO	washout valve
CP	codes of practice
PFA	pulverised fuel ash
PPFAC	portland pulverised fuel ash cement
OPC	ordinary portland cement
SRPC	sulphate resisting portland cement
HSFG	high strength friction grip

3. Institutions: Wherever the following abbreviations are used they shall have the meanings indicated:

AASHTO	American Association of State Highway and Transportation Officials
AWWA	American Water Works Association
ACI	American Concrete Institute
ACRI	Air Conditioning and Refrigeration Institute
AI	Asphalt Institute
AISC	American Institute of Steel Construction
ANSI	American National Standards Institute
ASCE	American Society of Civil Engineers
ASHRAE	American Society of Heating, Refrigerating, and Air Conditioning Engineers
ASTM	American Society for Testing and Materials
AAMA	American Architectural Manufacturers Association
BS	British Standard
BS EN	European Standard adopted as British Standard
BSCP	British Standard Code of Practice
ISO	International Organisation for Standardisation

2.1.1.33 References and Standards

BS EN 74-1(2005): Couplers, spigot pins and baseplates for use in falsework and scaffolds. Couplers for tubes. Requirements and test procedures

BS EN 74-2 (2008): Couplers, spigot pins and baseplates for use in falsework and scaffolds. Special couplers. Requirements and test procedures

BS EN 74-3 (2007): Couplers, spigot pins and baseplates for use in falsework and scaffolds. Plain base plates and spigot pins. Requirements and test procedures

BS EN 12810-2 (2003): Façade scaffolds made of prefabricated components. Particular methods of structural design.

BS EN 12811-1 (2003): Temporary works equipment. Scaffolds. Performance requirements and general design.

BS EN 61439-1 (2009): Low-voltage switchgear and controlgear assemblies. General rules

BS EN 61439-2 (2011): Low-voltage switchgear and controlgear assemblies. Power switchgear and controlgear assemblies

BS EN 62271-200 (2012): High-voltage switchgear and controlgear. AC metal-enclosed switchgear and controlgear for rated voltages above 1 kV and up to and including 52 kV

BS 7354 (1990): Code of practice for design of high voltage open terminal stations.

2.1.2 ENVIRONMENTAL CONTROLS

2.1.2.1 Contractor's responsibilities

2.1.2.1.1 Compliance

(a) Be familiar and fully comply with the requirements of the Kenya Organic Law No. 04/2005 and its Environmental Impact Assessment Guidelines (2006).

(a) Obtain a copy & the Environmental Impact Assessment [EIA] and Environmental Audits from the Employer and fully comply with the recommendations described therein.

(b) Comply with regulations as required by the National Environment Management Authority (NEMA) and other applicable Authorities Having Jurisdiction including the Ministry of Environment

(b) Regulations pertaining to Waste, Effluent Monitoring, Air, PCB'S, Spills, 3 R Regulations and any other regulations affects the environment.

(c) Local Bylaws pertaining to sewer use and any other environmental requirements.

(d) Submit to Engineer a copy of Environmental Policy and a programme to implement the Policy prior to the commencement of the Work.

2.1.2.2 Discovery of unexpected contamination

2.1.2.2.1 Unexpected contamination

(a) During construction, contamination, which was not identified in previous site investigations, may become evident. This contamination may include;

i. Visibly contaminated soils (e.g., oil staining, organic);
ii. Soils containing methane gas (e.g., organic materials);
iii. Contamination in soil identified after testing;
iv. Building materials suspected of containing asbestos, PCB's or lead-based paint; and contaminated building materials.
v. Buried storage tank, fuel lines, and similar items.

(b) If unexpected contaminated materials are encountered, immediately inform Engineer and request direction on how to proceed.

2.1.2.3 Spills

2.1.2.3.1 Definition

(a) A spill is defined as a discharge "Into the natural environment, from or out of a structure, vehicle or other container, that is abnormal in quality or quantity in light of all the circumstances of the discharge".

2.1.2.3.2 Responsibility

(a) The Contractor is solely responsible and liable for, without being limited to, all clean up, reporting, repairs, removal, damages and associated costs, and any other actions arising from the spill.

(b) If a spill occurs, the Contractor shall, at its own expense:

i. Comply with the Construction Code
ii. Report the spill to the Ministry of the Environment.
iii. Contain the spill in a safe manner.
iv. Communicate the details immediately to the Engineer. Report the type of spill, quantity, and exact location, advise if any contaminant has entered a sewer line, floor drain or impacted any ground, which is not paved,
v. Proceed to clean up the spill in accordance with the contractor's environmental policy.
vi. Provide the necessary testing for contaminant levels and secure the necessary documentation for clean-up and disposal.

2.1.2.4 Contingency plan for control and clean-up of spill

2.1.2.4.1 Contingency plan

(a) Prior to commencing construction, prepare contingency plan for control and clean-up of spills.

2.1.2.5 Noise control

2.1.2.5.1 Noise control

(a) Control noise and vibration generated by Work.

(b) Have construction equipment used on Site comply with sound emission limits outlined in Local Authority noise by-laws. Provide temporary sound attenuation devices as required.

(c) Perform work using equipment and methods that do not create noise or vibrations that are considered by employer to be excessive or detrimental 10 ongoing airport operations. Noise levels that interfere with normal levels of conversation at security checkpoint immigration desks, customs desks or airline counters are deemed excessive. Use whatever

guards' equipment or shields that may be necessary to keep noise at an acceptable level. The maximum permissible noise level in airport operational spaces at any time of operational use is 75dB.

(d) Construction activities that create noise or vibration that is required to be stopped shall not be chargeable to owner. Employer will not pay delays, standby charges or any other contractor cost as a consequence of instances where the work is required to be stopped.

2.1.2.5.2 Noise abatement

(a) In addition to requirements of the anti-noise by-laws, take special precautions and apply noise abatement measures to reduce public exposure to noise to a minimum.
(b) These precautions and measures consist of, but are not limited to, the following:
   i. Shields or other physical barriers to restrict the transmission of noise.
   ii. Soundproof housings or enclosures for noise producing machinery such as compressors, pumps, motors or generators.
   iii. Efficient intake and exhaust silencers on air equipment.
   iv. Efficient intake and exhaust mufflers on internal combustion engines.
   v. Sound deadening lining material on hoppers and storage bins.
   vi. Conducting truck loading, unloading and hauling operations so that noise is kept to a minimum.
   vii. The use of electric rather than internal combustion engine power on chain saws, hoisting equipment in fixed locations, or other equipment, where electric power is available.
   viii. Placing stationary noise producing equipment at maximum distance from public areas.

2.1.2.6 Dust control

2.1.2.6.1 Dust

(a) During progress of the Work, provide adequate measures to control dust.

(b) Cover or wet down dry materials to prevent blowing dust and debris.

(c) Prevent blowing dust on and from the Site from paved and unpaved temporary roads and excavated areas by wetting.

(d) Comply with Ministry of the Environment and the Engineer's requirements regarding minimizing dust and airborne pollution.

(e) Wash down the streets within the Work Site on a weekly basis and as additionally directed by the Engineer.

(f) Securely cover excavated material being removed from the Site and all fill materials being delivered to the Site to prevent blowing of dust or tines into the streets and haul routes.

(g) Transport dusty materials in covered haulage vehicles.

(h) Transport wet materials in suitable watertight haulage vehicles.

2.1.2.7 Odour control

2.1.2.7.1 Odour

(a) Do not use products with strong odour, if product odour is unacceptable to Engineer change product to acceptable product at no additional cost to Employer

2.1.2.8 Insect and Pest Control

2.1.2.8.1 Insect and pest control

(a) The Contractor shall provide control measures, restraining procedures, and treatments to prevent infestation and spread of insects, rodents and other pests deemed to be present at Site and/or noticed during course of the Work.

(b) Carry out fumigation, pest control procedure, and posting of warning signs, notices including contents of such notices in accordance with requirements of International Pesticide Code of Conduct FAO (1985) and any other authorities having jurisdictions. Pesticides used shall be in accordance with International Pesticide Code of Conduct FAO and any other authorities having jurisdictions.

2.1.2.9 Equipment fuelling, maintenance and storage

2.1.2.9.1 Equipment fuelling, maintenance and storage

(a) Obtain the Engineers acceptance of refuelling areas.

(b) Submit procedures for interception and rapid clean up and disposal of fuel spillages to Engineer for review prior to starting Work.

(c) Ensure that materials required for clean-up of fuel spillages are readily accessible on Site at all times, Carry out refuelling of equipment at acceptable refuelling areas.

(d) Ensure that water used for cleaning of equipment does not drain into streams, lakes or watercourses. Do not empty fuel, lubricants and/or pesticides into any watercourse, or on ground. Clean construction equipment prior to entering public roadways to prevent littering. Do not permit debris from cleaning equipment into storm sewers or watercourses.

(e) Store equipment and materials in orderly manner and in location acceptable to the Engineer.

2.1.2.10 Protection of natural environment

2.1.2.10.1 Protection of natural environment

(a) Submit to Engineer an environmental plan.

(b) Site waste management implementation plans (if any), and sketch showing areas proposed to be used for construction storage, areas for implementation of Site separation of construction waste, and including dimensions of such areas and location and size of trees within and adjacent to these areas.

2.1.2.11 Site Review

2.1.2.11.1 Site visits

(a) Ministry of the Environment, Local Authorities or their representatives, having jurisdiction may visit Site periodically during construction. Where Work does not comply with environmental protection requirements, said authorities have power to place a stop work order. Engineer's acceptance of Work may be withheld until Ministry of the Environment or other Local Authorities concerned has issued their approval.

2.1.3 CONTRACTOR'S ESTABLISHMENT AND GENERAL OBLIGATIONS

2.1.3.1 Scope

(a) This Section covers the establishment of the Contractor's organisation, camp and constructional plant off the site and their removal on completion of the contract. It also covers payment for certain general obligations, risk and liabilities and general items of cost not covered elsewhere.

2.1.3.2 Use of the site

2.1.3.2.1 Site use

(a) The Site shall not be used by the Contractor for any purpose other than for executing the Works or carrying out other work which is associated with the Works and approved by the Engineer**.**

(b) Concrete batching and mixing plant erected on the Site shall not be used to provide concrete for work outside the Site.

(c) Bituminous materials batching and mixing plant erected on the Site shall not be used to provide bituminous materials for work outside the Site.

(d) Rock crushing plant shall not be erected on the Site unless stated in the Contract.

(e) The location and size of stockpiles of materials, including excavated material, within the Site shall be as agreed by the Engineer. Stockpiles shall be maintained in a stable condition.

(f) Entry to and exit from the Site shall be obtained only at the locations stated in the Contract or agreed by the Engineer.

2.1.3.3 General requirements

2.1.3.3.1 Camps, constructional plant and testing facilities

(a) The Contractor shall establish his construction camps, offices, stores, workshops and testing facilities off the site.

(b) The exact location of these facilities shall be approved beforehand by the Engineer. Ablution and other facilities for site staff shall also be provided off the site as required and the standard of accommodation and the location of all facilities shall comply with the requirements of the authorities concerned and those of the Engineer.

(c) Prior to starting with construction, the Contractor shall also move all constructional plant to the Site. On completion of the work and after receiving approval in writing from the Engineer, all constructional plant, buildings, fencing and other temporary structures shall be removed and the camp site shall be restored to its original condition and left neat and tidy.

2.1.3.3.2 Building regulations

(a) All buildings erected by the Contractor upon the site and camp site or sites and the layout of the buildings and the sites shall comply with the Laws of Kenya and all Bye-Laws in so far as they are applicable.

2.1.3.3.3 Signboards

(a) The Contractor shall provide and erect a signboard at the main entrance to the Site were directed by the Engineer. The board, with suitable inscription, shall include the name of the Project, the name of the Employer, the name of the Consultant and the name of the Contractor, etc. The board approx. 3.30m x 3.20m size, shall be approved by the Engineer, before erection.

2.1.3.3.4 Maintenance during construction

(a) During construction the Contractor's camps and other facilities shall be maintained in a neat and tidy condition.

2.1.3.3.5 Legal and contractual requirements and responsibility to the public

(a) The Contractor shall take all the necessary steps to comply with the Conditions of Contract, particularly in respect of the insurances and sureties required and his general obligations to the public and the Employer. He shall comply with all the regulations of statutory bodies.

2.1.3.3.6 Liaison with Government and Police Officials

(a) The Contractor shall keep in close contact with the Police and other Government officials of the area regarding their requirements in the control of traffic and other matters and shall provide all assistance or facilities which may be required by such officials in the execution of their duties.

2.1.3.4 Contractor's Offices, Stores, Workshops, Etc.

2.1.3.4.1 General

(a) Offices for the Contractor's supervisory staff and administration shall be erected by the Contractor at his own expense at a location to be agreed upon with the Engineer.

2.1.3.4.2 Contractor's offices, stores and workshops

(a) The Contractor shall provide and maintain at an approved location a suitable office together with such site offices as may be necessary for the efficient control of the Works. He shall also provide and maintain on approved sites sufficient suitable stores, tanks and workshops for the proper storage of materials, fuel, plant and equipment and the efficient maintenance of all such plant and equipment.

(b) The stores shall be of such size and construction as to provide adequate storage and protection for stocks of materials, fuel, spares and the like in quantities ensuring uninterrupted progress of the work and the workshops shall be suitably equipped for carrying out major repairs, overhaul or modification by the Contractor of all plant and equipment in or on the Works and other work connected with the permanent work.

2.1.3.4.3 Contractor's quarters and camps

(a) No Labour camps will be allowed on site.

2.1.3.4.4 First aid

(a) The Contractor shall provide, equip and maintain adequate first-aid stations throughout the Works, and erect conspicuous notice boards directing where these are situated and provide all requisite transport.

(b) The Contractor shall comply with the government medical or labour requirements at all times and provide, equip and maintain base dressing stations, where directed and at all times have experienced first-aid personnel and dressers available throughout the Works for attending minor injuries.

2.1.4 ENGINEER'S ACCOMMODATION AND ATTENDANCE UPON ENGINEER AND HIS SITE PERSONNEL

2.1.4.1 Scope

(a) The Section covers the provision of facilities for the supervisory staff of the Engineer and for the Employer.

2.1.4.2 Facilities for the Engineer

2.1.4.2.1 General

(a) The Contractor shall provide and maintain an office, survey equipment etc for the Engineer, his staff and for the Employer. Materials and workmanship shall be to generally recognised standards for temporary, prefabricated or permanent buildings of this type.

(b) Detailed drawings showing the design, the construction details, the type of materials proposed and their characteristics, shall be submitted by the Contractor for the Engineer's approval, which shall be obtained before starting the construction of the office or ordering the relevant materials.

(c) All buildings for offices shall be constructed from approved materials. Materials containing asbestos shall not be used. The Contractor shall provide the buildings with potable water, electricity, sanitary installations, sewage disposal arrangements, furniture and equipment, and shall maintain them, all to the satisfaction of the Engineer, 24 hours of the day during the Contract Period.

(d) All facilities shall conform to the best standards for the required types. The facilities described herein shall be understood to represent the minimum requirements. The Contractor shall provide all additional incidentals necessary, so that the facilities will be completely adequate and satisfactory in every respect for the intended use. All equipment and furniture shall be new and unused when initially put in place.

(e) The Contractor shall maintain, replace and / or restore as directed, any facilities or parts thereof that become damaged, worn out, lost or stolen, except through causes due to negligence. The Contractor shall also provide an adequate stock of all expendable items, such as light bulbs, light tubes, kitchenware, soap, towels, toilet paper, paper towels,

drinking cups, materials and accessories and at all times ensure proper and continuing functioning of all components and parts of the Engineer's office.

(f) The offices and installations, etc including all required equipment to be provided under this Contract shall be handed over to the Engineer in finished and fully functioning condition not later than 1 month after the Engineer's order to commence Work (according to the relevant clause of the Conditions of Contract) and such buildings shall be to the entire satisfaction of the Engineer. Suitable temporary office for the Engineer and his staff shall be provided from the date of the order to commence the Works until such time as the permanent office is available for use.

(g) The offices for the Engineer shall be adjacent to the Contractor's establishment.

(h) The Site office shall be connected to water and an electricity supply. The Contractor shall be responsible for cleaning and maintaining the office and toilets and shall provide soap, towels and all necessary fittings and cleaning materials.

2.1.4.3 Attendance upon Engineer

2.1.4.3.1 Assistance to the Engineer

(a) The Contractor shall provide all assistance such as labourers, all tools and protective clothing, wooden pegs, iron pins and pickets, water, cement and aggregate for concreting, transport for labour and materials, as may be required by the Engineer and his staff for checking, setting out, surveying and measuring or testing the work.

2.1.5 EARTHWORKS

2.1.5.1 Site Visit

2.1.5.1.1 Site visit

(a) The Contractor is recommended to visit the Site before tendering and to ascertain the nature of the ground to be excavated. No claims arising from failure to do so will be considered. Trial holes may be dug at the Tenderer's expense if prior permission is obtained from the Engineer.

(b) Trial holes must be reinstated to the approval of the Engineer after inspection.

2.1.5.2 Definitions

2.1.5.2.1 Generally

(a) "Top soil" is soil capable of supporting vegetative growth.

(b) "Suitable material" shall be approved and to consist of naturally occurring or processed material which at the time of deposition is capable of being compacted in accordance with the specified requirements to form stable areas of fill. The soluble sulphate content of the material placed within 500 mm of concrete, cement bound material or cementitious material shall not exceed 1.9 grams of sulphate, expressed as SO_3, per litre. The total sulphate content, expressed as SO_3, of the material placed within 500 mm of metal work shall not exceed 0.5% by mass.

(c) The method of testing of the total sulphate content shall be in accordance with **BS 1377**.

(d) "Unsuitable material" is material other than suitable material and shall include the following:

i. Material susceptible to volume change, including marine mud, soil with a liquid limit exceeding 65% or a plasticity index exceeding 35%, swelling clays and collapsible soils.

ii. Peat, vegetation, timber, organic, soluble or perishable material.

iii. Dangerous or toxic material or material susceptible to combustion, and

iv. Metal, rubber, plastic or synthetic material.

(e) "Rock" is hard material which in the opinion of the Engineer can only be removed by the use of blasting, wedges or pneumatic drills and shall include individual boulders or other masses exceeding 0.20 m^3 in size.

(f) "Rock fill" shall consist of pieces of hard, durable rock of which, in the opinion of the Engineer, not more than 30% by mass is discoloured or shows other evidence of decomposition. Concrete, masonry, brick and similar materials shall not be used instead of rock unless permitted by the Engineer. No individual particle shall exceed 0.1 m^3 in size or the thickness of the filling whichever is the least, suitably graded for deposition and compaction.

(g) "Hardcore" shall comprise the following material to pass rings varying from 28 to 150 mm, or else, single sized hardcore may be used:

i. Rockfill.

ii. Broken stone, hard brick, concrete or other comparable hard, inert, approved material. The material shall be free from dust, rubbish or deleterious foreign matter.

(h) "General filling material" shall be "suitable material". It may contain up to 25% rock distributed evenly throughout the whole mass of the material. General filling material shall contain no material exceeding 200 mm in size.

(i) "Special filling material" shall be "general filling material" capable of passing through a 75 mm BS sieve. The material shall be sampled and tested according to **BS 1377**.

(j) "Embankment", "filling area" or "area of fill" means an area on the Site other than a foreshore or sea-bed where the ground level shall be raised by filling in layers as part of the Works.

(k) "Trench excavation" means excavating from ground level not exceeding 5000 mm in width at surface.

(l) "Bulk excavation" means excavation in the open other than trench excavation.

Note: The definitions of trench excavation and bulk excavation stated in sub-clauses (k) and (l) are for the purposes of the Specification only and do not apply to the measurement of excavation in Bills of Quantities which are measured in accordance with the current edition of the Standard Method of Measurement of Building Works for use in East Africa.

2.1.5.3 Materials

2.1.5.3.1 Fill material

(a) Fill material shall consist of naturally occurring or processed material which at the time of deposition is capable of being compacted in accordance with the specified requirements to form stable areas of fill.

(b) Fill material, other than public fill, shall not contain any of the following:

i. material susceptible to volume change, including marine mud, soil with a liquid limit exceeding 65% or a plasticity index exceeding 35%, swelling clays and collapsible soils,
ii. peat, vegetation, timber, organic, soluble or perishable material,
iii. dangerous or toxic material or material susceptible to combustion, and
iv. metal, rubber, plastic or synthetic material.

(c) Special fill material shall consist of material which has a liquid limit not exceeding 45%, a plasticity index not exceeding 20% and a coefficient of uniformity exceeding 50.

(d) Granular fill material shall consist of clean, hard, durable material.

(e) Rock fill material shall consist of pieces of hard, durable rock of which in the opinion of the Engineer not more than 30% by mass is discolored or shows other evidence of decomposition. Crushed rock or crushed concrete may be permitted subject to approval by the Engineer.

(f) Hardcore filling shall be good hard stone, ballast or quarry waste to the approval of the Engineer, free from dust, broken from 150mm gauge downwards or to be 75% of the finished thickness of the layers being incorporated, whichever is the lesser. Hardcore shall be free from all weeds, roots, vegetable soil, clay, black cotton soil or other unstable material.

It shall be well graded with sufficient small material incorporated to fill all interstices and laid in layers not exceeding 200mm thick, each layer well compacted by at least 8 passes of a 10-ton smooth wheeled roller or a 2 ton vibrating roller until all movement ceases. Sufficient water is to be added to obtain maximum compaction to the Engineer's approval. To each layer a 25mm thick layer of sand complying with the specification for fine aggregate for concrete shall be spread over the surface and forced into the hardcore by the use of a vibrating roller weighing not less than 2 tons. This operation should be carried out when the materials are dry and repeated whilst the sand is well watered. Should all the sand be absorbed, the Engineer may require a further layer to be applied and the process repeated.

The top surfaces of the hardcore shall be levelled or graded to falls as required and shall then be blinded with a layer of similar material broken to 25mm gauge and finished with a 10 ton smooth-wheeled roller. The surface so obtained shall be to the Engineer's approval

(g) The soluble sulphate content of fill material placed within 500 mm of concrete, cement bound material or cementitious material shall not exceed 1.9 grams of sulphate, expressed as SO_3, per litre.

(h) The total sulphate content, expressed as SO_3, of fill material placed within 500 mm of metalwork shall not exceed 0.5% by mass.

(i) The use of public fill as fill material for earthwork may be permitted and the size limitation, transportation, stockpiling, deposit, spreading, compaction and any particular requirements of such material shall be as stated in the Contract.

(j) Well-graded material shall consist of material which has a coefficient of uniformity exceeding 10.

(k) Uniform-graded material shall consist of material which has a coefficient of uniformity of 10 or less.

2.1.5.4 Excavation

2.1.5.4.1 Generally

(a) Carry out and adequately support excavation in such a manner to maintain excavations in a stable condition and to prevent settlement of structures or utilities due to excavation or dewatering.

(b) Constructional Plant or other vehicles shall not be operated or parked adjacent to excavations, and earthworks, materials or other materials shall not be placed adjacent to excavations unless this has been allowed for in the design of the Temporary Works for the support of the excavation.

(c) Keep excavation free of water in accordance with Clause 2.1.5.13.

(d) Neatly trim the face of excavation.

(e) Carry out excavation to the lines, levels, dimensions and slopes specified.

(f) Carefully level the bottom of excavation and step or bench horizontally as specified. Remove any pockets of soft material or loose rock in the bottoms of pits and trenches and fill the resulting cavities and any large fissures with Grade 10 concrete. Do not trim the side faces of excavations for at least 24 hours after placing any blinding concrete required by the Contract.

(g) Backfill and compact strictly in accordance with the Specifications and at no extra cost "over-excavated" areas where the Contractor's proposed method of excavation, if approved, involves excavation in excess of that specified in certain areas.

(h) Maintain excavated surfaces to be used for construction traffic at a level of 300 mm minimum above formation level unless in rock. Make good any damage to the surface arising from such use with material having the same characteristics as the material which has been damaged.

(i) Ensure that no construction traffic uses an area once trimming to final formation level has commenced, with the exception of plant necessary for such trimming, and ensure that no damage is caused to the surface by this plant.

(j) Make good, at no extra cost, surfaces which, after excavation, have been allowed to deteriorate to a condition that makes compaction of backfilling impracticable, either by carrying out additional excavation and filling in accordance with this Specification or, by waiting until the condition of the exposed material is, in the opinion of the Engineer, fit to receive the approved backfill.

(k) Excavate in such a manner that suitable material is kept separate and store in temporary spoil heaps, where required for use in the Works without contamination by unsuitable material or deterioration. Where, in the opinion of the Engineer, suitable material has become contaminated by unsuitable material or allowed to deteriorate, this material shall be removed from Site and replaced with suitable imported material at the Contractor's expense.

(l) Take necessary precautions to prevent damage to existing drains and services encountered in and around the excavation. Should any damage occur, notify the Engineer and the relevant authorities concerned immediately and make good at no extra cost. When so instructed, temporarily divert ditches, land drains or other waterways encountered in the excavation and subsequently reinstate.

(m) Take necessary precautions to prevent damage to tops of piles during excavation.

(n) Bottoms of excavation shall be approved before any new work is laid. Inform the Engineer when excavation is ready for inspection. Do not trim and blind the bottom of excavation without approval.

2.1.5.4.2 Obstructions

(a) Notify the Engineer of the location and nature of any buried obstruction encountered during excavation. Take up disused drains encountered in the excavation and clear away. Remove any contaminated earth. Disinfect as necessary and seal off ends with concrete. Break up and remove disused manholes and backfill where required with approved material properly compacted.

(b) Break out and remove old walls, foundations, piles and other underground structures encountered in the excavation and backfill where required with approved material properly compacted.

2.1.5.4.3 Removal of excavated material

(a) Remove unsuitable material from Site. Do not remove suitable material from Site without the permission of the Engineer, unless surplus to requirements of the Contract. Unsuitable material and surplus materials shall become the property of the Contractor unless otherwise provided for in the Contract.

(b) Inform the Engineer of the proposed dumping areas and take responsibility for making arrangements for disposal of these materials. Notwithstanding the foregoing the Engineer retains the right to direct the manner in which dumping is to be carried out.

2.1.5.4.4 Excavations adjacent to structures and utilities

(a) Excavations shall be carried out by hand adjacent to utilities that are known, proven or suspected to exist.

(b) Unless otherwise permitted by the Engineer excavations next to structures shall be carried out by hand.

2.1.5.5 Excavation material

2.1.5.5.1 Interpretation

(a) The Engineer will determine the class and extent of each type of excavation material. Where the Contractor considers that materials to be excavated may be of any class other than CLASS 2 (NORMAL or SOFT) he must inform the Engineer in sufficient time for the Engineer to determine the class and the precise extent of such material. Should the Contractor fail to inform the Engineer in sufficient time, all excavated material will be deemed to be Class 2.

2.1.5.5.2 Class 1: Rock or Hard Material

(a) All material which cannot be removed except by blasting or by the use of metal wedges and sledgehammers or by ripping with a heavy tractor and rear-mounted hydraulic single type heavy-duty ripper.

(b) Boulders greater than 0.5 m^3 when their nature and size is such that they cannot be removed without recourse to one or more of the methods described in 1 above. Where such boulders

constitute 50% or more of the volume of a particular part of the excavation, such part will be considered Class 1 material throughout.

2.1.5.5.3 Class 2: Normal or Soft Material

(a) All material which can be removed without recourse to the methods described for Class 1 above and / or Classes 3 or 4 below.

2.1.5.5.4 Class 3: Compacted Gravel or Decomposed Rock

(a) All material such as consolidated murram or gravel, decomposed or stratified rock, stones and boulders less than 0.5 m^3, harder than Normal or Soft Material but which can be excavated by ripping or which, in confined spaces, requires excavation by hand using compressor tools.

2.1.5.5.5 Class 4: Waterlogged Material

(a) All material which is waterlogged at the time of excavation and which necessitates de-watering and pumping. Rates entered in the tender Bills of Quantities against excavation so described will be deemed to include for all de-watering, pumping, construction of sumps and any drains or other incidental construction or operations necessary to the work. Excavations requiring occasional pumping on account of accumulated surface water will not be included in this class.

2.1.5.6 Explosives

2.1.5.6.1 Blasting

(a) Explosives must not be used without the prior approval of the Engineer. Blasting operations are carried out at the Contractor's sole risk, and all blasting must be carried out in accordance with government regulations.

2.1.5.7 Borrow Pits

2.1.5.7.1 Borrow pits

(a) No borrow pits will be allowed to be opened on the site.

2.1.5.8 Protection against Termites

2.1.5.8.1 Termite protection

(a) The ground under surface beds and below suspended wood floors shall be poisoned with an approved registered TERMITICIDE of the chlordane or aldrin type mixed with water. Great care is to be taken to apply the solution evenly over the whole surface. The concentration of the solution shall be in accordance with the manufacturer's instructions and to the approval of the Representative / Agent.

(b) Where the ground to be treated is of earth filling, the upper layer of fill shall be levelled by raking, but where of natural ground, it shall be dug up, well loosened to a depth of not less than 50 mm so as to enable the solution to penetrate into the soil and similarly levelled. After the solution has been applied and allowed to soak in, the soil shall be well rammed and consolidated to at least 90% Modified AASHTO.

(c) Before applying the solution to the ground under the floor, 75 mm deep V-shaped channels shall be raked out alongside all walls enclosing the floors and against sleeper walls and piers etc under floors and the channels flooded with poison solution. After the solution has soaked in, the channels shall be back filled and rammed.

(d) The bottom of all foundation trenches and holes shall be similarly poisoned, but without digging up and loosening the soil.

(e) The poisoned layer of soil under suspended wood floors shall be protected with a 75 mm thick layer of approved clean gravel or broken stone, levelled to an even surface on top.

(f) Where the concrete surface beds are laid above damp course level, the ground at damp course level shall be poisoned as above and a layer of clean earth filling laid on the poisoned ground up to underside of concrete beds, all well consolidated to at least 90% Modified AASHTO.

(g) Great care shall be taken whilst laying the concrete floor beds, protective layers and filling to avoid rupturing the poisoned layer of soil under the floors. Should the poisoned layer be ruptured at any point it shall be made good and the affected areas treated again.

(h) The termiticide shall be delivered to the site in sealed containers, clearly labelled or stamped with the name of the product;

(i) Contractors are advised that special precautions must be taken to protect the workmen working with the termiticide;

(j) The poisoning of the ground under floors shall be done as soon as practicable, so that it may dry out before the floors are laid;

(k) The poisoning of the ground must be carried out under the supervision of the Representative / Agent;

(l) Post signs in areas of application to warn workers that soil termiticide treatment has been applied. Remove signs after areas are covered by other construction.

(m) The Contractor shall provide a written warranty, executed by Applicator and Contractor, certifying that applied soil termiticide treatment will prevent infestation of subterranean termites. If subterranean termite activity is discovered during warranty period, Contractor will re-treat soil and repair or replace damage caused by termite infestation.

(n) Warranty period shall be 10 years from date of substantial completion.

2.1.5.8.2 Application

(a) Apply soil treatment solution as follows:

Under slab on grade structures, treat soil before concrete slabs are placed, using the following application rates:

i. Apply 15 litres of chemical solution per 3m to soil in critical areas under slab, including entire inside perimeter of foundation walls, along both sides of interior partition walls,

around plumbing pipes and electric conduit penetrating slab, and around interior column footers.

ii. Apply 3.75 litres of chemical solution per 3 m^2 as an overall treatment under slab and attached slab areas where fill is soil or unwashed gravel. Apply 5.75 litres of chemical solution to areas where fill is washed gravel or other coarse absorbent material.

iii. Apply 15 litres of chemical solution per 3m of trench for each foot of depth from grade to footing, along outside edge of building. Dig a trench 150 mm to 200 mm wide along outside of foundation to a depth of not less than 300 mm. Punch holes to top of footing at not more than 300 mm OC and apply chemical solution. Mix chemical solution with the soil as it is being replaced in the trench.

(b) Under crawlspace and basement structures, treat soil along exterior and interior walls of foundations with shallow footings as specified above for exterior of slab on grade structures.

Treat soil under or around crawlspace structures as follows:

i. Apply 15 litres of chemical solution per 3m of trench along inside of foundation walls, along both sides of interior partitions, and around piers and plumbing. Do not apply an overall treatment in crawlspaces.

ii. Apply 15 litres of chemical solution per 3m of trench, for each 300 mm of depth from grade to footing, along outside of foundation walls, including part beneath entrance platform porches, etc.

iii. Apply 15 litres of chemical solution per 3m along the inside and outside of foundation walls of porches.

iv. Apply one gallon per 3 m^2 of soil surface as an overall treatment only where attached concrete platform and porches are on fill or ground.

(c) At hollow masonry foundations or grade beams, treat voids at rate of 2 gallons per 3m, poured directly into the hollow spaces.

(d) At expansion joints, control joints, and areas where slabs will be penetrated, apply at rate of 15 litres per 3m of penetration.

(e) All Government laws and regulations, as well as local authorities' regarding the termiticide, shall be strictly adhered to.

2.1.5.9 Damp-Proof Membrane

2.1.5.9.1 Damp proof membrane

(a) A protective membrane of No 500 gauge or 1000 gauge to BS EN 13967:2012, shall be laid over the building under the floor slab where specified.

(b) Where the joints occur, the membrane shall be triple folded with a 150mm fold and taped at 300mm centres with approved 50mm wide adhesive tape. The sheeting shall not be stretched, but shall be laid loose with sufficient wrinkles to permit shrinkage up to 15%.

(c) The Contractor shall include for all necessary costs to ensure that membrane surfaces shall not be pierced during the laying and concreting of floors.

2.1.5.10 Forming of Embankments

2.1.5.10.1 Forming embankments

(a) The Contractor shall carry out the forming of embankments in accordance with the Drawings and shall adhere to the slopes, levels, depths and heights shown thereon.

(b) Unless otherwise directed or permitted by the Engineer, all suitable excavated materials shall be used to form embankments. Any such excavated material which is surplus to this requirement shall be disposed of in tips. Any material which according to the Specification requirements is unsuitable for forming embankments shall be similarly disposed of.

(c) All filling material other than rock in embankments or below formation level in cuttings shall be deposited in layers not exceeding 225mm loose depth unless as a result of compaction trials the Engineer approves spreading to a greater depth up to a maximum of 375mm loose depth. Each layer shall extend over the full width of the embankment and shall be compacted.

(d) Rock used in rock-fill embankments shall be of such size that it can be deposited in horizontal layers each not exceeding 450 mm loose depth and extending over full width of the embankment except for any specified external cover to slopes or new formation level.

The materials shall be spread and levelled by a crawler tractor weighing not less than 15 tonnes. Each layer shall consist of reasonably well-graded rock and all large voids shall be filled with broken fragments before the next layer is placed. The top surface and side slopes of embankments so formed shall be thoroughly blinded with approved fine graded material to seal the surface. Such material may be surface soil on side slopes.

(e) Isolated boulders each within the range 0.05 m^3 to 0.3 m^3 in size may be incorporated more than 600 mm below formation level in embankments not or rock-fill at the discretion of the Engineer, provided that the specified compaction requirements are met. No stone exceeding 0.05 m^3 should be placed less than 600 mm below formation level of carriageways and verges.

(f) During the construction of embankments the Contractor shall control and direct constructional traffic uniformly over the full width.

(g) Fill material shall not be stockpiled on embankments, unless this is permitted by the Engineer.

(h) Should the quantity of excavation from the Works, including that from any widened cuttings, be insufficient to make up the embankments, the deficiency shall be made good by approved imported suitable material and the Contractor shall be responsible for locating and obtaining such material.

(i) Where materials of different characteristics are readily available those of relatively high bearing capacity shall be placed in the topmost 600mm below formation level.

2.1.5.11 Compaction of Earthworks

2.1.5.11.1 Compaction of fill material

(a) Fill material in areas of fill shall be compacted in layers to a stable condition as soon as practicable after deposition and in a manner appropriate to the location and to the material to be compacted.

(b) The permission of the Engineer shall be obtained before the next layer is deposited on each laye of compacted fill material.

(c) Except as stated in Clauses 2.1.5.11.3 (b), 2.1.5.11.4(a) and 2.1.5.12.2(b), fill material shall be compacted to obtain a relative compaction of at least 95% throughout unless otherwise stated in the Contract.

2.1.5.11.2 Moisture content of fill material

(a) Fill material other than rock fill material and material as stated in Clause 2.1.5.11.4(a) shall be at optimum moisture content during compaction. The tolerance on the optimum moisture content percentage shall be ±3%, provided that the fill material is still capable of being compacted in accordance with the specified requirements to form stable areas of fill. All necessary measures shall be taken to achieve and maintain the specified moisture content.

2.1.5.11.3 Compaction of fill material adjacent to structures and utilities

(a) Fill material shall be compacted in such a manner that structures or utilities are not disturbed or damaged.

(b) Fill material around water, sewage and drainage pipes which are constructed as part of the permanent work shall be compacted by hand rammers or manually operated power equipment. Fill material within 300 mm above the top of sewage and drainage pipes shall be compacted to obtain a relative compaction of at least 85% throughout.

2.1.5.11.4 Compaction of rock fill material

(a) Every layer of rock fill material shall be compacted by at least eight passes of a vibrating roller or by other equivalent compaction method approved by the Engineer. The final surface of rock fill material shall be compacted by at least two additional passes of a vibrating roller or by other equivalent compaction method approved by the Engineer.

(b) Vibratory rollers used for the compaction of rock fill material shall have a static load per 100 mm width of roll of at least 2 kN for layers with a compacted thickness not exceeding 500 mm and atleast 4 kN for layers with a compacted thickness exceeding 500 mm.

2.1.5.11.5 Compaction of general fill material with a large portion of coarse material

(a) For general fill material of which less than 90% passing a 20 mm BS test sieve, it will be difficult to permit determination of the moisture content and maximum dry density.

(b) Spread and level each horizontal layer of general fill material with a thickness not less than 1.5 times of the maximum size of the general fill material and not exceeding the maximum depth of compacted layer in accordance with Table 2.1.5.1. If this criterion is not met due to the presence of over-sized coarse material in the general fill, the over-sized coarse material shall be removed or broken down to sizes acceptable to the Engineer. Each layer shall be systematically compacted by a vibratory roller with the stipulated minimum number of passes corresponding to the minimum static load per 100 mm width of the roller.

(c) The number of passes of the roller shall only be counted when the roller is travelled on the material to be compacted at a speed of not more than 2 km per hour with full vibration. The plant other than vibratory roller to carry out material spreading or to provide some preliminary compaction only to assist the use of heavier plant shall be disregarded in counting the number of passes.

(d) Variation from the method or the use of plant different from that specified in Clause 2.1.5.11.4(b) will be permitted only if the Contractor demonstrates at site trials that equivalent compaction is achieved by the alternative method or plant. The procedure to be adopted for these site trials shall be agreed with and approved by the Engineer.

(e) Without prejudice to the provision of the Conditions of Contract and in order that the Engineer may take proper provision for the supervision of compaction in the permanent work, the Contractor shall, not less than 24 hours before he proposes to carry out compaction processes, apply in writing to the Engineer for permission to do so.

(f) When materials of widely divergent grading are used in embankments and fill areas, they shall be spread and compacted in separate clearly defined areas.

(g) If more than one class of material is being used in such a way that in the opinion of the Engineer it is not practicable to define the areas in which each class occurs, compaction plant shall be operated as if only the material which requires the greatest compactive effort is being compacted.

Table 2.1.5.**1: Compaction requirement for general fill material with a large portion of coarse material**

Force per 100 mm width	Well graded material		Uniform graded material	
	Maximum depth of compacted layer (mm)	Minimum no. of passes	Maximum depth of compacted layer (mm)	Minimum no. of passes
0.25-0.45			150	16
0.46-0.70			150	12
0.21-1.25	125	12	150	10
1.26-1.75	150	8	200	10
1.76-2.30	150	4	250	10
2.31-2.80	175	4	275	8
2.81-3.50	200	4	250	8
3.51-420	225	4	300	8
4.21-4.90	250	4	300	8

2.1.5.12 Completion of earthwork surfaces

2.1.5.12.1 Completion of earthworks final surfaces

(a) Earthworks final surfaces shall be completed to a stable condition as soon as practicable after excavation or after deposition and compaction of fill material has been completed. The subsequent permanent work or surface protection shall be carried out as soon as practicable after the earthworks final surface has been completed.

(b) Earthworks final surfaces shall be completed to smooth alignments without abrupt irregularities unless otherwise stated in the Contract.

2.1.5.12.2 Completion of formations

(a) Formations above structures or utilities shall be completed after construction of the structure or utility.

(b) Except in excavations in rock and in areas of fill formed of rock fill material or fill material as stated in Clause 2.1.5.11.4(a) formations shall be compacted to obtain a relative compaction of at least 98% to a depth of 200 mm below the formation.

(c) Unless otherwise permitted by the Engineer, proof rolling shall be carried out on formations. The formation shall be rolled in the presence of the Engineer by at least two passes of a non-vibrating rubber tyred roller. The roller shall have a static load per 100 mm width of roll of at least 4 kN and shall travel at a speed not exceeding 2 km/h. Any defect in the formation which is revealed during proof rolling by deformation of the formation which in the opinion of the Engineer is excessive shall be made good as instructed by the Engineer.

(d) After all other formation work and testing have been completed and damage caused by testing reinstated, formations for pavements shall be rolled with one pass of a smooth steel-wheeled non-vibrating roller. The roller shall have a load per 100 mm width of roll of at least 2 kN.

(e) Unless otherwise permitted by the Engineer, formations which will not be immediately covered by the subsequent permanent work shall be protected by methods agreed by the Engineer.

2.1.5.12.3 Protection of earthworks final surfaces and formations

(a) Earthworks final surfaces and formations shall be maintained in a stable condition and shall be protected from damage due to water or other causes and from exposure to conditions which may adversely affect the surface.

(b) Formations shall not be used by Constructional Plant or vehicles other than those which in the opinion of the Engineer are essential to construct the subsequent work.

2.1.5.13 Earthworks to be kept free of water

2.1.5.13.1 Earthworks to be kept free of water

(a) The Contractor shall arrange for the rapid dispersal of water shed on to or entering the earthworks from any source at any time during construction, or of water which is shed onto the completed sub-grade. He shall provide within the Site where necessary temporary water-courses, ditches, drains, pumping or other means of maintaining the earthworks free from standing water. Water discharged from the Site shall not be run into a road but be carried direct to an approved sewer, ditch or river through troughs, chutes or pipes.

(b) Such provision shall include carrying out the work of forming the cutting and embankments in such a manner that their surfaces have at all times a sufficient minimum crossfall and, where practicable, a sufficient longitudinal gradient to enable them to shed water and prevent ponding.

(c) In pumping out excavations and in any lowering of the water tables the Contractor shall pay due regard to the stability of all structures.

(d) The cost of compliance with the requirements of this Clause shall be covered in the rates for earthworks.

2.1.5.14 Use of Vibratory Compaction Plant

2.1.5.14.1 Vibratory compaction plant

(a) Where vibratory rollers or other vibratory compaction plant are used the mechanism for vibration shall be kept working continuously during compaction operations, except during periods when the Engineer permits or directs discontinuance of vibration.

(b) Unless otherwise permitted by the Engineer, the frequency of vibration shall be maintained within the range of amplitude and frequency recommended by the manufacturers of the plant for the material to be compacted.

(c) The frequency shall be recorded by a tachometer indicating speed of rotation of any shaft producing vibration.

2.1.5.15 Provision of Spoil Heaps

2.1.5.15.1 Spoil heaps

(a) The Contractor shall provide spoil heaps at his own expense for the disposal of surplus materials and all rubbish collected when clearing the Site and during the Construction of the Works. The sites for these shall be approved by the Engineer.

2.1.5.16 Testing: fill material – general requirements

2.1.5.16.1 Batch: fill material

(a) A batch of fill material is any quantity of fill material of the same type and which in the opinion of the Engineer has similar properties throughout. For the purpose of testing for moisture content and relative compaction a batch shall, in addition to the above, be fill material which is deposited in a single layer in any area of fill presented by the Contractor for testing on one occasion.

2.1.5.16.2 Samples: fill material

(a) Each sample of fill material shall consist of at least four increments taken from different parts of the batch. The increments shall be combined and thoroughly mixed and shall then be divided by quartering or by using a riffle box to obtain specimens of an appropriate size to carry out the individual tests.

(b) The size of samples of fill material other than rock fill material shall be in accordance with BS 1377, Part 1, Section 7. Each sample of rock fill material of Grade size not exceeding 200 shall have a mass of at least 250 kg and each sample of rock fill material of Grade size exceeding 200 shall have a mass of at least 1000 kg.

2.1.5.17 References and Standards

BS 1377-1 (1990): Methods of test for soils for civil engineering purposes. General requirements and sample preparation.

BS EN 13967(2012): Flexible sheets of waterproofing, Plastic and rubber damp proof sheets including plastic and rubber basement tanking sheet. Definitions and characterstics.

2.1.6 STEEL REINFORCEMENT

2.1.6.1 Steel Rod Reinforcement

2.1.6.1.1 Materials

(a) Steel rod reinforcement shall consist of:

i. Mild steel bars complying with **BS 4449**

ii. Hot rolled high yield bars complying with **BS 4449**

iii. Cold reduced steel wire **BS 4483**

(b) Where cold worked high yield bars are to be used these shall be square twisted bars formed by a torsion-controlled process.

2.1.6.1.2 Workmanship

(a) The Contractor shall obtain a manufacturer's certificate of test in accordance with the appropriate standard for each steel batch relating to reinforcement delivered to site and shall immediately forward copies of the same to the Engineer for his retention.

(b) Where hot rolled high yield deformed bars are to be used, the results of bond tests to **ASTM C234-91a**, using concrete of the same quality as that to be used in the works shall be forwarded to the Engineer.

(c) Notwithstanding the manufacturer's certificate, the Engineer may require that any reinforcement delivered to the site be sampled and tested. Any reinforcement so sampled and tested which fails to comply with this specification will be rejected.

All reinforcement shall be delivered to the Site either as straight bars or ready- cut and bent to shape.

All reinforcement shall be stored in clean conditions in an orderly manner to the satisfaction of the Engineer such that the batch to which each piece belongs can be readily identified.

2.1.6.2 Steel Fabric Reinforcement

2.1.6.2.1 Materials

(a) Steel fabric reinforcement shall be electrically cross-welded steel mesh reinforcement complying with **BS 4483.**

(b) Epoxy coatings to reinforcement and patching material for epoxy coatings shall comply with **BS ISO 14654**: Parts 1 & 2 except as stated in Clauses 2.1.6.2.1(b). The coatings shall be applied by the electrostatic spray method in accordance with **BS ISO 14654**: Part 1 at a factory approved by the Engineer.

(c) The film thickness of the coating after curing shall be at least 0.15 mm and shall not exceed 0.28 mm over the complete periphery including deformations and ribs. The bond classification of coated bars determined in bond performance tests shall not be less than that of uncoated bars.

(d) Galvanizing to reinforcement shall comply with **BS 729**. Galvanized reinforcement shall be chromate passivated as part of the galvanizing process by quenching the bars immediately after galvanizing in a solution containing at least 0.2% sodium dichromate in water. The galvanizing shall be applied after cutting and bending of the reinforcement.

(e) Metallic zinc-rich priming paint for repairs to galvanized reinforcement shall comply with BS **4652**.

2.1.6.3 Tying Wire

2.1.6.3.1 Materials

(a) Tying wire for reinforcement adjacent to and above Class F4 and F5 finishes shall be 1.2 mm diameter stainless steel wire complying with **BS 1052**.

(b) Tying wire for epoxy coated reinforcement shall be 1.6 mm diameter soft annealed steel wire coated with nylon, epoxy, plastic or other dielectric material.

(c) Tying wire for galvanized reinforcement shall be 1.6 mm diameter galvanized soft annealed steel wire.

(d) Tying wire for other reinforcement shall be 1.6 mm diameter soft annealed steel wire.

2.1.6.4 Tying devices and clips

2.1.6.4.1 Materials

(a) Tying devices and clips for reinforcement shall be a proprietary steel type approved by the Engineer.

(b) Tying devices and clips for reinforcement adjacent to and above Class F4 and F5 finishes shall be stainless steel.

(c) Tying devices and clips for epoxy coated reinforcement shall be coated with nylon, epoxy, plastic or other dielectric material.

(d) Tying devices and clips for galvanized reinforcement shall be galvanized.

2.1.6.5 Cover Spacers

2.1.6.5.1 Materials

(a) Cover spacers for reinforcement shall be concrete blocks or a proprietary plastic or concrete type. Proprietary plastic and concrete cover spacers shall be a type approved by the Engineer.
(b) Cover spacers for Class F3, F4 and F5 finishes shall be a proprietary plastic or concrete type.

(c) Cover spacers for epoxy coated reinforcement and galvanized reinforcement shall be a proprietary plastic type.

(d) Cover spacers shall be as small as practicable consistent with their purpose and shall be designed to maintain the specified cover to reinforcement.

(e) Cover spacers shall be capable of supporting the weight of reinforcement and construction loads without breaking, deforming or overturning.

(f) The strength and durability of concrete blocks and proprietary concrete cover spacers shall not be less than that of the surrounding concrete.

(g) Cover spacers for Class F3, F4 and F5 finishes shall be of a colour similar to that of the surrounding concrete and shall not cause indentations in the formwork.

(h) Chairs, supports and spacers other than cover spacers for reinforcement shall be steel. The steel shall be coated with nylon, epoxy, plastic or other dielectric material for epoxy coated reinforcement and shall be galvanized for galvanized reinforcement.

2.1.6.6 Reinforcement connectors

2.1.6.6.1 Materials

(a) Reinforcement connectors shall be a proprietary type approved by the Engineer.

(b) Reinforcement connectors for tension joints shall be a cold swaged or threaded type. The connectors shall be capable of developing the full tensile strength of the parent bar and shall comprise high tensile steel studs and seamless steel tubes fitted with protective plastic caps.

(c) Reinforcement connectors for compression joints shall be a wedge locking or bolted sleeve type.

2.1.6.7 Handling and storage of reinforcement

2.1.6.7.1 Handling of reinforcement

(a) Reinforcement shall not be subjected to rough handling, shock loading or dropping from a height.

(b) Reinforcement shall be stored off the ground on level supports and in a manner which will not result in damage or deformation to the reinforcement or in contamination of the reinforcement.

2.1.6.7.2 Storage of reinforcement

(a) Fabric reinforcement shall be stored horizontally.

(b) Different types and sizes of reinforcement shall be stored separately.

(c) Reinforcement shall not be stored on or adjacent to concrete surfaces which form part of the permanent work.

(d) Epoxy coated reinforcement and galvanized reinforcement shall be stored on wooden or padded cribbing.

2.1.6.8 Cutting and bending reinforcement

2.1.6.8.1 Cutting and bending reinforcement

(a) Reinforcement shall be cut and bent in accordance with **BS 8666** to the specified shapes and dimensions and shall be bent at temperatures of at least 5°C and not exceeding 100°C.

(b) Epoxy coated reinforcement shall be bent cold. Bar cutting and bar bending equipment for epoxy coated reinforcement shall have padded supports and contact areas shall be fitted with nylon or plastic mandrels.

(c) Grade 460/425 reinforcement shall not be rebent or straightened after bending. Grade 250 reinforcement which projects from the hardened concrete may be bent aside and rebent provided that the internal radius of the bend is at least twice the diameter of the bar and that bending is not carried out by levering against the concrete or by other methods which in the opinion of the Engineer are likely to damage the concrete.

(d) The ends of bars to be used with reinforcement connectors for compression joints shall be sawn square with all burrs removed.

2.1.6.9 Surface condition of reinforcement

2.1.6.9.1 Surface condition of reinforcement

(a) Reinforcement shall be clean at the time of fixing and shall be free from loose mill scale, loose rust or any substance which in the opinion of the Engineer is likely to reduce the bond or affect the reinforcement or concrete chemically; the reinforcement shall be maintained in this condition until concrete is placed around it.

(b) If the surface condition of the reinforcement deteriorates such that it does not comply with the requirements stated in Clause 2.1.6.9.1 (a), the reinforcement shall be cleaned or dealt with by other methods agreed by the Engineer.

2.1.6.9.2 Repairs to epoxy coatings and galvanised coatings

(a) If the coating to epoxy coated reinforcement is delaminated or split at any point or if the coating to epoxy coated reinforcement or galvanized reinforcement is damaged:

- at any point by an amount exceeding 25 mm^2 in area or 50 mm in length, or
- at more than three points in a 1 m length by amounts each even not exceeding 25 mm^2 in area or 50 mm in length,

that part of the reinforcement shall not be used in the permanent work. If the coating to epoxy coated reinforcement or galvanized reinforcement is damaged at more than six points in the cut and bent length of a bar by amounts each even not exceeding 25 mm^2 in area or 50 mm in length, that length of bar shall not be used in the permanent work.

(b) All damaged areas not exceeding 25 mm2 in area or 50 mm in length and cut ends of epoxy coated reinforcement shall be repaired using patching material applied in accordance with the manufacturer's recommendations.

(c) Damaged areas not exceeding 25 mm^2 in area or 50 mm in length and cut ends of galvanized reinforcement shall be repaired by applying two coats of metallic zinc-rich priming paint. Sufficient paint shall be applied to provide a zinc coating of at least the same thickness as the galvanized coating.

(d) Repairs to epoxy coatings and galvanized coatings shall be carried out within 8 hours of cutting or damage. Traces of rust shall be removed from the surface of the reinforcement before the repair is carried out.

2.1.6.10 Fixing reinforcement

2.1.6.10.1 Fixing reinforcement

(a) Bar reinforcement, fabric reinforcement and reinforcement connectors for tension joints from each batch shall not be fixed until testing of the batch has been completed.

(b) Reinforcement shall be fixed rigidly in position and secured against displacement.

(c) A sufficient number of intersecting and lapping bars shall be tied using tying wire, tying devices or clips to prevent movement of the reinforcement. The ends of tying wire, tying devices and clips shall not encroach into the cover to reinforcement.

(d) Laps and joints in reinforcement shall be made only at the specified positions and by the specified method.

(e) Sufficient numbers of cover spacers, chairs, supports and spacers other than cover spacers shall be provided to maintain the reinforcement in the correct location and to maintain the specified cover at all positions. Cover spacers, chairs, supports and spacers other than cover spacers shall be placed at a maximum spacing of 1.5 m. Chairs, supports and spacers other than cover spacers shall be positioned adjacent to or above cover spacers and shall have at least the same cover as that specified for the reinforcement.

(f) Prefabricated reinforcement cages shall be adequately supported and braced before lifting.

(g) Reinforcement which is free-standing shall be secured in position and braced to prevent movement due to wind and other loads.

2.1.6.10.2 Reinforcement connectors

(a) Reinforcement connectors shall be fixed in accordance with the manufacturer's recommendations and using equipment recommended by the manufacturer.

2.1.6.10.3 Welding

(a) Reinforcement shall not be welded unless approved by the Engineer.

2.1.6.10.4 Exposed reinforcement

(a) Reinforcement which is to be left exposed shall be protected by coating with cement slurry or by other methods agreed by the Engineer.

2.1.6.10.5 Access over reinforcement

(a) Reinforcement shall not be contaminated or displaced as a result of access over the reinforcement; access shall be obtained by using planks and ladders or by other methods agreed by the Engineer

2.1.6.10.6 Tolerances

Tolerances on cutting and bending reinforcement shall comply with **BS 8666**, Table 2.

The cover to reinforcement shall be within 5 mm of the specified cover.

2.1.6.10.7 Inspection of reinforcement

(a) The Contractor shall allow the Engineer to inspect the completed reinforcement before carrying out any work, including erecting formwork adjacent to reinforcement, which will make access to the reinforcement difficult. The Contractor shall inform the Engineer 24 hours, or such shorter period agreed by the Engineer, before carrying out such work.

2.1.6.11 References and Standards

BS EN ISO 1461 (2009): Hot dipped galvanised coatings on fabricated iron and steel articles. Specifications and test methods.

BS 1052 (1980): Specification for mild steel wire for general engineering purposes.

BS 8666 (2005): Scheduling, dimensioning, bending and cutting of steel reinforcement of concrete. Specification.

BS 4652 (1995:2000): Specification for zinc-rich priming paint (organic media).

BS ISO 14654 (1999): Epoxy-coated steel for the reinforcement of concrete.

BS 4483 (2005): Steel fabric for the reinforcement of concrete. Specification.

BS 4449 (2005+A2:2009): Steel for the reinforcement of concrete. Weldable reinforcing steel. Bar, coil and decoiled product. Specification

ASTM C234-91a (2011): Standard test method for comparing concrete on the basis of bond development with reinforcing steel.

2.1.7 FORMWORK AND FINISHES TO CONCRETE

2.1.7.1 Materials

2.1.7.1.1 Formwork

(a) Formwork shall be timber, metal, plastic or other material which will produce the specified finish. Materials used as formers for profiled formwork, chamfers, splays, rebates and other features shall be such that they produce the same finish as the main formwork.

(b) Plywood for formwork shall have a close, uniform grain and the edges shall be sealed with barrier paint, polyurethane varnish or other impermeable material.

(c) The faces of formwork for Class F4 and F5 finishes shall have a uniform texture and a matt, not a shiny or polished, surface. The edges of the formwork shall be straight and square.

2.1.7.1.2 Formwork Class of finish

(a) The characteristics of each class of finish shall be as stated in Tables 2.1.7.1, Tables 2.1.7.2, and Tables 2.1.7.3.

(b) Formwork of the type stated in Tables 2.1.7.1 will normally produce a concrete surface which complies with the characteristics of finish stated in Tables 2.1.7.1 but other types of formwork may be used to produce the specified finish.

(c) The Class of formed and unformed finish required for different concrete surfaces shall be as stated in Tables 2.1.7.1unless otherwise stated in the Contract. The higher Class of finish shall start at least 150 mm below the finished ground level for concrete surfaces which are partly buried.

2.1.7.1.3 Release agents

(a) Release agents shall be a proprietary type approved by the Engineer. Release agents containing mineral oils shall not be used. Barrier paint, polyurethane varnish, wax or other materials shall not be used instead of a release agent.

(b) Release agents shall be a type which will not stain or colour the concrete and which will not affect the bond between the concrete and subsequent coverings. Release agents other than those which incorporate a surface retarder to produce a Class T1 finish shall be a type which will not affect the hardening of the concrete.

(c) Release agents used on formwork for water retaining structures for potable and fresh water shall be non-toxic and shall not impart a taste to the water.

(d) Release agents used on steel formwork shall contain a rust-inhibiting agent.

(e) Release agents used on formwork for Class F4 and F5 finishes shall be a chemical release agent.

(f) On areas of formwork which in the opinion of the Engineer are likely to be affected by pedestrian traffic, rain or dust, release agents for Class F4 and F5 finishes shall be a type which evaporates to leave a dry film on the formwork, unless protection from such effects is provided.

Tables 2.1.7.**1: Formed finishes**

Class of finish	**Type of formwork normally used**	**Characteristics of finish**			
		Formwork pattern	Abrupt irregularities permitted	Gradual irregularities permitted	Specific requirements
F1	Sawn timber	Not required	< 10 mm	< 15 mm in 2 m	No specific requirements
F2	Plywood	Pattern of formwork joints and tie holes as stated in Clause 2.1.7.4.3 (a) and 2.1.7.4.3 (b)	< 5 mm	< 10 mm in 2 m	Even surface No grout runs
F3			< 3 mm	< 5 mm in 2 m	Even surface No grout runs
F4	Sealed plywood				Uniform, dense and smooth surface No grout runs No grain pattern No crazing No major blemishes
F5			< 2 mm	< 3 mm in 2 m	Uniform, dense and smooth surface No grout runs No grain pattern No crazing No blemishes No staining or discolouration

Table 2.1.7.**2: Unformed finishes**

Class of finish	**Method of producing finish**	**Characteristics of finish**		
		Abrupt irregularities permitted	Gradual irregularities permitted	Specific requirements
U1	Levelling the surface of the compacted concrete with a screed board	Screed marks < 5 mm	< 10 mm in 2 m	No specific requirements
U2	Forming a Class U1 finish and tamping the surface	Tamp marks < 10 mm	Not applicable	Ridged surface
U3	Forming a Class U1 finish and wood floating or power floating the surface	Float marks < 3 mm	< 10 mm in 2 m	Uniform, dense and smooth surface
U4	Forming a Class U3 finish and brushing the surface with a stiff brush	Brush marks < 3 mm	< 10 mm in 2 m	Rough texture
U5	Forming a Class U3 finish and steel trowelling the surface under firm pressure or power floating the surface	Nil	< 5 mm in 2 m	Uniform, dense and smooth surface, free from trowel marks No staining or discolouration

Table 2.1.7**.3: Treated finishes**

Class of finish	**Type of finish**	**Method of producing finish**	**Characteristics of finish**
T1	Exposed Aggregate	Washing and brushing the concrete surface	Cement matrix removed and coarse aggregate exposed to a depth not exceeding one-third of the nominal maximum coarse aggregate size
T2	Point tooled	Point tooling the concrete surface	Cement matrix and aggregate surface removed sufficiently to expose the aggregate with a minimum penetration into the matrix between aggregates
T3	Bush hammered	Bush hammering the concrete surface	Uniform, dense and smooth surface
T4	Broken rib	Hammering or chiselling the edges and faces of the concrete surface	Fragments of concrete ribs removed
T5	Light blasting	Blasting the concrete surface by abrasives and compressed air or by water jetting	Cement matrix removed and coarse aggregate exposed to a minimum depth
T6	Heavy blasting		Cement matrix removed and coarse aggregate exposed to a depth not exceeding one-third of the nominal maximum coarse aggregate size

Table 2.1.7.**4: Class of finish**

Description of surface	**Type**	**Class of finish**	
		Formed	**Unformed**
Surfaces to be covered	screeded	-	U2
	rendered, plastered	F2	-
	Tiled	F2	U3
	painted	F4	U5
Surfaces for treated finishes		F3	U3
Surfaces for pedestrian traffic		-	U4
Construction joints (for Class T1 finish)		F2	U3
Movement joints		F3	U3
Benching, screeds		F3	U5
Blinding, foundations, pile caps		F1	U1
Piers, blocks, pipe surrounds	below FGL	F1	U1
	above FGL	F2	U3
Manholes, chambers	external below FGL	F1	U1
	external above FGL	F2	U3
	internal	F2	U3
Culverts, channels	external below FGL	F1	U1
	external above FGL	F2	U3
	internal	F4	U5
Water retaining structures	external below FGL	F2	U3
	external above FGL	F4	U5
	internal	F4	U5
Buildings	external below FGL	F1	U1
	external above FGL	F2	U3
	internal	F4	U5
Bridges, retaining walls, walls	below FGL	F1	U1
	above FGL, not exposed to direct public view	F4	U5
	above FGL, exposed to direct public view	F5	U5
	internal,not exposed to direct public view	F2	U1

2.1.7.1.4 Formwork ties

(a) Formwork ties and components shall be a type such that any removable part can be removed without damaging the concrete; any part left in the concrete shall be at least 40 mm or the specified nominal cover to the reinforcement, whichever is greater, from the concrete surface.

(b) Unless otherwise permitted by the Engineer, formwork ties and components used with profiled formwork shall be a type such that holes left by the ties and components are small enough to be located completely within the recesses in the concrete surface.

2.1.7.1.5 Cement mortar for concrete surfaces

(a) Cement mortar for filling blowholes shall consist of cement and fine aggregate together with the minimum amount of water necessary to achieve a consistency suitable for completely filling the blowholes.

(b) Cement mortar for filling holes left by formwork ties and components shall consist of 1 part of cement to 3 parts of fine aggregate together with the minimum amount of water

necessary to achieve a consistency suitable for compacting the mortar into the holes; the mix shall contain a non-shrink admixture.

(c) Cement mortar for filling blowholes and holes left by formwork ties and components in concrete surfaces with Class F4 and F5 finishes shall be the same colour as the hardened concrete; light-coloured sand or white cement may be used for this purpose.

2.1.7.1.6 Surface retarders and abrasives

(a) Surface retarders shall be a proprietary type approved by the Engineer and shall be a type which will not stain or colour the concrete.

(b) Abrasives for blasting shall be grit or other materials approved by the Engineer and shall not contain any iron, clay or other materials which will stain or colour the concrete.

2.1.7.2 Trial panels

2.1.7.2.1 Trial panels

(a) A trial panel shall be constructed for each Class F4, F5, U5 and T finish to demonstrate that the proposed materials, mix design, methods of production and methods of construction, including curing and removal of formwork, will produce the specified finish.

(b) Trial panels for Class F4 and F5 finishes shall be constructed before the relevant formwork for the permanent work is erected, and trial panels for Class U5 and T finishes shall be constructed before the relevant permanent work is concreted. The trial panels shall be constructed at least 4 weeks before the relevant permanent work is carried out.

(c) The Contractor shall inform the Engineer at least 24 hours, or such shorter period agreed by the Engineer, before constructing trial panels.

(d) Trial panels shall be constructed using the materials, mix design, methods of production and methods of construction, including curing and removal of formwork, submitted to the Engineer

(e) Trial panels shall be horizontal, vertical or inclined as appropriate and shall be constructed at locations agreed by the Engineer. Unless otherwise stated in the Contract each trial panel shall be not less than 2 m by 2 m by 300 mm thick, and shall contain reinforcement representative of the most congested reinforcement which will be used in the permanent work.

(f) Trial panels shall incorporate formwork ties and components, horizontal joints, vertical joints, chamfers, splays, rebates and other features representative of those which will be used in the permanent work.

(g) Trial panels shall be protected from damage and shall be left in position until the Engineer instructs their removal.

(h) If in the opinion of the Engineer the specified finish has not been produced in the trial panel, particulars of proposed changes to the materials, mix design, methods of production or methods of construction shall be submitted to the Engineer; further trial panels shall be constructed until the specified finish is produced in the trial panel. Further trial mixes shall be made unless in the opinion of the Engineer non-compliance of the trial panel was not due to the concrete mix.

(i) Formwork for Class F4 and F5 finishes shall not be erected and elements with Class U5 and T finishes shall not be concreted until in the opinion of the Engineer the specified finish has been produced in the trial panel.

(j) Unless permitted by the Engineer, the materials, mix design, methods of production or methods of construction, including curing and removal of formwork, used to produce the specified finish in trial panels shall not be changed.

2.1.7.3 Storage of materials

2.1.7.3.1 Storage of formwork

(a) Formwork shall be stored off the ground on level supports and in a manner which will not result in damage or deformation to the formwork or in contamination of the formwork.

(b) Formwork for Class F4 and F5 finishes shall be covered and protected from exposure to conditions which may affect the formwork.

2.1.7.3.2 Storage of release agents and surface retarders

(a) Release agents and surface retarders shall be stored in sealed containers marked to identify the contents and protected from exposure to conditions which may affect the material. The materials shall be stored in accordance with the manufacturers' recommendations and shall not be used after the recommended shelf life has been exceeded.

2.1.7.4 Design and construction of falsework and formwork

2.1.7.4.1 Design and construction of falsework and formwork

(a) Falsework and formwork shall be designed and constructed to maintain the position and shape of the formwork such that the hardened concrete surface complies with the characteristics of finish stated in Tables 2.1.7.1 and with any more stringent tolerances stated in the Contract; allowance shall be made for cambers.

(b) Falsework and formwork shall be capable of being dismantled and removed without shock, disturbance, damage or loading to the concrete and in such a manner that the specified requirements for removing or leaving in position side formwork, soffit formwork and props will be achieved without disturbing other formwork or props.

(c) Formwork shall be used to form the top surface of concrete inclined at a slope exceeding 15^{o} to the horizontal unless it can be demonstrated that the specified finish will be produced without the use of formwork.

2.1.7.4.2 Construction of formwork

(a) Formwork to top surfaces shall be anchored to prevent flotation.

(b) Formwork shall not have any splits, cracks or other defects. The faces and edges of formwork shall be clean and formwork faces shall be free of projecting nails.

(c) Formwork which has been previously used shall be repaired and the edges resealed before it is erected. Formwork which in the opinion of the Engineer has deteriorated to an extent such that it will not produce the specified finish shall not be used for that Class or a higher Class of finish.

(d) Formwork shall be firmly supported and individual panels shall be rigid. Joints between formwork panels, stop ends and adjoining concrete shall be tight and shall not permit grout loss. Gaps shall be sealed with gaskets, filler, sealant or tape before the application of release agents.

(e) Formwork shall be cut in such a manner that reinforcement and built-in components passing through the formwork are maintained in position; the joints shall be tight and shall not permit grout loss.

(f) Formers for profiled formwork, chamfers, splays, rebates and other features shall be rigidly and evenly fixed to the formwork along the complete length and shall not permit grout loss.

(g) Formwork ties and components shall be fixed in such a manner that they do not touch reinforcement or built-in components. Formwork ties and components shall fit tightly against formwork faces and shall not permit grout loss.

(h) If required for cleaning or inspection, temporary openings shall be provided in the formwork. Formwork panels for Class F2, F3, F4 and F5 finishes shall be the same size and shall form a regular pattern approved by the Engineer. The lines of joints between panels shall be straight and continuous, horizontal and vertical, or inclined to suit the pattern of profiled formwork, and shall be coincident with construction joints and other joints and with recesses in the concrete surface. The number of make-up pieces shall be kept to a minimum.

2.1.7.4.3 Construction of formwork for Class F2, F3, F4 and F5 finishes

(a) Holes left by formwork ties and components in concrete surfaces with Class F2, F3, F4 and F5 finishes shall be in line horizontally and vertically and shall form a regular pattern approved by the Engineer. Unless otherwise permitted by the Engineer, holes in profiled formwork shall be located in such a manner that the holes are completely within recesses in the concrete surface.

(b) Unless otherwise stated in the Contract or permitted by the Engineer, chamfers shall be provided for all external angles of 90° or less in concrete surfaces with Class F2, F3, F4 and F5 finishes.

(c) Formwork for curved concrete surfaces with Class F2, F3, F4 and F5 finishes shall not be made up of a series of flats unless permitted by the Engineer.

2.1.7.4.4 Construction of formwork for Class F4 and F5 finishes

(a) Each type of formwork for Class F4 and F5 finishes shall be obtained from one source and different types of formwork shall not be mixed unless permitted by the Engineer. Damaged formwork shall not be used unless permitted by the Engineer. Parts of steel formwork which will be in contact with concrete shall be free from rust.

(b) For concrete surfaces with Class F4 and F5 finishes, joints between formwork panels shall be sealed with foamed rubber strips. The foamed rubber strips shall be sufficiently compressible to form a grout-tight joint. The width of the resulting gap between the panels shall not be greater than 1mm and the sealing strips shall not protrude proud of the surface of the formwork panels. Alternatively, subject to the approval of the Engineer, joints between formwork panels may be sealed with an approved filler provided the butting

edges of the panels are smooth and the resulting gap between the panels is not wider than 1 mm. Joints between formwork panels shall not be sealed by tape fixed to the formwork faces.

(c) Formwork for Class F4 and F5 finishes shall be protected from spillages, rust marks and stains.

2.1.7.4.5 Built-in components

(a) Built-in components, void formers and box-outs shall be fixed in position before concreting. Unless permitted by the Engineer, void formers and box-outs shall not be used instead of built-in components. Polystyrene shall not be used for void formers and box-outs unless permitted by the Engineer.

2.1.7.5 Application of release agent

2.1.7.5.1 Application of release agents

(a) A release agent shall be used on all formwork other than permanent formwork and formwork on which a surface retarder is used to produce a Class T1 finish. The release agent shall be applied by the method and at the rate of application recommended by the manufacturer or as demonstrated to be satisfactory by use in the trial panel.

(b) Formwork faces shall be cleaned before release agents are applied. Concrete, reinforcement and built-in components shall not be contaminated by release agents.

(c) Each type of release agent used on formwork for Class F4 and F5 finishes shall be obtained from one manufacturer and different types of release agent shall not be used on formwork for the same element.

(d) Release agents shall be applied to formwork for Class F4 and F5 finishes after the formwork has been erected and before the reinforcement is fixed or, if this is not practicable, immediately before the formwork is erected. The release agent covering shall be complete and uniform.

2.1.7.6 Inspection of formwork and reinforcement

2.1.7.6.1 Inspection of formwork and reinforcement

(a) The Contractor shall allow the Engineer to inspect the completed formwork and reinforcement, including trial panels, before carrying out any work, including fixing reinforcement adjacent to formwork and erecting formwork adjacent to reinforcement, which will make access to the formwork faces or reinforcement difficult. The Contractor shall inform the Engineer 24 hours, or such shorter period agreed by the Engineer, before carrying out such work.

(b) The Contractor shall allow the Engineer to inspect formwork for Class F4 and F5 finishes before it is erected and shall inform the Engineer 24 hours, or such shorter period agreed by the Engineer, before erecting the formwork.

2.1.7.7 Removal of falsework and formwork

2.1.7.7.1 Times for removal of falsework and formwork

(a) Except as stated in Clause 2.1.7.7.1(c), falsework and formwork shall not be loosened or removed before the minimum times stated in Table 2.1.6.5 have elapsed. The times stated are for a minimum ambient temperature of 15°C, for elements without superimposed loads and for concrete containing OPC, PPFAC or both OPC and PFA not exceeding the OPC replacement level as specified in Clause 16.14. If other conditions apply, particulars of proposed changes to the minimum times shall be submitted to the Engineer for approval.

(b) For the purpose of determining the minimum times for loosening or removing falsework and formwork, copings at the top of columns in water retaining structures shall be classified as slabs and roof slabs in water retaining structures shall be classified as beams.

(c) Falsework and formwork supporting concrete in flexure may be loosened or removed when the strength of the concrete in that element is 10 MPa or twice the stress to which it will be subjected, whichever is greater, provided that deflection which in the opinion of the Engineer is unacceptable will not result and that superimposed loads will not be applied. The strength of the concrete shall be determined from tests on test cubes which have been made with concrete from the same pour and which have been cured by the same method and under similar conditions as the concrete in the element.

Table 2.1.7**.5: Minimum times for loosening or removing falsework and formwork**

Type of falsework or Class F1, F2, F3 and F4 finishes formwork	**Class F1, F2, F3 and F4 finishes**		**Class F5 finish**
	Concrete without PFA	**Concrete with PFA**	**Concrete with or without PFA**
Vertical (non-profiled) (profiled)	12 hours 7 da	15 hours 7 days	48 hours 7 days
Inclined to top surfaces	12 hours	15 hours	48 hours
Soffits of slabs (props left in)	4 days	4 days	10 days
Soffits of beams (props left in)	7 days	7 days	14 days
Props to slabs	10 days	10 days	10 days
Props to beams	14 days	14 days	14 days

2.1.7.7.2 Removal of falsework and formwork

(a) Formwork shall be removed without hammering or levering to the concrete and in such a manner that there is no shock, disturbance, damage or loading to the concrete. Side formwork shall be removed without disturbing soffit formwork and soffit formwork shall be removed without disturbing props except as provided for in Clause 2.1.7.7.2 (b).

(b) Individual props may be removed to allow the removal of soffit formwork provided that the formwork has been designed accordingly and that each prop is replaced as soon as the

formwork has been removed.

(c) Falsework and formwork for Class F5 finishes shall be loosened and removed in a continuous operation and in accordance with a consistent programme agreed by the Engineer. All formwork shall be loosened before individual panels are removed and all formwork shall be removed within the programmed period. Individual panels or make-up pieces shall not be left in position.

(d) After removal, formwork which is intended for re-use shall be cleaned and stored as stated in Clause 2.1.7.3.1.

2.1.7.8 Unformed finishes

2.1.7.8.1 Unformed finishes

(a) Unformed finishes shall be produced by the methods stated in Table 2.1.7.2.

(b) Brushing to produce a Class U4 finish shall be carried out in straight lines in a direction agreed by the Engineer; brushing shall be carried out when the concrete has hardened sufficiently for the float marks to be removed and for the ridges to be formed without displacing the aggregate.

(c) Floating and trowelling shall not be carried out until the concrete has hardened sufficiently to allow the specified finish to be produced with the minimum amount of floating and trowelling such that excess laitance is not produced.

2.1.7.9 Treated finishes

2.1.7.9.1 Treated finishes

(a) Treated finishes shall be produced by constructing a concrete surface with a Class F3 or U3 finish as appropriate and applying the treatment to the surface by the methods stated in Table 2.1.7.3.

(b) The treatment shall be applied in a continuous operation in accordance with a consistent programme agreed by the Engineer.

(c) Washing and brushing to produce a Class T1 finish shall not be carried out until the concrete has hardened sufficiently for the cement matrix to be removed without disturbing the coarse aggregate. After washing and brushing have been completed and the concrete surface has hardened, the surface shall be cleaned.

(d) The cement matrix shall not be removed or the aggregate exposed by mechanical methods unless permitted by the Engineer.

(e) Class T1 finishes may be produced by using a surface retarder applied to the formwork or to the concrete surface. The surface retarder shall be applied by the method and at the rate of application recommended by the manufacturer, or as demonstrated to be satisfactory by use on the trial panel.

(f) Plywood to which a surface retarder is to be applied shall be sealed with barrier paint, polyurethane varnish or other impermeable material agreed by the Engineer. The

formwork shall be removed in small sections and the coarse aggregate exposed by washing and brushing the concrete surface.

(g) Unless permitted by the Engineer, formwork to which a surface retarder has been applied shall not be re-used unless a surface retarder is to be used again on the formwork. Formwork to which a surface retarder has been applied and which is to be re-used shall be cleaned before the retarder is applied.

(h) Point tooling to produce Class T2 finishes and bush hammering to produce Class T3 finishes shall be carried out evenly in small areas and not in distinct lines. Tooling and hammering shall not start until at least 7 days after concreting.

(i) Hammering or chiselling to produce a Class T4 finish shall be applied from only one direction, and only either hammering or chiselling shall be applied, on any one face. Hammering and chiselling shall not start until at least 14 days after concreting.

(j) Blasting to produce Class T5 and T6 finishes shall not be carried out until the concrete has hardened sufficiently for the cement matrix to be removed without disturbing the coarse aggregate. Adjacent surfaces shall be protected from blasting and dust shall be controlled by screens and by water-spraying.

2.1.7.10 Compliance of finishes

2.1.7.10.1 Inspection of finishes

(a) Before any subsequent work is carried out on a concrete surface, the surface shall be inspected by the Engineer to determine if the specified finish has been produced. Formed finishes shall be inspected as soon as the formwork has been removed.

(b) Blowholes or holes left by formwork ties and components shall not be filled and spatterdash or other coverings shall not be applied before the inspection; any such filling or covering carried out before the inspection may be rejected.

2.1.7.10.2 Compliance of finishes

(a) Concrete surfaces shall have the characteristics stated in Table 2.1.7.1 and Table 2.1.7.2 for the different Classes of formed and unformed finish before any subsequent work is carried out on the concrete surface and shall have the characteristics stated in Table 2.1.7.3 for the different Classes of treated finish.

(b) The Engineer shall determine if the specified finish has been produced and may use the trial panels as a means of comparison.

(c) Abrupt irregularities shall be measured by direct measurement. Gradual irregularities shall be measured using a 2 m long straight edge on surfaces intended to be flat and by a method agreed by the Engineer on other surfaces.

2.1.7.11 Work on concrete surfaces

2.1.7.11.1 Remedial and repair work on concrete surfaces

(a) Remedial or repair work shall not be carried out on concrete surfaces unless permitted by

the Engineer; any such work carried out without permission may be rejected.

2.1.7.11.2 Filling blowholes and formwork tie holes

(a) Blowholes exceeding 3 mm in size in water retaining structures and water tight structures, and blowholes exceeding 10 mm in size in other structures shall be filled with cement mortar. The size of blowholes shall be the maximum dimension measured across the hole on the concrete surface.

(b) If the number and size of blowholes in concrete surfaces with Class F3, F4 and F5 finishes is in the opinion of the Engineer greater than in the trial panel the blowholes shall be filled, unless in the opinion of the Engineer filling is not required.

(c) Holes left by formwork ties and components shall be cleaned and filled by ramming cement mortar into the holes in layers. Holes in concrete surfaces with a Class F5 finish shall be filled to a level slightly below the concrete surface; the holes shall not be overfilled and rubbed down.

(d) Filling of blowholes and holes left by formwork ties and components shall be carried out as soon as practicable after the Engineer has inspected the finish and with the minimum interruption to curing.

2.1.7.11.3 Spatterdash

(a) Spatterdash shall consist of cement and coarse sand or granite fines in the proportions 1:2 by volume mixed with the minimum amount of water necessary to achieve the consistency of a thick slurry. Spatterdash shall be thrown with a hand trowel onto the surface to a thickness not exceeding 6 mm and shall cover at least 60% of the area which is to be plastered or rendered. Spatterdash shall be wetted one hour after application and shall be allowed to cure and harden before under coats are applied.

(b) Spatterdash shall be applied as soon as practicable after the Engineer has inspected the finish and after the concrete surface has been cleaned and wetted.

2.1.7.12 Protection of finishes

2.1.7.12.1 Protection of finishes

(a) Materials, Constructional Plant or other vehicles shall not use or be placed on or against concrete surfaces unless permitted by the Engineer.

(b) Concrete surfaces with Class F4, F5, U5 and T finishes shall be protected from running water, spillages, rust-marks and stains by covering the surface with polyethylene sheeting or timber or by other methods agreed by the Engineer. Protection from rust-marks caused by reinforcement bars shall be by polyethylene sleeves tied to the bars or by coating the bars with cement slurry; the bars shall not be coated with oil or grease.

(c) Concrete surfaces with Class F4, F5, U5 and T finishes shall be protected from damage by securing timber battens to the surface, by erecting barriers or fences or by other methods agreed by the Engineer.

(d) Concrete surfaces with a Class F5 finish shall be protected from exposure to extreme variations in weather conditions for at least 14 days after the formwork has been removed.

2.1.8 CONCRETE WORK

2.1.8.1 General

2.1.8.1.1 Designation of concrete mixes

(a) Designed mix concrete shall be designated by the grade strength in MPa followed by the nominal maximum aggregate size in mm and the suffix D.

(b) Standard mix concrete shall be designated by the grade strength in MPa followed by the nominal maximum aggregate size in mm and the suffix S.

(c) Designed mix concrete or standard mix concrete of the same grade strength but with different constituents, work abilities or other properties shall be designated as such by the addition of a suitable description. If the grade of concrete is designated by one number only, the number shall be the grade strength in MPa.

2.1.8.2 Materials

2.1.8.2.1 Cement

(a) Cement shall comply with the following:

Ordinary and rapid hardening Portland cement: **BS EN 197-1:2011**

Sulphate resisting Portland cement : **BS 4027**

Portland pulverised-fuel ash cement : **BS EN 197-1:2011**

(b) The PFA content of PPFAC shall be 25% ± 3% by mass of the PPFAC.

(c) PFA shall comply with **BS 3892**: Part 1 except that the criterion for maximum water requirement shall not apply.

2.1.8.2.2 Aggregates

(a) Aggregates shall be obtained from a source approved by the Engineer.

(b) Fine aggregate shall be clean, hard, durable crushed rock, or natural sand, complying with **BS 12620**.

(c) Coarse aggregate shall be clean, hard, durable crushed rock complying with **BS EN 12620**. The ten percent fines values shall be at least 100 N. The water absorption shall not exceed 0.8%. The flakiness index shall not exceed 35%.

2.1.8.2.3 Water

(a) Water for concrete and for curing concrete shall be clean fresh water taken from the public supply.

2.1.8.2.4 Admixtures

(a) Admixtures shall comply with the following:

Pigments for Portland cement and Portland cement products	:	**BS EN 12878**
Accelerating admixtures, retarding admixtures and water-reducing admixtures	:	**BS EN 480**
Super plasticising admixtures	:	**BS EN 480**

(b) The chloride ion content of admixtures for concrete containing embedded metal or for concrete made with SRPC shall not exceed 2% by mass of the admixture or 0.03% by mass of the cementitious content, whichever is less.

2.1.8.2.5 Curing compound

(a) Curing compound shall be a proprietary type approved by the Engineer and shall have an efficiency index of at least 80%.

(b) Curing compound shall contain a fugitive dye. Curing compounds containing organic solvents shall not be used. The curing compound shall become stable and achieve the specified resistance to evaporation of water from the concrete surface within 60 minutes after application. Curing compound shall not react chemically with the concrete to be cured and shall not crack, peel or disintegrate within one week after application. Curing compound shall degrade completely within three weeks after application.

(c) Curing compound for use on concrete surfaces against which potable or fresh water will be stored or conveyed shall be non-toxic and shall not impart a taste to the water.

2.1.8.3 Concrete

2.1.8.3.1 Concrete mix

(a) Concrete shall be a designed mix unless the Engineer permits the use of a standard mix. Designed mixes shall be designed by the Contractor.

(b) Unless otherwise permitted by the Engineer, the minimum design slump value for designed mix concrete for reinforced elements, after the addition of superplasticiser if used, shall be 75 mm. Should the Contractor wish to use designed mix concrete with a design slump value less than 75 mm in reinforced elements, the Engineer may require the Contractor to demonstrate that such concrete can be satisfactorily placed and compacted in trial sections simulating the appropriate sections of the Works.

i. Cement, PFA, aggregates, water and admixtures for concrete shall comply with Clauses 2.1.8.2.1 to 2.1.8.2.4. All-in aggregate shall not be used.

ii. SRPC shall only be used if stated in the Contract. PFA shall not be used with SRPC.

iii. PFA shall not be used in addition to PPFAC.

2.1.8.3.2 Standard mix

(a) Standard mix concrete shall comply with the following requirements:

i. Cement shall be OPC or PPFAC.

ii. The total mass of dry aggregate to be used with 100 kg of OPC or with 110 kg of PPFAC shall be as stated in Table 2.1.8.1

iii. The percentage by mass of fine aggregate to total aggregate shall be as stated in Table 2.1.8.2.

iv. Admixtures other than water-reducing admixtures shall not be used unless permitted by the Engineer.

Table 2.1.8**.1: Mass of total aggregate for standard mix concrete**

Grade strength (MPa)	Nominal maximum aggregate size (mm)	40	20	10
	Slump value (mm)	85-170	75-150	65-130
10	Mass of total aggregate (kg)	800	690	-
20		550	500	400
25		490	440	360
30		440	380	300

Table 2.1.8**.2.: Percentage by mass of fine aggregate to total aggregate for standard mix concrete**

Grade strength (MPa)		Nominal maximum aggregate size (mm)	40	20	10
10	C, M or F	Percentage by mass of fine aggregate to total aggregate	30 - 45	35 - 50	-
20, 25 or 30	C		30 - 40	35 - 45	45 - 55
	M		25 - 35	30 - 40	40 - 50

		(%)			
	F		25 - 30	25 - 35	35 - 45

2.1.8.3.3 No fines concrete

(a) No-fines concrete shall comply with the following requirements:

i. Cement shall be OPC or PPFAC.

ii. The nominal maximum aggregate size shall be 20 mm; not more than 15% by mass shall be retained on a 20 mm BS test sieve and not more than 10% by mass shall pass a 10 mm BS test sieve.

iii. The aggregate: cement ratio by mass shall be at least 10 and shall not exceed 15.

iv. The cementitious content shall be such that each particle of aggregate is coated with cement paste but the compacted concrete has an open texture which permits the flow of water through the hardened concrete.

2.1.8.4 Submissions

2.1.8.4.1 Particulars of materials for concrete

(a) The following particulars of the proposed cement, PFA and aggregates shall be submitted to the Engineer:

i. a certificate not older than 6 months for each type of cement showing the manufacturer's name, the date and place of manufacture and showing that the cement complies with the requirements stated in the Contract and including results of tests for:- chemical composition
   - fineness
   - compressive strength at 3, 7 and 28 days
   - initial and final setting times
   - soundness
   - proportion by mass of PFA contained in PPFAC.

ii. a certificate not older than 6 months for PFA showing the source of the PFA and showing that the PFA complies with the requirements stated in the Contract and including results of tests for:
   - chemical composition
   - fineness
   - moisture content, and

iii. a certificate not older than 6 months for each nominal maximum aggregate size showing the source of the aggregate and showing that the aggregate complies with the requirements stated in the Contract and including results of tests for:
   - grading
   - silt content
   - chloride content
   - flakiness index of coarse aggregate.
   - ten percent fines value
   - water absorption

(b) The following particulars of the proposed admixtures shall be submitted to the Engineer:

i. manufacturers'

ii. description of physical state, colour and composition,
iii. recommended storage conditions and shelf life,
iv. method of adding to the concrete mix,
v. any known incompatibility with other admixtures or cement,
vi. dosage,
vii. effects of under-dosage and over-dosage, and
viii. a certificate not older than 6 months for each type of admixture showing the manufacturer's name, the date and place of manufacture and showing that the admixture complies with the requirements stated in the Contract and including results of tests for:
- uniformity
- chloride content.

(c) The following particulars of the proposed curing compound shall be:

i. submitted to the Engineer:
ii. manufacturer's
iii. description of physical state, colour and composition,
iv. recommended storage conditions and shelf life,
v. method of application,
vi. rate of application, and
vii. a certificate showing the manufacturer's name, the date and place of manufacture and showing that the curing compound complies with the requirements stated in the Contract and including results of tests for efficiency index.

2.1.8.4.2 Particulars of concrete mix

(a) The following particulars of each proposed designed concrete mix shall be submitted to the Engineer:

i. quantity of each constituent per batch and per cubic metre of compacted concrete, with required tolerances on quantities of aggregates to allow for minor variations in grading, silt content etc. The maximum permitted variation in the quantity of fine aggregate shall be ± 20 kg of fine aggregate per 100 kg of cement.

ii. grading of coarse and fine aggregates,

iii. workability after the addition of superplasticisers, in terms of designed slump value or designed flow value,

iv. method of placing concrete,

v. method of controlling the temperature of the concrete, if required,

vi. test or trial mix data for designed mix concrete of the same grade and with similar constituents and properties, if available, and

vii. test data for designed mix concrete of the same or other grade produced in the plant or plants proposed to be used, if available.

(b) The particulars shall be submitted to the Engineer for information at least 7 days before trial mixes are made or, if trial mixes are not required, at least 7 days before the mix is placed in the permanent work.

2.1.8.4.3 Particulars of ready- mixed concrete supplier

(a) The name of the suppliers and the location of each plant, including a back- up plant, from which the Contractor proposes to obtain ready-mixed concrete shall be submitted to the

Engineer at least 14 days before trial mixes are made or, if trial mixes are not required, at least 14 days before the ready-mixed concrete is placed in the permanent work.

2.1.8.4.4 Particulars of batching and mixing plant

(a) Particulars of the proposed batching and mixing plant to be used on the Site, including a layout plan and the output of the plant, shall be submitted to the Engineer at least 7 days before the plant is delivered to the Site.

2.1.8.4.5 Particulars of precast concrete units

(a) The following particulars of the proposed precast concrete units shall be submitted to the Engineer:

ii. details of precasting yards,

iii. a certificate showing the manufacturer's name, the date and place of manufacture, the identification numbers of the precast concrete units and including results of tests for:

- compressive strength of concrete cubes at 28 days
- routine tests, including loading tests, carried out at the precasting yards,

iv. details of lifting points and methods of handling, and

v. procedure for testing precast units.

(b) The particulars, other than certificates, shall be submitted to the Engineer at least 14 days before the first delivery of the precast concrete units to the Site. The certificates shall be submitted for each batch of precast concrete units delivered to the Site.

2.1.8.4.6 Particulars of construction joints

(a) Particulars of the proposed positions and details of construction joints in concrete which are not stated in the Contract shall be submitted to the Engineer for approval at least 14 days before the relevant elements are concreted.

2.1.8.5 Trials

2.1.8.5.1 Trial mix concrete

(a) Trial mixes are not required for designed mix concrete of Grade 20 and below, or for standard mix concrete.

(b) If test data for designed mix concrete of the proposed grade and with similar constituents and properties and produced in the plant or plants proposed to be used are submitted in accordance with Clause 2.1.8.4.2, and are acceptable to the Engineer, no trials for that designed mix will be required.

(c) If test data for designed mix concrete of the proposed grade and with similar constituents and properties produced in plant other than that proposed to be used are submitted in accordance with Clause 2.1.8.4.2, and are acceptable to the Engineer, the Engineer may require Plant Trials to be carried out in accordance with Clause 2.1.8.5.2.

(d) If test data for designed mix concrete produced in the plant or plants proposed to be used,

but of a grade or with constituents and properties other than those proposed, are submitted in accordance with Clause 2.1.8.4.2, and are acceptable to the Engineer, the Engineer may require Laboratory Mix Trials to be carried out in accordance with Clause 2.1.8.5.3

(e) If no test data for designed mix concrete are submitted or if test data submitted in accordance with Clause 2.1.8.4.2, do not in the opinion of the Engineer demonstrate the suitability of the proposed plant and mix design, the Engineer may require both Plant Trials and Laboratory Mix Trials in accordance with Clause 2.1.8.5.2and Clause 2.1.8.5.3 respectively.

(f) Plant Trials and Laboratory Mix Trials shall be completed at least 35 days before the concrete mix is placed in the permanent work.

(g) The Contractor shall inform the Engineer at least 24 hours before conducting Plant Trials or Laboratory Mix Trials.

2.1.8.5.2 Plant Trials

(a) Plant Trials shall be made using the plant or plants proposed and the mix designs and constituents submitted to the Engineer.

(b) One batch of concrete of a proposed designed mix shall be made on each of three days in each plant proposed to be used. The batch shall be at least 60% of the mixer's nominal capacity. If the concrete is batched in a central plant and mixed in a truck mixer, three different truck mixers shall be used.

(c) Three samples of concrete shall be provided from each batch at approximately $^1/_6$, $^1/_2$ and $^5/_6$ of the discharge from the mixer. Each sample shall be of sufficient size to perform a slump test or a flow table test, and make two 150mm test cubes.

(d) Each sample taken in accordance with the above Clause shall be tested to determine its slump value or its flow value.

(e) Two 150 mm test cubes shall be made from each sample taken in accordance with the above Clause and stored, cured and tested to determine the compressive strength at 28 days.

2.1.8.5.3 Laboratory Mix Trials

(a) Laboratory Mix Trials shall be made in the Contractor's laboratory using the mix designs and constituents submitted to the Engineer.

(b) Three separate batches shall be made, each of sufficient size to provide samples for two slump tests or two flow table tests, and to make six 150mm test cubes.

(c) Two slump tests or two flow table tests shall be performed on separate specimens from each batch of Laboratory Trial Mix concrete.

(d) Six 150 mm test cubes shall be made from each batch of Laboratory Trial Mix concrete, stored, cured and tested for compressive strength at 28 days.

2.1.8.5.4 Compliance criteria plant trials

(a) The results of tests on concrete taken from Plant Trials in accordance with Clause 2.1.8.5.2

and shall comply with the following requirements:

i. The average of the nine slump values shall be within 20mm or 25%, whichever is the greater, of the designed slump value. The average of the nine flow values shall be within +/- 35mm of the designed flow value.

ii. The range of the three slump values for each batch of concrete shall not exceed 20% of the average of the three slump values for that batch. For flow table tests, the range of the three flow values for each batch of concrete shall be within 70mm.

iii. The average compressive strength at 28 days of the 18 test cubes shall exceed the Grade strength by at least 10 MPa and the compressive strength of each individual test cube shall exceed the Grade strength by at least 4 MPa.

iv. The range of the compressive strength of the six test cubes from each batch of concrete shall not exceed 20% of the average compressive strength of the six test cubes from that batch.

2.1.8.5.5 Compliance criteria: Laboratory Mix Trials

(a) When test data relating to the proposed plant or plants submitted in accordance with Clause 2.1.8.4.2 show that the plant standard deviation exceeds 5 MPa, or in the absence of acceptable data, the results of tests on Laboratory Mix Trial concrete shall comply with the following requirements:

i. The average of the six slump values shall be within 20mm or 25%, whichever is the greater, of the designed slump value. The average of the six flow values shall be within +/- 35mm of the designed flow value.

ii. The average compressive strength at 28 days of the 18 test cubes shall exceed the Grade strength by at least 12 MPa and the compressive strength of each individual test cube shall exceed the Grade strength by at least 6 MPa.

(b) When test data relating to the proposed plant or plants submitted in accordance with Clause 2.1.8.4.2 show that the plant standard deviation does not exceed 5 MPa and the data are acceptable to the Engineer, the results of tests on Laboratory Mix Trial concrete shall comply with the following requirements:

i. The average of the six slump values shall be within 20 mm or 25%, whichever is the greater, of the designed slump value. The average of the six flow values shall be within +/- 35mm of the designed flow value.

ii. The average compressive strength at 28 days of the 18 test cubes shall exceed the Grade strength by at least 8 MPa and the compressive strength of each individual test cube shall exceed the Grade strength by at least 2 MPa.

2.1.8.5.6 Non-compliance: trial mix concrete

(a) If the result of any test for workability or compressive strength of laboratory mix trial and plant trial concrete does not comply with the specified requirements for the property, particulars of proposed changes to the materials, mix design or methods of production shall be submitted to the Engineer; further laboratory mix trials or plant trials shall be made until the result of every test complies with the specified requirements for workability and compressive strength of laboratory mix trial and plant trial concrete.

(b) If trial lengths or trial panels are constructed using the non-complying trial mix, further trial lengths or trial panels shall be constructed unless in the opinion of the Engineer the

changes to the materials, mix design or methods of production will not affect the results of the previous trial lengths or trial panels.

2.1.8.5.7 Approved concrete mix

(a) A concrete mix which complies with the specified requirements for laboratory mix trials, plant trials and for trial lengths or trial panels shall become an approved concrete mix. The designed slump value or designed flow value used to produce an approved concrete mix shall become the approved slump value or approved flow value.

(b) If laboratory mix trials or plant trials are not required, a concrete mix submitted as stated in Clause 2.1.8.4.2 and which complies with the specified requirements for trial lengths or trial panels shall become an approved concrete mix. The designed slump value or designed flow value of the concrete mix shall become the approved slump value or approved flow value.

2.1.8.5.8 Commencement of concreting

(a) Concrete shall not be placed in the permanent work until the concrete mix has been approved by the Engineer.

2.1.8.6 Handling and storage materials

(a) Cement in bags shall be stored in a dry, weatherproof store sheltered on the top and 3 sides with a raised floor. Each delivery shall be identified and kept separate and shall be used in the order of delivery.

(b) Bulk cement and PFA shall be kept dry. Cement and PFA of different types and from different sources shall be stored in separate silos clearly marked to identify the different contents of each.

(c) Aggregates shall not be handled or stored in a manner which will result in mixing of the different types and sizes or in segregation or contamination of the aggregates.

(d) Different types and sizes of aggregates shall be stored in separate hoppers or in separate stockpiles. The stockpiles shall have well drained concrete floors and shall have dividing walls of sufficient height to keep the different aggregates separate.

(e) Admixtures and curing compounds shall be stored in sealed containers marked to identify the contents and protected from exposure to conditions which may affect the material. The materials shall be stored in accordance with the manufacturers' recommendations and shall not be used after the recommended shelf life has been exceeded.

(f) The identification number, date of casting and lifting points shall be marked on precast concrete units in a manner agreed by the Engineer.

(g) Precast concrete units shall be lifted and supported only at the designed lifting points and shall not be subjected to rough handling, shock loading or dropping.

(h) Precast concrete units shall be stored off the ground on level supports and in a manner which will not result in damage or deformation to the units or in contamination of the units. Precast concrete units shall be protected from damage and damaged units shall not be used in the permanent work unless permitted by the Engineer.

2.1.8.7 Batching and mixing concrete

2.1.8.7.1 Batching concrete

(a) Measuring and weighing equipment for batching concrete shall be maintained in a clean, serviceable condition. The equipment shall be zeroed daily and calibrated when the equipment is set up on the Site and at a frequency of at least once per month. The accuracy of the measuring equipment shall be within 3% of the quantity of cementitious materials, total aggregates or water being measured and within 5% of the quantity of admixtures being measured.

(b) The quantities of cement, PFA and fine and coarse aggregate shall be measured by mass except that cement supplied in bags may be measured by using a whole number of bags in each batch. The mass of aggregates shall be adjusted to allow for the free moisture content of the aggregates.

(c) Separate weighing equipment shall be used for cementitious material and aggregates.

(d) The quantity of water shall be adjusted for the free moisture content of the aggregates and shall be measured by mass or volume.

(e) Liquid admixtures shall be measured by mass or volume and powdered admixtures shall be measured by mass.

2.1.8.7.2 Mixing concrete

(a) The quantities of concrete mixed and the speed of operation of a mixer shall comply with the manufacturer's recommendations.

(b) A mixer shall not be loaded in excess of its rated capacity and shall be emptied before being re-charged. A mixer which has been out of use for more than 30 minutes shall be cleaned before fresh concrete is mixed in it. Mixers shall be cleaned whenever there is a change in the type of cement being used.

(c) Mixing times or the number and rate of revolutions of mixer drums shall not be less than those recommended by the manufacturer unless it is demonstrated in the production of concrete that a shorter time or fewer or slower revolutions are adequate. Constituents shall be thoroughly mixed and admixtures shall be uniformly distributed throughout the concrete

(d) Water shall be added to truck mixed concrete at the batching plant and shall not be added in transit. Water shall not be added at the Site unless approved by the Engineer.

(e) Super plasticising admixtures used with concrete mixed off the Site shall be added at the Site unless otherwise permitted by the Engineer.

(f) Water shall not be added to partially hardened concrete.

2.1.8.8 Transportation of concrete

(a) Concrete shall not be transported in a manner which will result in contamination, segregation, loss of constituents or excessive evaporation.

(b) Concrete batched off the Site shall be transported to the Site in purpose-made agitators operating continuously or in truck mixers.

2.1.8.9 Records of concrete

(a) Delivery notes shall be provided for each delivery of concrete to the Site. The delivery notes shall be kept on the Site and shall be available for inspection by the Engineer at all times. Delivery notes shall contain the following details:

i. serial number of delivery note,

ii. name and location of batching and mixing plant,

iii. name of purchaser,

iv. name and location of the Site,

v. designation of concrete mix and approved slump value or approved flow value,

vi. constituents,

vii. quantity of concrete, and

viii. time of introduction of water to the concrete.

(b) Records of concreting operations shall be kept by the Contractor on the Site and shall be available for inspection by the Engineer at all times. Records shall contain the following details:

(a) designation of concrete mix and approved slump value or approved flow value,

(b) total quantity of each concrete mix produced that day,

(c) serial number of delivery note,

(d) arrival time of delivery vehicle,

(e) time of completion of discharge,

(f) quantity of water added at the Site,

(g) position where concrete is placed,

(h) results of flow table tests or slump tests,

(i) details of test cubes made, and

(j) temperature of concrete if a restriction on the temperature is stated in the Contract.

2.1.8.10 Records of concrete

2.1.8.10.1 Placing concrete

(a) The permission of the Engineer shall be obtained before concrete is placed in any part of the permanent work. If placing of concrete is not started within 24 hours of permission having been given, permission shall again be obtained from the Engineer. The Contractor shall inform the Engineer before concreting starts and shall allow the Engineer sufficient time to inspect the work which is to be concreted.

(b) Concrete shall be placed and compacted in its final position within 2½ hours of the introduction of cement to the concrete mix.

(c) Concrete which in the opinion of the Engineer is no longer sufficiently workable shall not be placed in the permanent work.

(d) Concrete shall not be placed in water other than by tremie or in bags.

(e) Concrete shall be placed as close as practicable to its final position and shall not be moved into place by vibration. Trunking or chutes shall be used to place concrete which will fall more than 2.7 m unless otherwise permitted by the Engineer.

(f) Concrete shall be placed in such a manner that the formwork, reinforcement or built-in components are not displaced.

(g) Unless otherwise permitted by the Engineer, concrete other than concrete placed by tremie shall be placed in horizontal layers to a compacted depth of not more than 450 mm if internal vibrators are used and to a compacted depth of not more than 150 mm in other cases.

(h) Concrete shall be placed continuously within the element to be concreted. Fresh concrete shall not be placed against concrete which has been in position for more than 30 minutes unless in the opinion of the Engineer the concrete already placed is sufficiently workable and the permission of the Engineer has been obtained. If permission is not obtained, a construction joint shall be formed as stated in Clause 2.1.8.11; concrete shall not be placed against the concrete already placed for at least 24 hours unless permitted by the Engineer.

2.1.8.10.2 Placing concrete by pumping

(a) Concrete pumps shall be operated and maintained in accordance with the manufacturer's recommendations. The pumps and pipelines shall be maintained in a clean condition. Internal surfaces of pipelines shall not be aluminium. Joints in pipelines shall be tightly fixed and shall not permit grout loss.

(b) Concrete pumps shall be positioned such that pipelines are as short and straight as practicable and require as little repositioning as practicable. Bends in pipelines shall be arranged in such a manner that the concrete, formwork, reinforcement or built-in components are not disturbed.

(c) Pipelines shall be lubricated by passing cement grout or concrete through the pipeline before the concrete is pumped. The initial discharge of pumped concrete shall not be placed in the permanent work.

2.1.8.10.3 Placing concrete by tremie

(a) Tremies used to place concrete shall be securely supported in position and the joints shall be watertight. A temporary seal of a type agreed by the Engineer shall be used to keep the water and the concrete separate at the start of concreting.

(b) After the concrete is flowing, the tremie shall be raised in a manner agreed by the Engineer; the lower end of the tremie shall be kept immersed in the concrete to a depth of at least 1 m. Water, mud and other deleterious material shall be prevented from entering the tremie after concreting has started.

(c) If the tremie becomes blocked or is removed from the concrete, concreting shall be stopped immediately unless otherwise permitted by the Engineer. Concreting shall not recommence for at least 24 hours unless permitted by the Engineer; contaminated concrete shall be removed before concreting recommences.

(d) Concrete placed by tremie shall be placed above the specified level by an amount which is sufficient to allow for the removal of contaminated concrete; contaminated concrete shall be removed.

2.1.8.10.4 Compacting concrete

(a) Concrete shall be compacted to form a dense homogeneous mass.

(b) Unless otherwise permitted by the Engineer, concrete shall be compacted by means of internal vibrators of suitable diameter. A sufficient number of vibrators shall be maintained in serviceable condition on the Site to ensure that spare equipment is available in the event of breakdown.

(c) Vibrators shall be used in such a manner that vibration is applied continuously and systematically during placing of the concrete until the expulsion of air has practically ceased; vibrators shall not be used in a manner which will result in segregation. Internal vibrators shall be inserted to the full depth of the concrete placed and shall be withdrawn slowly.

(d) Vibration shall not be applied by way of the reinforcement, and contact between internal vibrators and formwork, reinforcement or built-in components shall be avoided as far as possible. Concrete shall be vibrated in such a manner that the formwork, reinforcement or built-in components will not be displaced.

(e) Concrete which has been in position for more than 30 minutes shall not be vibrated except as stated in Clause 2.1.8.10.1 (h).

(f) No-fines concrete shall be compacted using a minimum amount of punning.

2.1.8.11 Construction joints

(a) Construction joints in concrete shall be formed only at the specified positions and by the specified method unless otherwise approved by the Engineer. The position and details of construction joints which are not stated in the Contract shall be arranged in such a manner that the possibility of the occurrence of shrinkage cracks is minimised.

(b) Construction joints shall be normal to the axis or plane of the element being constructed unless otherwise permitted by the Engineer.

(c) Water stops shall be provided at construction joints in water retaining structures and water tight structures.

(d) Laitance and loose material shall be removed from the surface of construction joints and the aggregate shall be exposed by a method agreed by the Engineer. The work shall be carried out as soon as practicable after the concrete has hardened sufficiently for the cement matrix to be removed without disturbing the coarse aggregate. The surface of the construction joint shall be cleaned after the matrix has been removed.

(e) The surface of the construction joint shall be clean and dry when fresh concrete is placed against it.

2.1.8.12 Curing concrete

(a) Concrete shall be protected against harmful effects of weather, running water and drying out by one of the following methods:

i. Method 1: A liquid curing compound shall be applied to the concrete surface by a low-pressure spray until a continuous visible covering is achieved.

ii. Method 2: The concrete surface shall be covered with hessian, sacking, canvas or other absorbent material agreed by the Engineer or with a layer of fine aggregate at least 25 mm thick; the hessian, sacking, canvas, absorbent material or fine aggregate shall be kept constantly wet.

iii. Method 3: The concrete surface shall be covered with polyethylene sheeting; concrete surfaces which have become dry shall be thoroughly wetted before the sheeting is placed.

iv. Method 4: Unformed concrete surfaces shall be covered with polyethylene sheeting until the concrete has hardened sufficiently for water curing to be carried out. Water curing shall be carried out by spraying the concrete surface continuously with cool water or by ponding immediately after the sheeting is removed. If in the opinion of the Engineer water curing is impracticable, Method 2 shall be used instead of water curing.

(b) Method 1 shall not be used on concrete surfaces against which concrete will be placed or which will have a Class T1 finish or which will be painted or tiled.

(c) Method 1, 2, 3 or 4 shall be carried out on unformed concrete surfaces immediately after the concrete has been compacted and finished. Method 1, 2 or 3 shall be carried out on formed concrete surfaces immediately after the formwork has been removed.

(d) Polyethylene sheeting shall be impermeable and shall have a nominal thickness of 0.125 mm.

(e) Hessian, sacking, canvas, absorbent material and polyethylene sheeting shall be lapped and securely held in position in such a manner that the concrete surface will not be damaged.

(f) Cold water shall not be applied to concrete surfaces or formwork intermittently in large quantities.

(g) The different methods of protection shall be maintained for the minimum periods stated in Table 2.1.8.3 after the concrete has been placed. The minimum periods may be reduced by the number of days during which formwork is left in position.

Table 2.1.8**.3. : Minimum periods of protection for concrete**

Type of structure	Method of protection	Minimum period of protection (days)	
		Concrete not containing PFA or PPFAC	Concrete containing PFA or PPFAC
Water retaining structures and water tight structures	1	7	7
	2,3 or 4	7	9
Others	1	7	7
	2,3 or 4	7	5

2.1.8.13 Installation of precast units

(a) Contact surfaces between in-situ concrete and precast concrete units shall be prepared as stated in the Contract. Dimensional tolerances shall be checked before the precast concrete units are lifted into position.

(b) Temporary supports and connections shall be provided as soon as practicable during installation of precast concrete units.

(c) Final structural connections shall be completed as soon as practicable after the precast concrete units have been installed.

(d) Levelling devices which have no load bearing function in the finished structure shall be slackened, released or removed after the precast concrete units have been installed.

2.1.8.14 Loading of concrete

(a) Loads which will induce a compressive stress in the concrete exceeding one-third of the compressive strength of the concrete at the time of loading or exceeding one-third of the grade strength, whichever is less, shall not be applied to concrete; allowance shall be made for the weight of the concrete in determining the loading. The strength of the concrete and the stresses produced by the loads shall be assessed by a method agreed by the Engineer.

(b) Loads from materials not forming part of the permanent work or from Constructional Plant or other vehicles shall not be applied to no-fines concrete.

2.1.8.15 Joints in concrete

2.1.8.15.1 Materials

(a) Materials for joints in water retaining structures and water tight structures for sewage and

effluent treatment shall be resistant to aerobic and anaerobic microbiological attack and resistant to attack by petrol, diesel oil, dilute acids and alkalis.

(b) Materials for joints in water retaining structures for potable and fresh water shall comply with the requirements of **BS 6920**.

(c) Joint filler shall be a proprietary type approved by the Engineer and shall be a firm, compressible, single-thickness, non-rotting filler; joint filler for joints in water retaining structures and water tight structures shall be non- absorbent.

(d) Bitumen emulsion for joints in water retaining structures and water tight structures shall comply with **BS 3416**. Bitumen emulsion for surfaces against which potable or fresh water will be stored or conveyed shall comply with **BS 3416**, type II.

(e) Joint sealant shall be a grade suited to the local climatic conditions and shall perform effectively over a temperature range of 0°C to 60°C. Joint sealant for exposed joints shall be grey.

(f) Joint sealant other than cold-applied bitumen rubber sealant shall be:

i. a gun grade for horizontal joints 15 mm wide or less and for vertical and inclined joints,

ii. a pouring grade for horizontal joints wider than 15 mm.

(g) Polysulphide-based sealant shall be a cold-applied two-part sealant complying with **BS EN ISO 11600**. Polysulphide-based sealant for expansion joints in water retaining structures and water tight structures shall have a transverse butt-joint movement range of at least 20%.

(h) Polyurethane-based sealant shall be a cold-applied two-part sealant complying with the performance requirements of **BS EN ISO 11600**.

(i) Hot-applied bitumen rubber sealant shall comply with **BS EN 14188-1**, type N1.

(j) Cold-applied bitumen rubber sealant shall be a proprietary type 200 approved by the Engineer.

(k) Joint sealant for joints in water retaining structures and water tight structures shall be as stated in Table 2.1.8.4.

(l) Primers and caulking material for use with joint sealant shall be a proprietary type recommended by the joint sealant manufacturer and approved by the Engineer.

(m) Different types of joint sealant and primers which will be in contact shall be compatible.

Table 2.1.8**.4: Joint sealant for water retaining structures and water tight structures**

Structure for retaining/excluding	**Type of joint**	**Type of joint sealant**
Sewage	All joints	Polyurethane-based
Other than sewage	Expansion joints	Polysulphide-based or polyurethane-based

	Horizontal joints other than expansion joints	Hot-applied bitumen rubber, polysulphide-based or polyurethane-based
	Vertical and inclined joints other than expansion joints	Polysulphide-based, polyurethane-based or cold-applied bitumen rubber

(n) Waterstops, including intersections, reducers and junctions, shall be a proprietary type approved by the Engineer. Waterstops shall be natural or synthetic rubber or extruded polyvinyl chloride

2.1.8.15.2 Storage of materials rubber

(a) Bitumen emulsion, joint sealant and primer for joint sealant shall be joints stored in sealed containers marked to identify the contents and protected from exposure to conditions which may affect the material. The materials shall be stored in accordance with the manufacturers' recommendations and shall not be used after the recommended shelf life has been exceeded.

(b) Joint filler, bond breaker tape and water stops shall be stored in accordance with the manufacturers' recommendations in a dry weatherproof store with a raised floor; absorbent joint filler shall be stored in sealed plastic bags and shall not be exposed to moisture or air.

(c) Bearing strip for sliding joints supplied in rolls of 5 m length or less shall be unrolled immediately after delivery and shall be stored flat at full length on an even surface; bearing strip supplied in rolls of more than 5 m length may be left in the original packing. Bearing strip shall be stored in accordance with the manufacturer's recommendations and shall be protected from mechanical damage and creasing; the two layers of strip shall be kept free from deleterious material.

2.1.8.15.3 Forming joints

(a) Materials for joints shall be used in accordance with the manufacturers' recommendations or as otherwise stated in the Contract.

(b) Joint filler shall be cut to size before fixing and shall be securely fixed in position to the existing concrete surface before concreting. There shall be no gaps between the joint filler and formation.

(c) Waterstops shall be securely fixed in position to formwork in such a manner that compaction of the concrete will not be affected. In-situ joints in waterstops shall be made using methods and equipment recommended by the manufacturer. Exposed waterstops shall be protected from exposure to conditions which may affect the waterstop and shall be kept free from rust, hydrocarbons and other deleterious material.

(d) Joints shall be formed in straight lines perpendicular to the surface of the concrete unless otherwise stated in Contract.

(e) Grooves for joint sealant shall be straight and shall be perpendicular to the surface of the concrete. The bottom of the groove shall be flat and shall be parallel to the surface of the concrete.

(f) Grooves shall be formed by using timber or other approved formers and shall not be formed by cutting back or raking out the joint filler. The grooves shall be located over the joint filler such that the upper surface of the joint filler is entirely contained in the groove.

(g) Before permanent sealing, grooves for joint sealant shall be protected from contamination by a temporary sealing strip or cover or by other methods agreed by the Engineer.

(h) The permanent sealing of joints shall be carried out at least 7 days after concreting unless otherwise permitted by the Engineer.

(i) Immediately before permanent sealing, timber formers, temporary seals, dirt and loose material shall be removed from the groove and the sides of the groove shall be cleaned and roughened by water jetting, sand blasting or by other methods agreed by the Engineer.

(j) Caulking material shall be firmly packed in the bottom of the groove if the joint sealant is not required to extend to the bottom of the groove.

(k) Bond breaker tape shall be fixed continuously and evenly along the bottom of the groove for the full width and length of the groove.

(l) Concrete surfaces within 75 mm of the edges of the joint shall be masked with tape before the primer is applied and until the sealing of the joint is complete.

(m) Primer for the joint sealant shall be applied to the sides of the groove in accordance with the manufacturer's recommendations.

(n) Joint sealant shall be applied between the minimum and maximum drying times of the primer recommended by the manufacturer. The components of the sealant shall be thoroughly mixed in accordance with the manufacturer's recommendations using a power operated paddle mixer for sufficient time to produce a homogeneous mass without entrapped air. The sealant shall be dispensed into the groove as soon as practicable after mixing and within the time recommended by the manufacturer.

(o) The groove shall be clean and dry at the time of applying the primer and joint sealant.

(p) Excess joint sealant shall be removed by using a purpose made finishing tool such that the finished surface of the sealant is between 4 mm and 6 mm below the face of the concrete.

(q) The best fit straight line of straight joints shall be within 25 mm of the specified line. The line of straight joints shall be within 10 mm of the best fit straight line.

(r) The best fit curved line of curved joints shall be as agreed by the Engineer and shall be within 25 mm of the specified line. The line of curved joints shall be within 10 mm of the best fit curved line.

(s) Joints shall be continuous across intersections of joints to within 5 mm of the best fit straight lines or best fit curved lines of each joint.

(t) The depth of grooves for joint sealant shall be within 3 mm of the specified depth.

2.1.8.16 Attendance upon Sub-Contractors

(a) Particular care shall be exercised by the Contractor to ensure that all pipes, ducts, drains, conduit, junction boxes, anti-static installations etc, are laid before the concrete floor and roof slabs is poured, and the Contractor will be held responsible for the cost of any additional cutting etc, and making good which becomes necessary through his failure to make proper arrangements for all sub-contractor work to be done in close co-operation with his own.

2.1.8.17 References and Standards

BS EN 197-1 (2011): Cement. Composition, specifications and conformity criteria for common cements

BS 4027 (1996): Specification for sulphate-resisting Portland cement.

BS EN 12620 (2013): Aggregates for concrete

BS EN 12878 (2005): Pigments for the colouring of building materials based on cement and/or lime. Specifications and methods of test

BS EN 480-14 (2006): Admixtures for concrete, mortar and grout. Test methods. Determination of the effect on corrosion susceptibility of reinforcing steel by potentiostatic electro-chemical test.

BS 6920-4 (2001): Suitability of non-metallic products for use in contact with water intended for human consumption with regard to their effect on the quality of the water. Method for the GCMS identification of water leachable organic substances
.
BS 3416 (1991): Specifications of bitumen-based coatings for cold application suitable for use in contact with potable water.

BS EN ISO 11600 (2003+A1:2011): Building construction. Jointing products. Classification and requirements for sealants

BS EN 14188-1 (2004): Joint fillers and sealants. Specifications for hot applied sealants

BS EN 450-1 (2012): Fly ash for concrete. Definition, specifications and conformity criteria

2.1.9 BRICKWORK AND BLOCKWORK

2.1.9.1 Generally

(a) Brickwork and blockwork shall be in accordance with **PD 6697:2010, BS EN 1996-3:2006, BS EN 1996-2:2006 and BS EN 1996-1-2:2005**

2.1.9.2 Materials

2.1.9.2.1 Clay bricks

(a) Clay bricks shall be a brand approved by the Engineer and shall be well burnt, hard, sound, square and clean.

(b) Brick size shall comply with **BS EN 771-1**. The nominal dimensions of clay bricks shall be 225 mm x 112.5 mm x 75 mm, 200 mm x 100 mm x 75 mm, and special sizes and shapes in accordance with the requirements stated in the Contract.

(c) Clay bricks for fair faced work shall be selected for evenness, texture, sharpness of arrises and uniformity of colour.

(d) The compressive strength of the clay bricks shall be at least 7.0 MPa.

2.1.9.2.2 Concrete bricks and blocks

(a) Concrete bricks and blocks shall be to **BS EN 771-2 & 3**, obtained from a manufacturer approved by the Engineer. The compressive strength of the concrete bricks shall be at least 7.0 MPa and for blocks and fixing bricks at least 2.8 MPa.

(b) The nominal dimensions of concrete bricks shall be 225 mm x 105 mm x 70 mm. The size of concrete blocks shall be as approved by the Engineer.

(c) Concrete bricks and blocks for fair faced work shall be selected for evenness, texture and sharpness of arises.

2.1.9.2.3 Concrete hollow blocks

(a) Concrete hollow blocks shall be obtained from an approved manufacturer.

(b) The average crushing strength of a random selected sample of 10 blocks shall not be less than 5.0 MPa of the gross area.

2.1.9.2.4 Brickwork reinforcement

(a) Brickwork reinforcement shall be expanded metal or mild steel rods and shall be galvanized or painted with two coats of bituminous paint.

2.1.9.2.5 Damp proof course

(a) Damp proof course shall be two layers of 2-ply bituminous paper or other types complying with **BS 6398** Class E; hessian-based types of bitumen damp proof course shall not be used.

2.1.9.2.6 Wall ties

(a) Wall ties between the ends of walls and concrete shall be:

i. 6 mm diameter steel rods 350 mm long galvanized or painted with two coats of bituminous paint, or

ii. 20 mm x 3 mm galvanized mild steel flats 350 mm long and fanged at both ends.

(b) Wall ties for walls built against the face of concrete structures shall be 20 mm x 3 mm galvanized mild steel flats 150 mm long and fanged at both ends.

(c) The length of mild steel flat ties which are fixed by shot firing into concrete walls may be reduced if permitted by the Engineer.

2.1.9.2.7 Mortar for brickwork and blockwork

(a) Cement shall be as Clause 2.1.8.2.1

(b) Water shall be as Clause 2.1.8.2.3

(c) Sand shall be as stated in Clause 2.1.17.1.

(d) Lime putty as **PD CEN/TR 15123, BS 8481 & BS EN 13914-2** shall be prepared by mixing hydrated lime with the minimum amount of water necessary to achieve a thick creamy consistency; the putty shall be left undisturbed for at least 16 hours before use.

(e) Lime shall be hydrated lime to **BS EN 459-1:2010 and BS EN 459-3:2011**, delivered in sealed bags bearing the manufacturer's name or brand.

(f) Measure mortar constituents by volume, using clean gauge boxes made to suit volumes required.

(g) Mix constituents shall be to the following proportions:

i. Cement mortar cement and sand 1:30
ii. Cement/lime mortar cement, lime putty and sand 1:1:6 for external walls and 1:2:9 for internal walls
iii. Fire brick mortar shall be:
   - An approved proprietary brand of fire cement, used neat, or
   - High alumina cement shall be to **BS EN 14647** and fine crushed fire brick 1:2

(h) Proportions given are for dry sand. Allow for bulking.

(i) Where plasticizers are used, they shall be used strictly in accordance with manufacturer's recommendations and the proportions of the mortar mix adjusted accordingly.

2.1.9.3 Submissions

2.1.9.3.1 Particulars of brickwork and blockwork

(a) The following particulars of the proposed materials for brickwork and blockwork shall be submitted to the Engineer:

- a certificate showing the manufacturer's name, the date and place of manufacture and showing that the materials comply with the requirements stated in the Contract and including results of tests for crushing strength of clay bricks, concrete bricks and blocks and concrete hollow blocks,

- details of brickwork reinforcement, damp proof course and wall ties, and details of materials for mortar.

(b) The particulars, including certificates, shall be submitted to the Engineer at least 14 days before the first delivery of the material to the Site. Certificates shall be submitted for each batch of the material delivered to the Site.

2.1.9.3.2 Samples of materials

(a) Samples of the following proposed materials shall be submitted to the Engineer at the same time as particulars of the material are submitted:

i. each type of brick and block, and

ii. Brickwork reinforcement, damp proof course and wall ties.

2.1.9.4 Trial panels

2.1.9.4.1 Trial panels

(a) A trial panel shall be constructed for each type of faced and fair faced brickwork or blockwork to demonstrate that the proposed materials will produce brickwork or blockwork which complies with the specified requirements.

(b) Trial panels shall be constructed at least 14 days before the relevant work starts.

(c) The Contractor shall inform the Engineer 24 hrs, or such shorter period agreed by the Engineer, before constructing trial panels.

(d) Trial panels shall be constructed using the materials submitted to the Engineer.

(e) Each trial panel shall be 1 m x 1 m and shall be constructed at a location agreed by the Engineer.

(f) Trial panels shall be used as a means of comparison against which the Engineer shall determine the compliance or otherwise of the brickwork or blockwork in the permanent work. Trial panels shall be protected from damage and shall be left in position until the Engineer instructs their removal.

2.1.9.4.2 Non-compliance: brickwork and blockwork

(a) If in the opinion of the Engineer the brickwork or blockwork in the trial panel does not comply with the specified requirements for brickwork or blockwork, particulars of proposed changes to the materials and methods of construction shall be submitted to the Engineer; further trial panels shall be constructed until the trial panel complies with the specified requirements.

2.1.9.4.3 Commencement of brickwork and blockwork

(a) Brickwork and blockwork shall not commence until in the opinion of the Engineer the trial panel complies with the specified requirements.

2.1.9.4.4 Changes in materials

(a) Unless permitted by the Engineer, the materials used to produce a trial panel which complies with the specified requirements shall not be changed.

2.1.9.5 Handling and storage of materials

2.1.9.5.1 Handling and storage of materials

(a) Bricks and blocks shall be unloaded and handled in a manner which will not result in soiling, chipping or other damage to the bricks and blocks. Bricks and blocks shall be stacked on a dry, level base and in a manner which will not result in damage to the bricks or blocks or in contamination of the bricks or blocks. Bricks and blocks shall be protected from damage and damaged bricks and blocks shall not be used in the permanent work unless permitted by the Engineer.

2.1.9.6 Laying bricks and blocks

2.1.9.6.1 Type of mortar

(a) Cement mortar shall be used for brickwork and blockwork:

i. below the damp proof course, including basement walls,

ii. for brickwork and blockwork not exceeding 150 mm thick,

iii. in load-bearing walls, and

iv. for pointing where the bed is cement mortar or where stated in the Contract.

(b) Cement lime mortar shall be used for brickwork and blockwork.

(c) Mortar shall be mixed using the minimum amount of water necessary to achieve the required consistency and shall be used within one hour after mixing. Unless otherwise permitted by the Engineer, the materials shall be mixed by a mechanical method.

2.1.9.6.2 Bond and gauge of brickwork and blockwork

(a) Stretcher bond shall be used for half brick walls and English bond shall be used for brick walls exceeding half brick thick. Stretcher bond shall be used for blockwork.

(b) Brick courses shall be gauged with four courses to 300 mm including joints.

(c) Bricks and blocks shall be laid on a full bed of mortar and the joints shall be filled solid to a thickness of 10 mm.

(d) Single frog bricks in load-bearing walls shall be laid with the frog facing upward and filled with mortar.

(e) Courses shall be kept level and perpends shall be kept in line vertically. Quoins and other angles shall be plumbed as the work proceeds and shall be constructed in advance of the remainder of the wall, but not exceeding five courses, and shall be racked back between levels.

(f) Bricks and blocks shall be wetted before laying during dry weather using the minimum amount of water necessary to prevent premature drying out of the mortar.

2.1.9.6.3 Laying damp proof courses

(a) Brickwork shall be flushed up with cement mortar to form a level and even bed to receive the horizontal damp proof course.

(b) Damp proof courses shall be laid in a continuous strip with 150 mm laps at the end of the length and at returns. The mortar joint shall be completed to the normal thickness.

2.1.9.6.4 Fixing wall ties

(a) At junctions of walls and concrete, wall ties shall be fixed at 300 mm centres vertically and shall project 250 mm into the wall.

(b) Wall ties shall be fixed for walls built against the face of concrete structures and shall be spaced at intervals of 900 mm horizontally and 300 mm vertically in a staggered pattern; the ties shall project 75 mm into the wall.

2.1.9.6.5 Finishing of joints in brickwork and blockwork

(a) Joints which will not be visible in the finished brickwork and blockwork shall be struck off as the work proceeds. Joints which will be exposed shall be struck flush and weather pointed as the work proceeds. Joints in brickwork to which plaster or other wet applied finishes will be applied shall be raked out to a depth of 10 mm.

2.1.9.7 Tolerances

2.1.9.7.1 Tolerances: brickwork and blockwork

(a) Brickwork and blockwork shall comply with the following requirements:

i. The position on plan shall be within 15 mm of the specified position.

ii. The length shall be within 15 mm of the specified length.

iii. The height shall be within 10 mm of the specified height.

iv. The level of bed joints shall be within 10 mm of the specified level in any 5 m length.

v. The brickwork and blockwork shall be straight to within 15 mm in any 5 m length.

vi. The brickwork and blockwork shall be vertical to within 15 mm in any 3 m height.

2.1.9.8 Testing: bricks and block

2.1.9.8.1 Batch: bricks and blocks

(a) A batch of bricks or blocks is any quantity of bricks or blocks of the same type, manufactured or produced at the same time in the same place, covered by the same certificates and delivered to the Site at any one time.

2.1.9.8.2 Samples: bricks and blocks

(a) Unless otherwise permitted by the Engineer, one sample of each type of bricks or blocks shall be provided at the same time as particulars of the material are submitted to the Engineer and one sample of each type of bricks or blocks shall be provided from each batch of the material delivered to the Site.

(b) The number of bricks or blocks in the sample shall be 10 for each batch of 15,000 bricks or blocks or part thereof.

(c) The method of sampling shall be in accordance with **BS EN 771-1**.

2.1.9.8.3 Testing: bricks and blocks

(a) Each brick or block in the sample shall be tested to determine the crushing strength of the brick or block.

(b) The method of testing shall be in accordance with **BS EN 771-1**.

(c) The average of the 10 crushing strengths of the bricks or blocks shall be calculated and referred to as the compressive strength.

2.1.9.8.4 Compliance criteria: bricks and blocks

The compressive strength of bricks and blocks shall be as stated in Clauses 2.1.9.8.1, 2.1.9.8.2 and 2.1.9.8.3 or as stated elsewhere in the Contract.

2.1.9.9 References and Standards

BS EN 771-1 (2011): Specification for masonry units. Clay masonry units

BS EN 771-2 (2011): Specification for masonry units. Calcium silicate masonry units

BS EN 771-3 (2011): Specification for masonry units. Aggregate concrete masonry units (dense and lightweight aggregates)

BS EN 998-1 (2010): Specification for mortar for masonry. Rendering and plastering mortar

PD 6697 (2010): Recommendations for the design of masonry structures to BS EN 1996-1-1 and BS EN 1996-2

BS EN 1996-3 (2006): Eurocode 6. Design of masonry structures. Simplified calculation methods for unreinforced masonry structures

BS EN 1996-2 (2006): Eurocode 6. Design of masonry structures. Design considerations, selection of materials and execution of masonry

BS EN 1996-1-2 (2005): Eurocode 6. Design of masonry structures. General rules. Structural fire design

PD CEN/TR 15123 (2005): Design, preparation and application of internal polymer plastering systems

BS 8481 (2006): Design, preparation and application of internal gypsum, cement, cement and lime plastering systems. Specification

BS EN 13914-2 (2005): Design, preparation and application of external rendering and internal plastering. Design considerations and essential principles for internal plastering
BS EN 459-1 (2010): Building lime. Definitions, specifications and conformity criteria
BS EN 459-3 (2011): Building lime. Conformity evaluation
BS 6398 (1983): Specification for bitumen damp-proof courses for masonry
BS EN 14647 (2005): Calcium aluminate cement. Composition, specifications and conformity criteria

BS 8215 (1991): Code of practice for design and installation of damp-proof courses in masonry construction

BS 6398 (1983): Specification for bitumen damp-proof courses for masonry

2.1.10 CURTAIN WALLING

2.1.10.1 Source

(a) Furnish curtain wall system components by one manufacturer or fabricator; however, all components need not be products of the same manufacturer.

2.1.10.2 Scope

2.1.10.2.1 Scope of the Works

(a) The Works comprise the design, fabrication, transportation, assembly and installation of the curtain walls as specified. Provide full-scale testing to show compliance.

2.1.10.2.2 Works included

(a) The Works include, but shall not be limited to :-

i. Aluminium/stainless steel framing members.

ii. Galvanized mild steel sections as reinforcement.

iii. Fixings, connections and provision of anchorages. Concrete embedments shall be provided under the Works but set by others.

iv. Glass and glazing materials including glass spacers, gaskets, sealants etc.

v. Spandrels, dressings to roofs/abutments, integral louvres and screens to A/C intakes/exhausts and operable windows.

vi. Stone panels and their support systems.

vii. Ironmongery and fittings.

viii. Sills, copings, water bars, flashings, seals and other attachments.

ix. Insulation against fire between storeys and designated compartments.

x. Isolation of dissimilar metals and moving parts.

xi. All preparatory work to the adjoining structure for attachment of the Works.

xii. Sealants within work of this section and at boundaries with work of other sections.

xiii. Thermal insulation at non-vision areas.

xiv. Mock-up erection and tests.

xv. Field tests for resistance to water leakage.

xvi. Material tests.

xvii. Final cleaning.

xviii. Lightning protection.

xix. Field or Site mock-up.

2.1.10.2.3 Related work

(a) Work related to, and requiring coordination with, but not forming part of the Works includes :-

i. Reinforced concrete structure.

ii. Rendering and screed to concrete structure.

iii. External and internal finishes.

iv. External paving and asphalt work.

v. Forming grooves and chases in the structure for the proper execution of the Works.

vi. Mechanical air-handling installation.

vii. Ceiling installation.

viii. Fixing of anchorages into structure.

ix. External curtain wall cleaning system.

x. Granite cladding.

xi. Lightning protection installation.

xii. Closure panel for Venetian Blind/shutter.

xiii. Waterproofing/water-tightness.

2.1.10.3 Contractor's design responsibility

(a) The Drawings and Specifications define design intent and performance requirements.

Details show preferred profiles. The Contractor shall be responsible for the final design.

Responsibilities include, but shall not be limited to, the following :-

i. Unless otherwise specified, the appearance of exposed elements, including width and depth, shall be consistent throughout the project.

ii. Unless otherwise specified, the overall thickness of each glass type, and the component thicknesses of each multiple layer glass type, shall be consistent throughout the project.

iii. Provide anchor adjustment capability for the full range of specified tolerances.

iv. Provide movable joints to accommodate the full range of manufacturing tolerances, field tolerances, thermal movements, floor sag, beam sag, and column settlement.

v. Provide corrosion protection between dissimilar materials.

vi. Provide a water-tightness/ "pressure equalization and rain screen" curtain wall.

vii. Provide a completed external envelope which is accessible and maintainable internally or externally.

2.1.10.4 Information to be provided

2.1.10.4.1 Tender submission

(a) Submit one copy of the following information when specified in the tender documents:-

i. Basic design of the curtain wall.

ii. Quality, finish, thickness and standard of aluminium/stainless steel and galvanized mild steel reinforcement.

iii. Quality, coating, thickness, standard and manufacturer of glass together with the manufacturer's certification that the glass proposed meets the testing requirement specified in Clause 2.1.10.5.4.

iv. Details of provision for wind load, thermal and building movements.

v. Sections of major mullions and transoms with supporting typical structural calculations.

vi. Typical design of spandrels, copings, louvres, and operable windows.

vii. Typical arrangement and jointing of components.

viii. Typical arrangement of fire barriers between perimeters of floors and curtain wall.

ix. Proposals for mock-up and testing.

x. The Contractor shall be required to submit the name, experience and qualification of the person who shall provide full-time supervision during installation of the curtain wall.

xi. Provide an itemized list of deviations from the Specification and Drawings for the Works. Identify the Specification item, or the Drawing. In the event that there are no deviations, provide a written statement of full compliance with the Drawings and Specifications. Failure to provide an itemized list of deviations in the required form, or a statement of full compliance shall, at the Engineer's discretion, be cause for return of some or all submittals for approval without review.

xii. Within 6 weeks of the date of acceptance of the tender or nomination by the Engineer, submit as specified a detailed programme for the Work, to show the

following :-

2.1.10.4.2 Programme for the Works.

(a) Submission of structural calculations, shop drawings and samples of materials.

i. Ordering of components.
ii. Manufacture of components.
iii. Preparation of all mock-up samples required.
iv. Testing in laboratory.
v. Delivery of components.
vi. Installation.
vii. Field tests.
viii. Final cleaning.

(b) 'Installation' shall be further sub-divided into principal constituent operations.

2.1.10.4.3 Provision of drawings and calculations

(a) Provide as specified the following submittals for approval. First submittals and resubmittals shall be complete and in the required form. Resubmittals shall include requested corrections and shall respond to previous comments.

(b) Each sheet that is revised shall bear a revision date and number. Revisions shall be flagged with a conspicuous revision symbol and number. Failure of a submittal to be complete, in the proper form, responsive to comments, or identifying revisions shall, at the Engineer's discretion, be cause for non-approval and return of documents without review.

(c) Failure of review comments to note a noncompliance with the Specification and Drawings shall not relieve the Contractor from his obligation to comply.

(d) The failure of the Contractor to note a noncompliance on a given submittal shall not preclude a directive by the Engineer for the Contractor to comply on future submittals. Allow sufficient time for preparation and processing of submittals and resubmittals.

(e) Provide drawings certified by a registered structural engineer, showing materials in place. Drawings shall include elevations, floor plans, sections and full size details. Details shall be fully drawn (not outlined). Drawings shall include the following information :-

i. Assembly and water-tightness and/or pressure equalization and rain screen system of curtain wall.

ii. Glass and metal thicknesses.

iii. Metal alloy, temper and finish.

iv. Glass strength, tint, coating, opacifier, frit and safety backing.

v. Fastener alloy, strength, plating, diameter, length and spacing.

vi. Glazing materials identification.

vii. Sealants identification by product name.

viii. Relative layout of walls, beams, columns and slabs with dimensions noted.

ix. Dimensioned position of glass edge relative to metal surface.

x. Provisions for thermal movements and building movements.

xi. Locations of, and details for, any embedded anchors.

xii. Identification of, and details for, thermal insulation.

xiii. Weld information and weld symbols conforming to **BS 499**.

xiv. Glazing details applicable to replacement glass, with outline of procedure for glass replacement.

xv. Provisions for adjustment of anchors relative to tolerances of building structure.

xvi. Details of spandrels, copings, louvres and operable window.

xvii. Details of ceiling and bottom/floor closure panels or strips if applicable.

xviii. Details of fire barriers between perimeters of floors and curtain wall.

xix. Details of lightning protection.

(f) Provide, as specified, shop drawings and fully coordinated structural calculations, certified by a registered structural engineer. Calculations shall be legible and shall incorporate sufficient cross
references to the shop drawings to make the calculations readily understandable and reviewable. Test reports shall not be an acceptable substitute for calculations. Calculations shall include the
following information :-

i. Analysis for all applicable loads on framing members.

ii. Analysis for all applicable loads on anchors, including anchors embedded in concrete.

iii. Section property computations for framing members.

iv. Analysis of stress in structural silicone applications at vision or spandrel glass lights.

v. Certification of a registered structural engineer.

(g) Drawings and structural calculations shall be required for test mock-ups. The requirements for test mock-ups shall generally be the same as for the actual Works, with particular reference to mock-up conditions.

(h) Additional submittal requirements :-

i. Prior to, or at the same time as, the first submittal of structural calculations for approval, provide dimensioned die drawings for all aluminium extrusions. In the event that extrusion profiles are not finalized, provide die drawings for the profiles contemplated at that time. If profiles are revised, providerevised die drawings with the first calculation or shop drawing submittal which follows the revision.

ii. Die drawings shall show all profile dimension, metal thickness, alloy and temper.

iii. Prior to construction, provide die drawings of gaskets and weather-strips. Die drawings shall show all profile dimensions and shall identify materials.

iv. Prior to construction, provide glass manufacturer's wind pressure analysis and thermal stress analysis, as well as glass manufacturer's review of shop drawings stating that details shall be suitable for the proposed glass products.

v. Prior to construction, provide sealant manufacturer's test reports confirming sealant adhesion, compatibility and absence of staining for all relevant substrates.

vi. Prior to construction, provide certification that insulating glass conforms to BS 5713.

vii. Prior to submitting any documents for approval, submit laboratory test reports for structural silicone assembly.

(i) Samples of materials :-

i. Submit together with Clause 2.1.10.4.3(e) above, samples of all materials together with fully glazed samples of principal junctions and assemblies.

ii. Submission shall consist of three samples of each material and principal junction or assembly, two to be retained by the Engineer, and the other to be returned after approval. Approved samples shall be so marked by the Engineer. Samples of materials required shall be as follows :-

Aluminium/Stainless steel sections	300 mm length of each.
Galvanized mild steel	300 mm length of each section.
Sheet, plate, mesh	500 x 1000 mm piece of each type.
Glass	600 x 600 mm piece per type and/or edge finish.
Fastening devices	Each type.
Sealants	150 mm cured sample each type.
Gaskets	300 mm length of each type.
Flashings	300 x 300 mm piece of each type.
Stone	300 x 300 mm piece of each type.
Access panel/sash window	500 x 500 mm part with all accessories.

(j) Samples shall show the complete range of colour, texture and other characteristic changes through the manufacture, fabrication, assembly, installation and cleaning processes. Submit finished samples of every extrusion or section to be used and of every other material of the thickness and weight as required by the Engineer. Aluminium samples shall include samples
of high and low colour range of anodic and organic coating finish and shall be labelled accordingly. Stone samples should specify the name of the quarry, country and provide samples of full range of colour, texture and the grading of the stone.

(k) Erection and protection method statement;

Submit together with Clause 2.1.10.4.3(e) above, a detailed method statement for erection

and protection of the works.

(l) Mock-up samples;

Refer to Clause 2.1.10.6.13

(m) Structural adequacy tests of anchorages;

2.1.10.5 Materials

2.1.10.5.1 Generally

(a) Materials shall be structurally sound, able to withstand local pollutants and marine conditions, as well as the varying relative humidity as may be experienced in the vicinity of the project. In addition, the materials shall be free from defects and blemishes and shall conform to the relevant specified standards.

(b) Materials of common type shall be obtained from the same manufacturer.

(c) All materials or components shall be fully compatible with each other. Submit test certificates to prove compatibility of any materials or components as requested by the Engineer.

2.1.10.5.2 Steel

(a) Stainless steel shall be to **BS EN 10029** grading not inferior to 304 S15 with minimum thickness of 1 mm and with all exposed edges rolled round. Manufacturer's test certificates shall be provided with each consignment to the Site to show that the material has been tested and found to comply with the relevant requirements of **BS EN 10029**.

(b) Structural steel shall be to Clause 2.1.20.2.2, shall be galvanized in accordance with Clause 2.1.20.4.19 and be tested in accordance with Clause 2.1.20.3.2.

2.1.10.5.3 Aluminium

(a) Aluminium and Aluminium alloy shall be to Clause 17.07.

i. The following alloy and temper combinations are acceptable for extrusions subject to fabrication, finish and structural requirements : 6063-T5; 6063-T6; 6061-T6. Other alloys of the 6xxx series and other tempers may be submitted for approval.

ii. Nominal wall thickness of 3.0 mm or greater is acceptable for structural extrusions; wall thickness less than 3.0 mm may be acceptable and is subject to approval. Minimum nominal wall thickness for non-structural trim shall be 1.5 mm.

iii. The following alloy and temper combinations are acceptable for sheet and plate subject to fabrication, finish and structural requirements : 3003-Hl4; 5005-H14. Other alloys of the 3xxx, 5xxx and 6xxx series and other tempers may be submitted for approval. Provide 3.0 mm minimum nominal thickness

2.1.10.5.4 Glass

(a) Glass shall conform, as a minimum, to the following standards :-

i. **BS 952**.

ii. Heat-treated flat glass shall conform to **ASTM C 1048-4**, except that surface compression of heat strengthened glass shall be in the range 24000 to 45000 kPa.

iii. Tempered and laminated glass shall conform to **ANSI Z97.1-1984**.

(b) Provide tempered and/or laminated glass at the following locations :-

i. Doors.

ii. Fixed and operable glazing with a vertical edge within 300 mm of a door in the closed position and with the bottom edge less than 1500 mm above the walking surface.

iii. Fixed glazing with area exceeding one square meter, and with the lowest edge less than 450 mm above a walking surface, which is within 900 mm of such glazing; tempered and/or laminated glass is not required if there is a horizontal member with minimum 40 mm width located between 600 and 900 mm above the walking surface.

iv. Any additional locations required by local building regulations.

(c) Provide heat strengthened glass where required by design wind pressures, anticipated thermal stress, and use in a spandrel area. Provide fully tempered and/or laminated glass only where required by local building regulations or where design pressures are beyond the capacity of heat strengthened glass.

(d) Glass reflective metallic coatings shall conform to the following criteria.

i. Pinholes with diameter exceeding 1 mm shall not be acceptable and shall be permitted only within 75 mm of an edge.

ii. Clusters of pinholes shall not be acceptable.

iii. Scratches shall not have length exceeding 75 mm and shall be permitted only within 75 mm of an edge.

iv. No objectionable mottle or streaking shall be visible when glass is viewed at angles of 45 degrees through 90 degrees from a distance of 4 m or more.

(e) Reflective glass shall have the following properties :-

i. Shade coefficient shall not exceed : 0.30.

ii. Summer heat gain 'U' shall not exceed : 5.5 $W/m^2/oC$.
('U' = thermal conductance value.)

iii. Visible daylight transmittance shall not be less than: 8%.

(f) Edge quality criteria for annealed and heat strengthened glass shall be as follows :-

i. Shark teeth shall not penetrate more than half of glass thickness.

ii. Serration hackle may occur only within 150 mm of corners.

iii. Flare shall not exceed 1.0 mm as measured perpendicular to glass surface across the

edge. Flare shall not occur at setting blocks.

iv. Bevel shall not exceed 1.6 mm.

v. Flake chips may occur only within 200 mm of corners; depth shall not exceed 0.8 mm and length or diameter shall not exceed 6.0 mm.

vi. Rough chips shall not be permitted. Rough chips shall be those which exceed any of the dimensional limits for flake chips.

(g) Insulating glass shall have double edge seals. Primary seal shall be extruded polyisobutylene continuously bonded to glass surfaces and desiccant filled metal spacer, including corners. Minimum width of primary seal shall be 3.0 mm. Secondary seal shall be a 2 part neutral cure structural silicone. Secondary seal shall completely cover spacer with no gaps or voids, and shall be continuously bonded to both plates of glass.

(h) Laminated glass shall consist of two layers of heat strengthened glass with equal thickness and an interlayer with 1.5 mm nominal thickness.

(i) In addition to conforming to **BS 952** and **ASTM C 1048-4**, monolithic heat strengthened and tempered glass shall conform to the following flatness tolerances :-

i. Bow and warp have the same meaning. They are both defined as deviation of a glass surface from a true plane, with the glass free-standing or installed in a frame and positioned in a vertical plane.

ii. Localized bow refers to any straight line segment with a length of 300 mm on a glass surface.

iii. Overall bow refers to any straight line segment on a glass surface which extends between opposite edges across the smaller glass dimension and is perpendicular to at least one edge. The length of the line segment is the gage length.

iv. Localized bow shall not exceed 1.6 mm.

v. Overall bow shall not exceed : 1.0 mm per 300 mm for gage length in the range zero to 1 m; 0.75 mm per 300 mm for gage length in the range 1 m to 2.40 m; one half of the values listed in **ASTM C 1048-4**, Table 2 for gage lengths exceeding 2.40 m.

vi. Where heat treating results in essentially parallel ripples or waves, the maximum peak-to-valley deviation shall not exceed 0.127 mm. Requirements for localized bow and overall bow shall also be satisfied. Direction of ripples shall be consistent throughout the building and approved by the Engineer.

vii. The specified bow and ripple tolerances are intended as manufacturing quality control limits.

(j) Tempered glass shall be subjected to quality control measures (i.e. heat soaking) to minimize inclusions which could result in spontaneous breakage. Such inclusions are defined as a material defect by this specification. Installed tempered glass which experiences spontaneous breakage shall be replaced (material and labour) under the warranty provisions.

(k) Plastic films used to opacify glass shall conform to the following requirements :-

i. Minimum nominal thickness of polyethylene shall be 0.1 mm. Colour shall be black.

ii. Minimum nominal thickness of polyester shall be 0.08 mm. Film shall be pigmented and have a black colour.

iii. The bonding surface shall be completely coated with a solvent based adhesive.

iv. Monolithic opacified glass shall have a safety backing for fallout resistance.

(l) Vision glass shall be as specified.

(m) Spandrel glass shall be as specified.

2.1.10.5.5 Stone

(a) Stone nominal thickness shall be determined by the specified tests and design rules but shall not be less than as specified.

(b) Actual stone thickness shall not be less than nominal thickness minus 2.0 mm.

(c) Stone shall be free of damage to front face, back face and edges.

(d) Stone type shall be as specified.

(e) Stone finish shall be as specified and within acceptable colour range.

2.1.10.5.6 Anchors in stone

(a) Stone shall be supported by continuous kerf clips in sawn grooves at two opposite edges of each piece of stone. Kerf clips shall be set in a continuous bed of neutral cure silicone sealant, which has been shown by specified test requirements not to stain the stone.

(b) Kerf clips shall be formed stainless steel or anodized aluminium extrusions.

(c) Anchors in stone other than kerf clips for use in limited areas shall be considered if submitted. Such anchors shall be stainless steel and may be supplemented by an epoxy adhesive. However anchors
which rely solely on adhesive shall not be acceptable. Alternate anchors shall be subject to approval.

(d) The following types of anchors shall not be acceptable :-

i. Wires.

ii. Anchors whose only means of attachment to stone or building is a bed of grout or mortar.

iii. Anchors which are secured in a hole with lead wool packing.

iv. Anchors which transfer load from one piece of stone to another, rather than to the building structure.

(e) Anchors in stone shall provide for differential thermal movement of stone and the support system.

2.1.10.5.7 Glazing materials

(a) Gaskets and weather-strips except at structural silicone glazing shall conform as a minimum to **BS 6262** except :-

i. Sponge gaskets shall be extruded black neoprene with a hardness of 40± 5 durometer Shore A and conforming to **ASTM C 509**. Design sponge gaskets to provide 20% to 35% compression.

ii. Dense gaskets shall be black extrusions with a Shore A hardness of 75±5 for hollow profiles and 60± 5 for solid profiles, and conforming to **ASTM C 864-5**. Outdoor gaskets shall be neoprene or Santoprene. Indoor gaskets shall be neoprene, Santoprene or EPDM. Where indoor and outdoor gaskets are reversible for reglazing, EPDM shall not be used for either gasket.

iii. Injection mold all corners of gaskets where compatible with installation procedures.

iv. Interior and exterior gasket profiles shall be designed to produce a glass edge pressure of not less than 0.70 N/mm, nor more than 1.75 N/mm.

(b) Gaskets at structural silicone glazing :-

i. Glazing gaskets, sealant backers within glazing pockets and continuous glass spacer pads at structural silicone shall be black heat cured silicone rubber.

ii. Gaskets which maintain glass face clearance while serving as a backer for a silicone weather seal may have a friction fit. All other gaskets and weather strips, including backers for structural silicone, shall have a continuous spline or a continuous groove which engages a matching groove or leg on the aluminium frame.

iii. Double side tape is acceptable as a glass spacer pad when used in conjunction with structural silicone, subject to verification of compatibility.

(c) Setting Blocks :-

i. Setting blocks shall be dense extruded neoprene, silicone or EPDM with a hardness of 85±5 durometer Shore A, a minimum length of 100 mm and a minimum width corresponding to the glass thickness. Setting blocks shall be equidistant from the glass centreline. Location of setting blocks at glass quarter points is acceptable. The distance from the vertical glass edge to the nearest edge of the setting block shall not be less than 150 mm or 0.125 times glass width, whichever is greater.

ii. Shims used in conjunction with setting blocks shall be of thesame material, hardness, length and width as the setting locks.

iii. Setting blocks and chairs shall be secured against migration.

iv. Silicone setting blocks shall be required where structural silicone occurs at the sill.

v. Silicone setting blocks shall be acceptable for insulating glass units with silicone edge seals. Neoprene or EPDM setting blocks shall be acceptable only if permitted by the insulating glass fabricator, and if structural silicone does not occur at the sill.

(d) Side/Centering Blocks

i. Provide side blocks at both jambs, between the midheight and top corner of the glass. Blocks shall be 55 □ 5 durometer Shore A dense neoprene, silicone or EPDM.

ii. Install block with clearance between block and bearing surface. Positively secure blocks in position.

iii. Side blocks shall not be required where glass is supported along the vertical edges with structural silicone.

iv. Extruded silicone side blocks shall be acceptable for insulating glass units with silicone edge seals. Neoprene or EPDM side blocks shall be acceptable only if permitted by the insulating glass fabricator.

(e) Structural gasket

i. Structural gaskets shall be composed of rubber based material having proven compatibility with silicone sealants when used in a 'wet' system.

ii. 'Dry' system gaskets shall be extruded with integral locking strips or 'zipper' type insertions producing a compression grip on the frame structure and the glass. They shall be continuously placed around the glazing. The dimensional tolerance and the resulting edge bite shall be as recommended by the manufacturer.

iii. Colour of the gaskets shall be as selected/approved by the Engineer.

2.1.10.5.8 Anchors in concrete and masonry

i. Anchors embedded in concrete and masonry shall be hot dip galvanized rolled steel, or hot dip galvanized cold formed steel to **BS EN ISO 1461**. Galvanize steel parts of anchors. After field welding, remove weld slag and touch up affected area as specified in Clause 2.1.20.4.19.

ii. Strength of embedded anchors shall be developed by integral projections or by welded deformed bars or headed studs.

iii. At masonry, through bolts shall be acceptable provided that bearing plates are used at both masonry surfaces. Expansion bolts shall be acceptable only with prior approval from the Engineer.

iv. At concrete, all bolts should be cast-in-situ. Expansion bolts shall be acceptable only when prior approval has been obtained from the Engineer.

v. Self drilling, self threading screws shall not be acceptable. Screws in plugs and powder actuated fasteners shall not be acceptable.

vi. Areas where curtain walls are installed in “wet area”/“area exposed to weather”, anchors are upgraded to Stainless Steel Anchors embedded in concrete.

2.1.10.5.9 Fasteners

(a) Fastener requirements listed below shall be applicable to screws, bolts, nuts, washers, rivets and pins.

(b) Fasteners outboard of or within a glazing pocket, gutter, flashed cavity or other potentially wet location (after completion of construction) shall be stainless steel type 302 or 304. Fasteners inboard of potentially wet locations shall be stainless steel type 302 or 304, cadmium plated carbon steel or zinc plated carbon steel.

(c) Stainless steel fasteners shall be to BS EN 10263-1 & BS EN 10263-5 and BS EN ISO 3506. Stainless steel washers shall comply with BS 4320 and BS 4464 as far as sizes and

tolerances are concerned.

(d) Bolts, screws, nuts and washers shall be to item 2.1.20.2.6, shall be galvanized to item 2.1.20.4.16 and be tested in accordance with item 2.1.20.3.9.

(e) Provide lock washer or other locking device at all bolted connections.

(f) Power actuated fasteners shall not be acceptable.

(g) Aluminium fasteners shall be to BS 1473.

(h) Actions subsequent to any failure of material or test specimens shall be in accordance with the requirements of Clause 2.1.20.3.10

2.1.10.5.10 Shims

(a) At connections subject to thermal movement or other movement, separate all pairs of moving surfaces with friction reducing pads. Pads shall have minimum 3 mm thickness, shall sufficiently reduce friction to permit movement, shall be resistant to wear, shall be positively retained in position (open ended slots shall not be acceptable). Pads shall not be subjected to heat damage from welding or cutting, or to excessive pressure from over-tightening of bolts.

(b) Shims which transfer shear forces (tending to slide one shim against another) shall be steel plates, set in a staggered pattern and fillet welded to each other and to the adjacent steel surfaces. The shims and welds shall be structurally designed to support the applied loads.

(c) Plastic shims shall be acceptable at static connections for which the shims transfer only compressive forces.

(d) Wood shims shall not be acceptable.

2.1.10.5.11 Weep hole filters

(a) Weep hole filters shall be 8 to 18 pore per centimeter PVC coated open cell urethane foam, compressed 30 to 50 percent.

2.1.10.5.12 Sealants

(a) Capping sealant shall be a one part gun grade moisture curing silicone elastomeric sealant.

The colour of the sealant shall be as selected/approved by the Engineer.

(b) Caulking sealant shall be either :-

i. One part gun grade neutral moisture curing silicone elastomeric sealant.

ii. One part gun grade moisture curing modified polyurethane.

The colour of the sealant shall be as selected/approved by the Engineer.

(c) Structural sealant shall be either :-

i. One part gun grade neutral moisture curing silicone elastomeric sealant.

ii. Two part neutral curing silicone elastomeric sealant. Products requiring mixing of components shall be acceptable only for shop application with mixing and

applicating equipment acceptable to the sealant manufacturer.

(d) Comply with printed instructions and recommendations of the sealant manufacturer regarding joint size limitations, mixing, priming, and application. Unless printed instructions advise to the contrary, do not apply sealants when substrates are wet or when the temperature is below 4^{o}C.

(e) Sealant back-up materials shall be polyethylene foam, urethane foam or extruded silicone as recommended by sealant manufacturer.

(f) All sealant shall be tooled as a separate operation after application.

(g) Coordinate with other sections to assure compatibility of intersecting sealants.

2.1.10.5.13 Thermal insulation and fire-proofing insulation

(a) The maximum Overall Thermal Transfer Values (OTTV) to be used in the design of the building envelope shall be :-

	Building (including walls and roof) (overall)
Commercial Building	23 w/ m^2

(b) Insulate spandrel glass and other non-vision areas with thermal insulation having a 63.0 mm minimum thickness and a 0.127 mm thick reinforced aluminium foil vapour barrier. Minimum R-value for insulation alone shall be 1.90 square meter - K/w.

(c) Insulation shall be retained by aluminium or galvanized steel clips or straps, or integral pockets within the window frames. Maximum spacing of clips and straps shall be 600 mm. Welded or glued impaling pins shall not be acceptable. Maintain 25 mm nominal air space between insulation and glass.

(d) Support insulation where it contacts fire-safing, to prevent bow of insulation from pressure exerted by fire-safing.

(e) Completely fill void at floor and roof edges with fireproof material. Thickness as required to provide a 2 hour fire rating.

(f) Support fire-safing insulation on galvanized steel support clips spaced at a maximum of 450 mm centres.

2.1.10.5.14 Operable windows

(a) Operable windows shall be required to conform to the requirements of this specification. Except as otherwise specified herein, operating windows shall also conform (as a minimum) to **BS 4873** and **BS 6375** :-

i. Weather-strips, glazing gaskets and glazing blocks shall be extruded neoprene. Provide gaskets on both sides of the vent glass.

ii. The required test specimen size is the maximum size operable window for this project.

iii. Locks and strikes shall be white bronze or type 302 or 304 stainless steel. Provide a minimum of two locks and two strikes per vent.

iv. Fixed frames and vent frames shall be extruded aluminium. Vent frames shall consist

of a tubular profile.

v. Weather-strips shall have a continuous spline engaged in a continuous groove in the aluminium sash and/or fixed frame. Two continuous lines of weather-strip shall be required at vent perimeters.

vi. Balance arms shall be four-bar stainless steel type 302 or 304 with adjustable friction shoe. Provide two balance arms per vent.

vii. Provide two limit stops per operable window. Material shall be type 302 or 304 stainless steel. Stops shall restrict clear opening to 100 mm. Effective ventilating area shall be based on the maximum clear opening, not on the gross window area.

viii. Special keys shall be required to open the operable windows.

ix. Hinges and fastening mechanisms shall withstand positive and negative pressures due to specified wind conditions when the windows are in the open or closed positions.

2.1.10.5.15 Aluminium honeycomb panels

(a) Overall nominal thickness shall be 25.0 mm.

(b) Face and back sheets shall be aluminium with nominal thickness of 1.0 mm. Alloy shall be of the 3xxx, 5xxx or 6xxx series and shall satisfy structural and finish requirements. Provide formed edge returns and seal edges with silicone sealant. Bonding surfaces shall be chemically pretreated to assure effective and durable bond.

(c) Core shall be hexagonal cell aluminium foil with minimum nominal thickness of 0.0762 mm. Cell size shall not exceed 6.0 mm measured across flats. Foil shall have an organic corrosion resistant coating. Alloy shall be 3003, 5052, or 2024.

(d) Adhesive shall be a thermal setting modified epoxy with a minimum set temperature of 121^{o}C. The adhesive shall form a fillet at the perimeter of each cell, and shall continuously bond each cell to the face and back sheets.

(e) The face sheet, back sheet, and core of each panel shall be cut from single piece of material.

(f) For panels in p lace, deviation from flatness of exterior face shall not exceed 2 mm along any straight line which extends from a panel edge to any other edge. Where the edge is concealed, the nearest exposed point to the edge shall be used.

(g) Panel exterior face shall be free of visual discontinuities such as ripples, creases, dents, bubbles and blisters, regardless of the measured deviation from flatness at such discontinuities.

2.1.10.5.16 Louvres

(a) Louvres shall consist of extruded aluminium perimeter frames and blades. Frame corners and blade ends shall be welded or fastened with 300 series stainless steel screws. Provide concealed extruded aluminium stiffeners for blades, such that vector sum of blade deflections parallel to blade principal axes does not exceed 1/175 times span at design pressure. Assume that pressure acts perpendicular to the plane formed by the corners of the perimeter frame, and that the tributary area for one blade equals its projected area on the same plane.

(b) Coordinate free area of louvres with mechanical requirements.

(c) Inactive louvres shall be closed by aluminium sheet with minimum 3.0 mm nominal thickness, fastened and sealed to the indoor louver surfaces.

(d) Provide aluminium bird screen mesh at active louvres. Mesh wire shall have 1.6 mm minimum nominal thickness. Openings within mesh shall be 13.0 mm.

(e) Finish for louvres and screens shall be the same as for other aluminium members.

2.1.10.5.17 Copings

(a) Copings shall comply with the following :-

i. Copings shall comprise aluminium minimum 3.0 mm thick or stainless steel minimum 2.0 mm thick. The surface of aluminium shall have finish to match colour of framing.

ii. Copings shall be rigid, reinforced with a metal frame if required and shall be fixed rigidly to the structure. Copings shall be strong enough to resist forces due to extreme wind forces and casual impact.

iii. Ends of coping panels and joints to curtain wall frame shall be tightly sealed up and an effective drainage system shall be provided to drain out any water that may penetrate through the joints.

2.1.10.5.18 Concealed and exposed flashing

(a) Acceptable materials are PVC sheet, neoprene sheet, stainless steel sheet and mill finish aluminium sheet. Minimum thicknesses are 1.6 mm for PVC and neoprene, 0.25 mm for stainless steel, and 1.0 mm for aluminium. Aluminium shall be required to have a bituminous coating against dissimilar materials.

(b) Provide sealed lap joints, end dams and transitions to gutters, dressings to roofs/abutments, louvres and screens to A/C intakes and exhausts.

(c) PVC sheet and neoprene sheet shall not be acceptable as primary gutters, which shall be metal with suitable corrosion protection.

(d) Exposed flashing shall be strong enough to resist forces due to typhoon and casual impact.

2.1.10.5.19 Maintenance/ replacement standby materials

(a) Upon completion of construction, deliver to a designated storage area replacement standby materials for maintenance and repair. Materials shall conform to the same requirements as materials used for construction.

(b) The replacement standby materials shall be stored in clearly labelled protective boxing and/or crates and positioned on support frames and/or storage racks which are placed in appropriate locations to ensure the material shall not be damaged or deteriorate.

2.1.10.5.20 Finishes

(a) Exposed metal surfaces shall be finished to match the appearance, colour and texture of the samples as approved by the Engineer.

(b) Finishes to metals shall be :-

i. Clear or coloured anodic finish to aluminium shall comply with **BS 3987**.

ii. No. 8 bright polished finish to exposed faces of stainless s teel.

iii. No. 7 polished finish to stainless steel or chromium plated ironmongery.

iv. Alternative finishes shall be approved by the Engineer.

v. Organic coatings to meet the requirements of **BS 4842** and/or **BS 6496**.

(c) All as specified and indicated on the drawings.

2.1.10.5.21 Protective treatments

(a) Protective treatment to concealed steel parts of the curtain wall system such as fixings, connectors, etc., shall be hot dip galvanizing to **BS EN ISO 1461**.

(b) All welding and provision of holes shall be completed before galvanizing.

(c) No in-situ welding is allowed unless prior approval has been obtained from the Engineer.

2.1.10.5.22 Anodic coating to aluminium and testing of same

(a) The thickness of anodic coating shall be minimum 0.025 mm. Coloured anodic coatings and testing of same shall be as approved by the Engineer.

(b) Samples of finished aluminium from production lots shall be tested in accordance with BS 3987.

(c) Complete certified inspection records for quality of finish and complete finish process records shall be maintained and made available to the Engineer on request.

(d) Repair of damage to finished surfaces by mechanical means (other than those specified) or by painting is strictly forbidden unless authorized in writing by the Engineer.

(e) Surfaces to be finished shall be free from mechanical imperfections such as scratches, scrapes and dents. Finished surfaces shall be free from finished imperfections such as spots, stains and streaks.

(f) Materials may be finished more than once provided that all specified requirements are satisfied. However, any material which has been finished twice and is still not acceptable shall be rejected

2.1.10.5.23 Organic coating finish to aluminium

(a) Organic coating finish shall comply with the following general requirements :-

i. All coatings, when cured, shall be visibly free of flowlines, streaks, sags, blisters or other surface imperfections.

ii. All finishes shall match in gloss, and fall within the colour range of the approved samples.

iii. Dry film thickness of coating on exposed s urface, when measured in accordance with **BS 4842** shall not be less than 45 microns, except in channel recesses and internal corners, which shall be visually covered.

(b) Paint all surfaces of metal cladding.

(c) Prepare and submit colour samples to the Engineer. After selection by the Engineer, prepare 6 sets each of two samples which shall define the colour and gloss range and submit to the Engineer for endorsement. Samples shall be identified and attached with a full laboratory report as per **BS 4842** and **BS 6496**.

(d) Painted aluminium finish shall be factory oven cured minimum two-coat finish of fluoropolymer resin supplied by a licensed formulator. The licensed formulator shall identify the finish which he supplies to meet the minimal requirements for formulation as set forth in the licensing agreement.

(e) Application of the finish shall be carried out in accordance with the specifications issued by the licensed formulator and by an applicator specifically approved by one (or more) of the formulators. The applicator shall provide written notification of approval by a formulator prior to application of the finish. The formulation shall contain at least 70% fluoropolymer resin in the residual solids.

(f) Pretreat metal surfaces in accordance with the procedure recommended by the manufacturer to provide proper surfaces for coating.

(g) Pigmented organic coatings for extrusions, structural shapes, sheet or plate, spray applied in the factory, shall meet the requirements of **BS 4842** and **BS 6496.**

(h) Field touch-up of painted aluminium is permitted only with the written permission of the Engineer. Unless touch-up is authorized, replace damaged material with new material.

2.1.10.5.24 Aluminium finish at structural silicone

(a) Mill finish shall not be acceptable at structural silicone bonding surfaces.

(b) Aluminium surface to which structural silicone will be adhered shall have a finish which demonstrates by test the ability to satisfy specified requirements. Subject to testing, acceptable finishes shall be as follows :-

i. Factory applied two-coat oven cured fluoropolymer paint conforming to **BS 4842** and/or **BS 6496**.

ii. Architectural Class I anodizing conforming to **BS 3987**.

iii. Alodine conversion coating.

2.1.10.6 Workmanship

2.1.10.6.1 Generally

(a) Material, components and systems shall be used in compliance with the standards and procedures of the appropriate manufacturers. All work shall be of the highest quality and be
carried out by competent tradesmen holding relevant trade certification, such that the finished

work satisfies the requirements of the specification. Practice shall conform to the relevant part and in the priority of :-

i. **BS EN 1999-1-1:2007+A1:2009**: Structural Use of Aluminium.

ii. Structural steel shall be to Section 2.1.19.

iii. **BS 6262** - Code of practice for glazing of buildings.

iv. **BS 8200** - Design of non-load bearing external vertical enclosures of buildings.

v. **BS EN ISO 11600:2003+A1:2011**- Specification for one-part gun grade silicone based sealants.

(b) Recommended glazing guidelines for reflective insulating glass by AAMA.

(c) Aluminium Curtain Wall Design Guide Manual by AAMA.

(d) Metal Curtain Wall Manual by AAMA.

(e) No temporary stress or force shall be applied at any time to the assembly, units, individual components or fixing devices which these have not been designed to withstand. Provide temporary supplementary frame stiffeners for curtain wall units for handling purposes when required.

(f) Conform strictly to the material finishes, shapes, sizes, thickness, and joint locations required by the agreed shop drawings and the Specification.

(g) Match all materials to produce continuity of line, colour and texture.

(h) Protect from damaging curtain wall units and components stored on the site.

(i) Store glass on the site in a dry well-ventilated sheltered location.

(j) Handling glass shall be kept to a minimum and all glass shall be carefully protected from soiling, condensation and damage. To avoid damage of glass, all glass must not be slided directly on hard surface and ensure the frames free from sand and any hard bits before installation.

(k) Carry out all final fitting and assembly work on the Site in a workshop established and equipped for that purpose.

(l) All components exposed in the finished work shall be free from warping, oil-canning effects and the telegraphing of welds, studs and other fasteners.

(m) Provide specified finishes on all exposed surfaces. Provide specified galvanizing on concealed steel.

(n) Systems with glass supported at all edges by structural silicone shall be unitized and shall be fully assembled, including silicone and glass, in the workshop.

2.1.10.6.2 Setting out

(a) Before commencing any work, verify all measurements of the "as constructed" building. If any discrepancies are found they shall be brought immediately to the attention of the Engineer. Design curtain wall anchorage to accommodate a minimum 25 mm construction tolerance in any direction of the building structure.

(b) Accurately set out the Works and take all necessary Site dimensions.

2.1.10.6.3 Joints in curtain wall

(a) Visible joints in the curtain wall shall be as shown on the drawings. Other joints shall be hairline joints, tightly fitted and coordinated with mullion grids.

(b) All fastening, jointing and splicing of members shall be concealed. Exposed fasteners shall only occur where expressly permitted by the Engineer. Where exposed in the finished work, screws shall be the countersunk head type, finished to match the adjacent surface.

(c) Fasteners shall not penetrate gutters and drainage systems.

2.1.10.6.4 Corrosion protection

(a) Aluminium in contact with dissimilar metal excluding non-magnetic stainless steel shall be treated with an approved treatment for the prevention of electrolytic action and corrosion.

(b) Aluminium surfaces in contact with mortar, concrete, plaster, masonry and similar materials and wet-applied materials in fire -proofing and absorptive materials shall be coated with an approved anti-corrosive moisture-barrier material.

(c) The Contractor shall clearly state what material is to be applied and provide a certificate from the curtain walling manufacturer certifying that the material is suited for its intended purpose

2.1.10.6.5 Metal to metal contact

(a) Separate metal surfaces in such a manner that metal does not rub against metal. Materials used for this purpose shall be lubricating devices, sealants, slip pads or gaskets.

2.1.10.6.6 Welding

(a) Welding of steel shall be in accordance with **BS 499** and **BS EN 1011-1** and **BS EN 1011-2**.

(b) Welding of aluminium shall be to **BS EN 1011-4:2000**

(c) Welding of Aluminium shall be tested to**, BS EN ISO 4136:2011**, **BS EN ISO 5173:2010+A1:2011, BS EN 1320:1997, BS EN 1321:1997**.

(d) The type, size and spacing of welds shall be as shown on the agreed shop drawings. Welding materials and methods shall be such as not to cause distortion, discolouration, or result in any other adverse effect on the required profiles and finishes of the exposed curtain wall.

(e) Weld spatter and welding oxides on exposed surfaces shall be removed, and prime painted with zinc rich coating.

(f) Unless otherwise shown or specified, weld beads on exposed surfaces shall be ground and finished to match and blend with finish on adjacent metal. Grinding and polishing of nonferrous metal shall be done only with clean wheels and compounds free from iron and iron compounds. No soldering and/or brazing shall be allowed.

2.1.10.6.7 Application of sealant and gaskets

(a) Sealant application shall be to **BS EN ISO 11600:2003+A1:2011**. Sealant and gaskets shall be as shown on the approved shop drawings.

(b) The design of all sealed joints shall be in accordance with the recommendation of the

sealant and/or gasket manufacturer.

(c) Protect all adjoining surfaces to s ealants and gaskets against staining.

(d) Joints, joint surfaces and glazing rebates shall be clean, dry, and free of any material that may have an adverse effect on the bonding or sealing of the sealant and gasket materials or on the proper drainage of the glazing rebates.

(e) Apply sealants and gaskets under the conditions and in the manner recommended by the manufacturer. No sealant that has started to set in its container or has exceeded its shelf life shall be used. Do not apply sealants externally during raining period.

(f) The sealant manufacturer shall provide written notification if the relevant substrates in contact with sealants shall or shall not require priming. The recommendations shall be based on tests conducted by the sealant manufacturer using samples of the relevant substrates for the project. Unless printed instructions state to the contrary, sealant shall not be applied when substrates are wet or when the temperature is below 4.5^{o}C.

(g) Fill all joints continuously and completely with sealant, forming a neat, uniform, concave or flat bead finish flush with adjoining surfaces unless otherwise shown on the drawings. All sealant surfaces shall be tooled smooth.

(h) Exposed sealants shall be installed so that top surfaces of the horizontal sealant beads shall be sloped to drain water away.

(i) Glazing gaskets shall be of the profile, dimension and durometer required to support the glass and resist water penetrations. Exterior glazing gaskets shall have factory made pre-molded corners.

2.1.10.6.8 Render stops

(a) Incorrect placement, leveling or lining-through of angles to in-situ finishings and the like fixed by others shall be immediately reported in writing to the Engineer.

2.1.10.6.9 Sequence of installation

(a) Coordinate and carry out the installation of the curtain wall in sequence with related work operations to be executed by others as necessary to achieve a weather-tight and satisfactory visual relationship between the various components and the structure, finishes and weather seals.

2.1.10.6.10 Erection

(a) Install materials in accordance with approved drawings. Provide labour, materials, equipment and supervision necessary for a complete installation. Align and anchor materials to building structure. Seal joints within work of this section and at joints with adjacent construction.

(b) Coordinate erection with requirements of materials hoist and manlift. Defer installation at areas obstructed during construction and install materials when obstructions are removed.

(c) Tolerances :-

i. Provide anchor adjustment capability for the full range of specified tolerances for the building structure and to accommodate construction tolerances and short term building movements (i.e. concrete column settlement).

ii. Work of this section shall be within the following tolerances.

- Deviation from plumb, level or dimensioned angle shall not exceed 3.0 mm per 3600 mm of length of any member, 6.0 mm in any total run in any line.
- Deviation from theoretical position in plan or elevation, including deviation from plumb, level or dimensioned angle, shall not exceed 10.0 mm total at any location.Change in deviation shall not exceed 3.0 mm per 3600 mm run in any direction.
- Maximum offset from alignment between two consecutive members placed end to end shall not exceed 1.5 mm.
- Maximum offset between glass framing members at corners of glazing pocket shall not exceed 0.8 mm.

(d) Anchorage :-

i. Anchor component parts securely in place by bolting.
ii. Welding may be used if prior approval is obtained from the Engineer. Install slip pads between moving parts.

iii. Provide non-corrosive separators between dissimilar materials.

iv. Remove weld slag and apply prime paint over welds. Touch up hot dip galvanizing that is damaged by welding or other causes.

v. Where slots or oversize holes are provided for adjustment only, secure the connection after final adjustment.

vi. Interlocking serrations in extruded aluminium brackets and washers shall be acceptable. Steel weld washers with 6.0 mm minimum thickness shall be acceptable with steel brackets.

vii. Special washers or nuts which rely on friction and/or surface indentation of the fastened partshall not be acceptable.

viii. Bolts shall be double nutted, have an acceptable spring washer or be painted/coated with a lock-tight liquid to prevent bolts from loosening.

ix. All fixings shall be concealed when the work is completed.

(e) Clean surfaces shall be sealed. Install backers, bond breakers, primers and sealants in accordance with drawings, test results and manufacturer recommendations. Tool sealants as a separate operation after application. Immediately remove any masking.

(f) Install thermal insulation, vapour barrier and fire-safing insulation with specified supports.

(g) Adjustment :-

i. Adjust operating windows and doors for proper fit within fixed frame.

ii. Adjust weather-strips for continuous contact and seal in closed position.

iii. Adjust hardware for proper operation from closed and locked position to fully open position.

2.1.10.6.11 Glazing

(a) Glazing shall be to **BS 6262** and in accordance with the manufacturer's recommendations.

i. Glazing shall be carried out from inside the building whenever possible.

(b) Glass and glazing materials shall be compatible with each other and the glass shall be protected from damage and staining of any kind.

i. The weather seal at glass perimeters shall be a combination of sponge and dense gaskets. Gaskets shall be hot melt injection molded at corners where compatible with installation procedure. Where gasket joints occur, tightly butt ends and seal with a compatible sealant. Gasket joints shall not occur at locations other than corners.

ii. Glass shall be new. Glass shall be of the specified type and quality with cleanly cut edges and sharp corners. Inspect glass before installation. Do not install defective glass.

iii. Before setting glass, inspect frame for proper dimensions and squareness. Adjust frame and/or glass size as required to meet specified requirements for glass bite dimensions and glass edge clearance.

iv. Except as otherwise specified, comply with **BS 6262**. Provide a minimum nominal glass bite of 13 mm. Where joint movement shall result in variable glass bite, increase nominal bite to provide 10.0 mm minimum bite and 6.0 mm minimum edge clearance. In no case shall the front and back clearances be less than 5.0 mm.

v. Thoroughly clean glazing pocket before setting glass. Solvents shall be compatible with finished aluminum, glass and glazing materials.

vi. Setting blocks shall be equidistant from the glass centreline.

vii. Location of setting blocks at glass quarter points is acceptable. The distance from the vertical glass edge to the nearest edge of the setting block shall not be less than 150 mm, or 0.125 times glass width, whichever is greater. Side blocks shall be located between the midheight and top corner of the glass. Side blocks, setting blocks and chairs shall be positively retained in position.

viii. Fasteners shall not penetrate glazing pockets.

ix. Remove and replace stops and apply sealants as required for a complete glass installation.

x. Defer glazing of openings which are obstructed during construction.Glaze such opening when obstructions are removed.

xi. Leave glass in crates until just prior to installation. Replace any glass which breaks or sustains edge damage, surface damage or damage to reflective coating as defined in Clause 2.1.10.5.4..

xii. Clean, prime and mask at structural silicone joints within 8 hours before applying the silicone.

xiii. Temporarily clamp glass during cure of structural silicone. After sufficient cure, remove clamps and fill any gaps in silicone.

xiv. Mask glass and aluminium during application of structural silicone. Remove masking immediately after tooling sealant.

xv. Structural silicone shall not be applied to edges of insulating glass units, or to edges of laminated glass units. Sealants used as weather seals shall not be adhered to, or placed against, the edge of a laminated glass unit inter-layer

2.1.10.6.12 Stone fabrication

(a) Fabrication tolerances for exposed surface of individual pieces of stone shall be as follows :-

i. Length and height (or width): 1.0 mm.

ii. Depth of a saw cut: 2.0 mm.

iii. Depth of a drilled hole: 3.0 mm.

iv. Deviation from flat plane in 1200 mm, any direction: 2.0 mm.

v. Deviation from square: 2.0 mm difference in diagonals.

vi. Deviation from nominal thickness: 2.0 mm.

vii. Position of kerf cut relative to outdoor face ±1.0 mm.

(b) Fabrication tolerances for exposed surface of one stone system assembly with stone anchored to a support system shall be as follows:-

i. Sealant joint width between pieces of stone: ±25% of nominal. (Joints which absorb thermal and building movements shall require stricter tolerance.)

ii. Overall length and height (or width), stone edge to stone edge: 3.0 mm.

iii. Offset (in/out) between adjacent stone edges: 1.5 mm maximum.

iv. Deviation from flat plane for overall length: 5.0 mm.

v. Deviation from flat plane for overall height (or width): 3.0mm.

vi. Difference in overall diagonals measured to outside corners of stone: 5.0 mm maximum.

i. Deviation from straight line along entire length of vertical edge: 2.5 mm maximum.

ii. Deviation from straight line along entire length of horizontal edge: 2.5 mm maximum.

iii. Offset (in plane) between adjacent granite corners: 3.0 mm maximum (distance between parallel horizontal or vertical lines through corners).

iv. Window opening dimension: 6.0 mm.

v. Where more than one tolerance applies, the stricter tolerance shall govern.

2.1.10.6.13 Mock-ups erection and tests

(a) Fabricate and erect within 60 days of the agreement by the Engineer of shop drawings, the following mock-up samples for the Engineer's approval prior to fabrication of the bulk :-

i. Furnish labour and materials to build and test mock-ups as shown on drawings. Mock-ups shall accurately represent job conditions including joints, sealants, glass, glazing, stone panels, anchors and finishes. Install sufficient fire-safing insulation to demonstrate details of installation. Install sufficient thermal insulation to demonstrate details of installation. Delay installation of fire –safing and thermal insulation until completion of air, water and structural tests.

ii. Each mock-up shall be glazed with one consistent set of gaskets. The use of multiple gasket profiles and/or thicknesses at the Contractor's discretion shall not be permitted.

iii. Prior to tests, remove and reglaze selected glass units, using the details and procedures intended for glass replacement on the actual building. Reglazed units shall satisfy test criteria.

iv. Provide at least one extra light of glass for each type and size on mock-ups. Glass which breaks during testing shall be replaced with new glass and the tests continued. Repeated glass breakage shall constitute failure.

v. Construct mock-ups in strict accordance with approved mock-up shop drawings. Deviations from or additions to details shown on Drawings shall be subject to approval.

vi. Construct mock-up with the exterior side facing outward.

vii. The testing laboratory shall be responsible for conducting and reporting the tests, and shall state in the report whether or not the test specimen is as specified, and shall specifically note deviations therefrom.

viii. If failures occur, revise and retest mock-ups until satisfactory test results are achieved. Modifications shall be realistic in terms of job conditions, shall maintain standards of quality and durability, and shall be subject to approval.

ix. Mock-up testing shall be done at an independent laboratory to be approved by the Engineer. If dynamic water infiltration test is specified,laboratory shall have capability to conduct dynamic testing as specified. Submit detailed information on laboratory facilities and test equipment for approval.

x. Mock-ups shall be subject to observation by the Engineer throughout their construction and testing. Provide minimum two week notice before beginning construction of mock-ups. Provide materials and personnel for prompt continuous construction of mock-ups. The Contractor shall coordinate chamber availability, shipping schedules and mock-up construction schedules directly with the laboratory.

(b) The testing laboratory shall not do any of the following :-

i. Act as consultant to the Contractor for the Works.

ii. Modify performance requirements.

iii. Modify mock-up configuration.

iv. Dismantle mock-ups until notified that no further testing is required.

(c) Undocumented tests shall not be permitted. All test results and all remedial work shall be documented in the laboratory report.

(d) Mock-up configuration is shown on Drawings. The mock-up design pressures and maximum test pressures shall be as specified.

2.1.10.7 Protection and Cleaning

2.1.10.7.1 Protection

(a) Provide protective sheeting or tape to aluminium or stainless steel members and ancillaries. Package and store materials in a manner that shall prevent surface damage or contamination, distortion breakage or structural weakening.

(b) Remove sheeting or tape as soon as practical so as not to stain and/or leave an adhesive residue on the relevant substrates.

(c) Protect glass against damage, discolouration or staining. Replace damaged or broken glass, regardless of the cause.

2.1.10.7.2 Labels

(a) No labels shall be adhered to glass other than those of the glass manufacturer which shall be adhered with a non-alkaline adhesive. Remove labels from glass after glazing

2.1.10.7.3 Cleaning

(a) Thoroughly wash and clean the work immediately prior to hand-over. No alkali washes or other patent cleaning solutions shall be used which may stain, mark or otherwise harm the installation.

(b) Periodically remove from the site debris, excess materials and unused tools and equipment resulting from this work. At the conclusion of construction, leave the premises in a clean condition

2.1.10.7.4 Ironmongery

(a) All hinges, locks, opening devices etc., shall be properly adjusted and in perfect working order. Hand over two sets of keys for each lock to the Engineer on completion.

2.1.10.7.5 Maintenance manual

(a) The Contractor shall provide a maintenance manual for the completed works which shall include, but not be limited to the following information :-

i. The name, address and telephone number of each firm and/or sub-contractor involved in the supply of components for the curtain wall.

ii. The manual shall include a clear, concise description of the construction methods

used to form the various areas of the curtain wall for the particular project.

iii. The manual shall include copies of material and component certification, as well as, test reports as required herein.

iv. The manual shall include a method statement covering the procedures for the replacement of damaged or otherwise defective components such as glass lights, stone panels, aluminum panels and/or components or anchors.

v. The manual shall include specific recommendations for routine maintenance, cleaning procedures, suitable cleaning agents as well as the frequency of inspections and adjustments that may be necessary.

vi. The manual shall include a full/complete set of Drawings, modified to incorporate any omissions and/or additions to the Works.

vii. The manual shall indicate the terms and periods of any guarantees and/or warranties.

2.1.10.7.6 Maintenance access

(a) The Contractor shall submit proposals whereby the curtain wall can be cleaned and maintained.

2.1.10.8 References and Standards

BS EN 10029 (2010): Hot-rolled steel plates 3 mm thick or above. Tolerances on dimensions and shape

BS EN 10048 (1997): Hot rolled narrow steel strip. Tolerances on dimensions and shape.

BS 952-1 (1995): Glass for glazing.Classification.

BS 952-2 (1980): Glass for glazing.Terminology for work in glass.

BS EN ISO 1461 (2009): Hot dipped galvanised coatings on fabricated iron and steel articles. Specifications and test methods.

BS 6262 (2005): Glazing for building.

BS 5713 (1979): Specification for hermetically sealed flat double glazing units

BS EN 10263-1(2001): Steel rod, bars and wire for cold heading and cold extrusion. General technical delivery conditions

BS EN 10263-5 (2001): Steel rod, bars and wire for cold heading and cold extrusion. Technical delivery conditions for stainless steels

BS 4320 (1968:1998): Specification for metal washers for general engineering purposes. Metric series.

BS 4464 (1969:1998): Specification for spring washers for general enegineering and automobile purposes.

BS 1473 (1972): Specification for wrought aluminium and aluminium alloys for general engineering purposes-rivet, bolt and screw stock.

BS 4873 (2009): Aluminium alloy windows and doorsets. Specification.

BS 6375 (2009): Performance of windows and doors.

BS 3987 (1991): Specification for anodic oxidation coatings on wrought aluminium for external architectural applications.

BS 4842 (1984): Specification for liquid organic coatings for application to aluminium alloy extrusions, sheet and preformed sections for external architectural purposes, and for the finish on aluminium alloy extrusions, sheet and preformed sections coated with liquid organic coatings

BS 6496 (1984): Specification for powder coatings for application and storing to aluminium alloy extrusions, sheet and preformed sections for external architectural purposes, and for the finish on Aluminium alloy extrusions, sheet and preformed sections coated with powder organic coatings

. BS EN 1999-1-1 (2007+A1:2009): Eurocode 9. Design of aluminium structures. General structural rules

BS 8200 (1985): Code of practice for design of non-loadbearing external vertical enclosures of buildings

BS 499-1 (2009): Welding terms and symbols. Glossary for welding, brazing and thermal cutting

BS EN 1011-4 (2000): Welding. Recommendations for welding of metallic materials. Arc welding of aluminium and aluminium alloys.

BS EN 1320 (1997): Destructive tests on welds in metallic materials. Fracture tests

BS EN 1321 (1997): Destructive test on welds in metallic materials. Macroscopic and microscopic examination of welds

BS EN ISO 3506 (2009): Mechanical properties of corrosion resistant stainless steel fasteners.

ASTM C1048-04 (2004): Standard Specification for Heat-Treated Flat Glass - ;Kind HS, Kind FT Coated and Uncoated Glass

ASTM C864-05 (2011): Standard Specification for Dense Elastomeric Compression Seal Gaskets, Setting Blocks, and Spacers

ASTM C509-06 (2011): Standard Specification for Elastomeric Cellular Preformed Gasket and Sealing Material

ANSI Z97.1 (2004): Safety Glazing Materials Used in Buildings - Safety Performance Specifications and Methods of Test

BS EN ISO 11600 (2003+A1:2011): Building construction. Jointing products. Classification and requirements for sealants

BS EN 1011-1 (2009): Welding. Recommendations for welding of metallic materials. General guidance for arc welding

BS EN 1011-2 (2001): Welding. Recommendations for welding of metallic materials. Arc welding of ferritic steels

BS EN ISO 4136 (2012): Destructive tests on welds in metallic materials. Transverse tensile test

BS EN ISO 5173 (2010+A1:2011): Destructive tests on welds in metallic materials. Bend tests

2.1.11 CARPENTRY AND JOINERY

2.1.11.1 Generally

2.1.11.1.1 Generally

(a) Timber generally shall be to **BS EN 942** and to be of mature growth, properly seasoned and sawn square.

(b) Timber shall be free from wood wasp holes, large loose or dead knots, splits or other defects that will reduce its strength.

(c) Pin holes and worm holes may be permitted to a slight extent in a small number of pieces, subject to the acceptance of the Engineer, provided that there is no active infestation of the materials, that the strength of the member is not impaired and that they do not appear on the finished faces of joinery work.

2.1.11.1.2 Timber for external use

(a) Species: Timber shall be either hardwood or softwood suitable for external use.

(b) Approved softwood may be cypress, pine, cedar or fir. Approved temperate hardwoods may be camphor, oak, teak or mahogany. Submit the species to be used to the Engineer's for approval

(c) Source of Supply: Obtain timber either softwood or hardwood from a sustainable forest or plantation.

(d) Seasoning: Moisture content to be in accordance with Clause 2.1.11.1.4

(e) Maintain the specified moisture content of the timber until preservative treatment described
below is applied.

(f) Preservative: Clear colourless copper chrome arsenic to **BS 4072** or other suitable approved preservative.

2.1.11.1.3 Storage

(a) Store timber in a dry, well ventilated place, and protect from the weather.

2.1.11.1.4 Moisture

(a) Calculate moisture content at the time of fabrication by the following formula :-

[Wet (or supplied) Mass – Dry Mass] / Dry Mass x 100 = Moisture Content (percentage)

(b) The dry mass shall be determined by drying in an oven at a temperature of 103^{o}C ± 2^{o}C until the weight is constant.

(c) The maximum permissible moisture content in timber to be incorporated into the work shall be as follows :-

i. Internal timber for use in Air Conditioned space 12%

ii. Internal timber generally 16%

iii. Timber with one face to the exterior of the building and one face to the interior (e.g. window frames) 18%

iv. External timber (e.g. fencing etc.) 20%

(d) If these percentages cannot be attained due to local circumstances of supply and availability, the Engineer' s attention must be drawn to the fact.

2.1.11.2 Materials

2.1.11.2.1 Softwood

(a) Submit samples of timber for joinery for approval where the grain shall be left exposed or where the surfaces shall be varnished or similarly treated.

(b) Softwood for carpentry to be Cypress, Pine, Cedar, Spruce or Fir or other species approved by the Engineer. All timber shall be appropriately stamped or marked to identify origin and grade. All timber shall be kiln dried and vacuum impregnated to international standards, with Copper Chrome Arsenate, or as directed otherwise by the Engineer.

2.1.11.2.2 Hardwood

(a) Hardwood shall only be used in special circumstances under the direction of the Engineer.

(b) Density of hardwood shall be 720 kg/m^3 (minimum) at 15% moisture content.

(c) Submit to the Engineer the following information:

(d) The species and country of origin.

(e) Teak, which is only permitted to be specified in special circumstances, shall have a density of 650 kg/m^3 (minimum) at 15% moisture content. They shall be accredited with a certificate from the Approved Authority.

2.1.11.2.3 Flooring

(a) Softwood or hardwood species used for timber flooring shall comply with Clause 2.1.11.2.1 and Clause 2.1.11.2.3.

(b) Boarded or strip flooring shall be selected and approved hardwood, as specified, or as submitted to the Engineer for selection. Finished thicknessshall be 20 mm (minimum).

(c) Wood block flooring shall be approved high density resin bonded fibreboard flooring or other approved hardwood as specified. Finished thickness shall be 20 mm (minimum). Blocks shall be 300 mm x 50 mm in size and colour matched.

(d) Wood parquet flooring blocks shall be 120 mm x 25mm in size and 8 mm thick, and shall be tongued & grooved.

2.1.11.2.4 Weather boarding

(a) Hardwood weather boarding shall be 150 mm wide and tapering from 25 mm to 10 mm thick and shall be :-

i. Sawn boarding or boarding wrot on one face and two edges with horizontal joints lapped 30 mm.

ii. Boarding as (a) but with wider edge rebated with joints lapped 20 mm.

2.1.11.2.5 Plywood

(a) Plywood shall be to **BS EN 636** and of the following grades, as specified :

i. "Grade 1 veneer" - hardwood faced, as specified, for natural finish.

ii. "Grade 2 veneer" - luan faced for painting.

(b) Generally the bonding adhesive between veneers shall be resin adhesive classified as moisture and weather resistant (M.R.) in **BS 1203**.

(c) Nominal standard thicknesses of plywood shall be 3, 4, 5, 6, 9, 12, 15, 18 and 25 mm.

(d) Plywood containing hardwoods of unknown species or from unidentified sources are expressly prohibited from use.

(e) Marine plywood shall be to **BS 1088-1:2003** and **BS 1088-2:2003** bonded with Type W.B.P. adhesive between plys.

2.1.11.2.6 Blockboard

(a) Blockboard shall be Grade 2 veneer for painting, and bonded with Type M.R. adhesive .

2.1.11.2.7 Hardboard

(a) Hardboard shall be to **BS EN 120** . "Standard" (Types SHA, SHB and SHC) or "tempered" (Type THE and THN) as specified.

2.1.11.2.8 Insulating board

(a) Insulating board (Softboard) shall be to **BS EN 120** .

2.1.11.2.9 Wood chipboard

(a) Wood chipboard shall be unsanded or sanded board to **BS EN 120**. Veneered chipboard shall be an approved proprietary.

(b) Melamine-faced chipboard shall be to **BS 7331:1990**. All wood chipboards shall be low formaldehyde emission chipboard (Class E1) unless permitted otherwise by the Engineer, or polyurethane - based chipboard with zero formaldehyde emission.

(c) Any boarding shall be used in wet areas such as kitchens or bathrooms shall be High Moisture Resistant board to **BS EN 120 :1992**.

2.1.11.2.10 Medium Density Fibreboard (MDF)

(a) Board type shall be moisture resistant grade (MDFMR) with density in excess of 600 kg/m^3 to **BS EN 120** .

2.1.11.2.11 Glass fibre

(a) Glass fibre insulating quilt shall be light-weight bonded mat weighing 12 kg/m3 uncompressed.

(b) Glass fibre insulating board shall be semi -rigid resin-bonded glass fibre weighing 45-48 kg/m^3.

2.1.11.2.12 P.V.C. or acrylic sheet

(a) PVC or acrylic sheet shall be clear, translucent or coloured, as specified, and to be approved by the Engineer.

2.1.11.2.13 Laminated plastic sheet

(a) Laminated plastic sheet shall be to **BS EN 438**. Class HG (Horizontal-General Purpose) or VG (Vertical-General Purpose) as specified.

2.1.11.2.14 Acoustic tiles

(a) Acoustic tiles shall be of an approved proprietary brand meeting the requirements of **BS EN 13964** manufactured from the following materials:-

(b) Wood or other organic fibre insulating board to **BS EN 120** , 12 mm (Minimum) thick for 300 mm x 300 mm tiles and 15 mm (minimum) thick for 400 mm x 400 mm tiles.

(c) Mineral fibre or wool insulating board 12 mm (minimum) thick for 300 mm x 300 mm tiles and 15 mm (minimum) thick for 400 mm x 400 mm tiles.

(d) Approved multi-purpose, dimensionally stable building board 6 mm (minimum) thick.

(e) Tiles shall have a plain, perforated or fissured surface with a factory applied decorative finish. The edges shall be square, bevelled, or bevelled and grooved to suit the suspension system.

2.1.11.2.15 Nails

(a) Nails shall be steel nails to **BS 1202:Part 1**, with "bright" finish, unless otherwise specified.

(b) Nail lengths shall be not more than the total thickness of sections to be joined less 5 mm, or not less than twice the thickness of section through which nails are driven.

(c) Where the thickness of the outer section through which nails are being driven is less than half that of the section to which nailing is being done, the depth of penetration of the nails into the latter shall be not less than 10 diameters of the nails being used.

2.1.11.2.16 Screws

(a) Wood screws shall be brass, stainless steel, alloy or other non-corroding metal to **BS 1210** with countersunk heads, unless otherwise specified. Steel screws shall only be used for temporary work. The proper dedicated screws shall be used for all Particle-board fixing.

(b) Screw lengths shall be not more than the total thickness of sections to be joined, less 5 mm, or not less than one and a half times the thickness of section through which screws are driven.

(c) Where the thickness of the outer section being screwed is less than half that of the section to which screwing is being done, the depth of penetration of the screwing into the latter shall be not less than the thickness of the outer section.

(d) Screw cups shall be brass cups or stainless steel.

2.1.11.2.17 Masonry nails

(a) Do not use masonry nails or drive pins without approval.

2.1.11.2.18 Explosive cartridge fixings

(a) Obtain approval before using explosive cartridge operated fixings. All fixings shall be in accordance with the BS 4078-1 & BS 4078-2. Use tools, normally of the indirect acting type, plus pins and cartridges which correspond with the manufacturer's specifications for that tool. A tool shall only be used by a person holding a certificate of competency specifying the maker and model of the tool on which he has been successfully trained.

2.1.11.2.19 Plugs

(a) Plugs for fixing to hard materials shall be proprietary plugs of plastic, soft metal, fibre or similar.

(b) Fixing to friable materials, plasterboard and the like shall be proprietary fixings specially designed for that situation.

(c) The use of wood plugs shall not be permitted.

2.1.11.2.20 Adhesive

(a) Adhesive for wood shall be as follows:-

i. For internal use; synthetic resin adhesive classified as moisture resistant and moderately weather-resistant (M.R.) in **BS 1204: Part 1**.

ii. For external use or internal use under very damp conditions:synthetic resin adhesive classified as weather-proof and boil-proof (W.B.P.) in **BS 1204:Part 1**.

(b) Adhesive for fixing laminated plastic sheet shall be synthetic resin adhesive classified as weather-proof and boil-proof (W.B.P.) in **BS 1204: Parts. 1 and 2.**

(c) Where the temperature exceeds 25°C, a "warm-setting" grade of adhesive shall be used.

(d) The use of animal glues shall not be permitted.

2.1.11.2.21 Resin for MDF panels

(a) All urea formaldehyde bonded MDF panels and MUF mouldings shall be manufactured with low emission resins conforming to European E1 emission standard of 9mg/100g (minimum).

2.1.11.2.22 Wood preservative

(a) Wood preservative shall be an approved proprietary brand exterior grade where completely concealed or not decorated, and colourless, coloured or suitable for overpainting where likely to be exposed or in contact with a painted finish.

2.1.11.2.23 Wood preservative to external timber

(a) Preparation: Timber shall be free from dirt and surface moisture.

(b) Application of Preservative: Apply by pressure impregnation in accordance with **BS 1281:1975**.

(c) Apply preservative in a manner that is not hazardous to health. Adhere strictly to the manufacturer's instructions.

(d) Cutting and Machining : Whenever possible, all cutting, planning, boring, drilling, notching or
Any other machining or manual operation shall be completed prior to preservative treatment.

(e) Incising : For certain timbers such as Douglas Fir which are difficult to impregnate, make 20 mm deep incisions coverage of 650 per m^2 in the direction of the grain all in accordance with BS 913. This method shall only be used on timber sections exceeding 80 mm thickness.

(f) Creosote Application : For timber where impregnation is not suitable and a paint finish is not required, when approved apply 2 coats of creosote in accordance with the manufacturer's instructions.

(g) Guarantee : : Obtain a guarantee of 30 years for timber components against rot, insect attack and fungal decay.

(h) Mosquito gauze shall be one of the following :-

i. Plastic covered glass fibre 7 x 7 mesh per 10 mm square.

ii. Copper wire 11 x 11 mesh per 10 mm square.

2.1.11.3 Workmanship

2.1.11.3.1 Generally

(a) Workmanship generally shall be to **BS EN 942.**

2.1.11.3.2 Dimensions

(a) Cut timber to required sizes and lengths as soon as practicable after the Works are begun, and store dry under cover so that the air can circulate freely around it.

(b) Dimensions of sections shown on the drawings are finished sizes. Allow for planing and sanding faces to finished sizes.

(c) Check site dimensions before prefabricating joinery fittings.

2.1.11.3.3 Framed joints

(a) Plane timber for joinery on all faces. Finish exposed faces to a fine glasspapered surfaces and round arrises to 1 mm radius.

(b) Faces of framed joints shall be square and shall be driven together to give a close, accurate fit.

(c) Prepare and frame up joinery work with dry joints and store until required for fixing. Before fixing open up all joints, put together with approved glue and wedge up. Replace any sections that have warped or developed shakes or other defects.

(d) Running bonded joints shall be cross-tongued, using approved tongues. For work over 40 mm thick, use double tongues.

(e) Protect from damage or discolouration joinery shall be left with clear finish. Submit proposals for protection for approval

2.1.11.3.4 Prototypes

(a) Prepare prototypes and obtain approval for repetitive fittings before starting fabrication.

(b) Plug and screw or secure timber sections to the backing by approved means.

(c) Check location of buried services before fixing to walls and other surfaces.

2.1.11.3.5 Nailing

(a) Nail timber sections securely to the backing and ensure that the nails do not split the timber. Split timbers shall be removed and replaced.

(b) Punch nail heads below timber surfaces visible in completed work.

(c) Nail weather boarding to wood framing with not less than two corrosion proofed nails in the width of each board at each framing member.

2.1.11.3.6 Wood preservative

(a) Apply wood preservative to all unexposed surfaces of timber including framing fillets etc. and backs of frames, skirtings etc.

(b) Do not fix laminated plastic sheet to timber with moisture content of more than 16%.

(c) Fix acoustic tiles and the like to timber battens or direct to sub-base by means of an approved adhesive used in accordance with the manufacturer's recommendations.

2.1.11.3.7 Boarded or strip flooring

(a) Heading joints shall be cross-tongued, and staggered not less than two board widths apart.

(b) Cramp flooring, to ensure a tight and accurate fit along the whole length of the joint.

(c) Fix flooring with galvanised, sheradised or cadmium-plated wire nails.

(d) Face nail square edged flooring not more than 100 mm wide, use two nails. Stop nail heads and finish flush.

(e) Secret-nail tongued and grooved flooring at each support with one nail placed just above the tongue and driven on skew. Punch nail heads flush.

2.1.11.3.8 Fixing battens

(a) On concrete, cast in or lay at 350 mm centres 50 mm x 40 mm twice splayed fixing battens pre-treated with wood preservative. Where laid on concrete bed, level in cement mortar (1:3), continuous support being provided for all batten lengths.

(b) Fill space between battens with lightweight concrete. Allow to dry out thoroughly.

(c) Apply one coat of approved bitumen/rubber latex emulsion at the rate of 1litre/m^2. Check and refix battens after drying-out as may be required.

2.1.11.3.9 Doors & frames general

(a) Door frames shall not be used as formers for door opening construction unless with the permission of the Engineer, and never when proprietary door sets are required in the Contract. In all such circumstances, templates or formers must be used.

2.1.11.3.10 Door with board finish

(a) Construct hardwood ledged doors with 20 mm (minimum) vertical tongued and grooved boarding in about 150 mm widths. V-jointed on face side with ledges 5 mm thicker than boarding thickness and 100 mm wide for top ledge and 175 mm wide for middle and bottom ledges. Nail boarding to ledges and screw ends of ledges to boarding.

2.1.11.3.11 Ledged and braced

(a) Construct hardwood ledged and braced doors as Clause 2.1.11.3.10 but with 100 mm wide diagonal braces of similar thickness to ledges. House braces to ledges and screw ends to boarding.

2.1.11.3.12 Framed, ledged and braced doors

(a) Construct framed, ledged and braced doors of 45 mm (minimum) thickness with 115 mm wide stile and top rail, 225 mm wide middle and bottom rail, and 100 mm wide braces. Fill in with vertical boarding as Clause 2.1.11.3.10.

2.1.11.3.13 Panelled doors

(a) Construct hardwood panelled doors 40 mm (minimum) thick, with 100 mm wide stiles, top rail and muntins and 200 mm wide middle and bottom rails. Flat panels shall be 20 mm thick. Groove rebate or leave open framing, as specified, for panels or glass.

2.1.11.3.14 Flush doors

(a) Stiles and rails generally shall be 75 mm wide. For doors exceeding 900 mm side or 2000 mm high stiles to be 100 mm wide.

(b) Infill for hollow core doors shall be 20 mm horizontal battens at 150 mm centres. Block out for lock fixing, door closers, or other ironmongery as specified, or composition board core approved by the Engineer.

(c) Infill for solid core doors shall be 25 mm vertical battens tightly cramped together with the covering fully bonded both sides.

(d) Cover both sides of the door with the following as specified :-

i. 3 mm standard hardboard

ii. 5 mm Plywood for painting

iii. 5 mm selected Hardwood faced plywood for clear finish

iv. Class HG laminated plastic bonded to 5 mm plywood

v. Other board finish accepted by the Engineer.

(e) Provide 12 mm selected hardwood lipping pinned and glued to all edges.

(f) Lipping to meeting edges of folding doors and meeting edges and heels of swinging doors shall be 25 mm thick, rebated or rounded.

(g) When specified, fit the bottom edge of doors with a 12 mm selected hardwood removable carpet strip screwed to the lipping.

2.1.11.3.15 Cupboard doors

(a) Construct cupboard doors as follows, as specified :-

i. MDF oxford cherry rounded at edges, or

ii. Hollow core doors as Clause 2.1.11.3.14 (b).

iii. Melamine Faced and lipped chipboard as Clause 2.1.11.2.9 (a).

2.1.11.3.16 Openings in flush doors

(a) Frame openings with 12 mm (minimum) selected hardwood lipping. Rebate lipping for glazing, if required.

(b) Provide glazing beads to match surrounding timber. Mitre at angles. Fix with screws and cups, where specified. Glazing beads shall not be less than 12 mm thick.

2.1.11.3.17 Half-hour fire resisting doors

(a) Half-hour fire doors to be 50 mm solid core flush door as described above, and shall be certified as having been tested in accordance with **BS 476**.

(b) Hinges with nylon bearings shall not be permitted in fire-resisting door assemblies.

2.1.11.3.18 One-hour fire resisting doors

(a) One hour fire doors shall be approved proprietary fire doors tested in accordance with **BS 476: Part 20-23.**

(b) Folding or swing fire doors shall incorporate proprietary smoke seals and intumescent strips where necessary to attain the requirements of **BS 476: Part20-23**.

2.1.11.3.19 Acoustic doors

(a) Acoustic doors shall be solid core doors with air-tight seals to all junctions with frames and threshold. Seal types shall be submitted to the Engineer for approval unless specified in the Contract.

2.1.11.3.20 Doors and window frames

(a) Construct doors and window frames with properly framed joints and fix using cramps or bolts and secure the bottom of door frames with dowels.

2.1.11.3.21 Bedding and pointing

(a) Bed frames in cement mortar, leaving no gaps. For external doors, rake out external face 10 mm deep, and point with an approved sealant.

2.1.11.3.22 Architraves

(a) Architraves shall be one length between angles. Mitre architraves at angle joints.

2.1.11.3.23 Drawers

(a) Construct drawers with 20 mm thick front, as specified, 15 mm thick back and sides, as specified, dovetailed and framed together and 5 mm thick bottom housed on three sides. Set drawers to slide on proprietary runners. Submit ironmongery for approval.

2.1.11.4 References and Standards

BS EN 942 (2007): Timber in joinery. General requirements

BS 4072 (1999): Copper/chromium/arsenic preparations for wood preservation.

BS 4078-1 (1987): Powder actuated fixing systems. Code of practice for safe use

BS 4078-2 (1989): Powder actuated fixing systems. Specification for tools

BS EN 636 (2012): Plywood. Specifications.

BS 1203 (2001): Hot-setting phenolic and aminoplastic wood adhesives. Classification and test method.

BS 1088-1 (2003): Marine plywood. Requirements.

BS EN 120 (1992): Wood based panels. Determination of formaldehyde content. Extraction method called the perforator method.

BS 7331 (1990): Specification for direct surfaced wood chipboard based on thermosetting resins.

BS EN 13964 (2004+A1:2006): Suspended ceilings. Requirements and test methods

BS 1202-1 (2002): Specification for nails. Steel nails

BS 1210 (1963): Specification for wood screws

BS 1204 (1993): Specification for type MR phenolic and aminoplastic synthetic resin adhesives for wood.

BS EN 14411 (2012): Ceramic tiles. Definitions, classification, characteristics, evaluation of conformity and marking

BS 476: Fire tests on building materials and structures.

BS 1088-2 (2003): Marine plywood. Determination of bonding quality using the knife test

BS EN 438-9 (2010): High-pressure decorative laminates (HPL). Sheets based on thermosetting resins (usually called laminates). Classification and specifications for alternative core laminates

2.1.12 IRONMONGERY

2.1.12.1 Materials

2.1.12.1.1 Dowels for fixing door frames

(a) Dowels shall be 16 mm diameter galvanised steel rod 75 mm long.

2.1.12.1.2 Fixing cramps

(a) Fixing cramps for door frames, and the like fixed in brick or block walls shall be 30 mm x 3 mm galvanised steel flat 250 mm girth, turned up at one end and twice drilled to suit No. 12 gauge screws and flanged at the other end.

2.1.12.1.3 Fixing bolts

(a) Unless otherwise specified, fixing bolts for door frames, and the like fixed to concrete shall be not less than 10 mm diameter proprietary expanding anchor bolts 120 mm long overall, with nut and washer.

2.1.12.1.4 Water bar

(a) Water bar shall be galvanised steel, stainless steel, aluminium plate or brass flat bars as specified.

2.1.12.1.5 Curtain track

(a) Curtain track shall be an approved proprietary brand complete with matching fittings of the same make, as follows :-

i. Rigid UPVC 'T' box section track with nylon slides.

ii. Regular of double duty enamelled steel 'C' section track with nylon runner.

iii. Regular of double duty enamelled steel 'C' section track complete with cord operation.

2.1.12.1.6 Curtain rail

(a) Curtain rail shall be stainless steel heavy duty hollow tube as Clause 2.1.16.1.9 with matching purpose-made end flanges, all to the dimensions specified.

2.1.12.1.7 Towel rail

(a) Towel rail shall be stainless steel heavy duty hollow tube as Clause 2.1.16.1.9 with matching purpose-made end flanges.

2.1.12.1.8 Timber connectors

(a) Steel connectors for timbershall be galvanised, round, tooth-plate type to **BS EN 912:2011**Table 3.

2.1.12.2 Workmanship

2.1.12.2.1 Metal dowels

(a) Fix dowels 40 mm into bottom of door frame jambs, etc., with a tight push fit, and bed the other end in floor in cement mortar.

2.1.12.2.2 Fixing cramps

(a) Fix cramps to frames at 900 mm (maximum) centres with the upper and lower cramps 300 mm (maximum) from the end of the jamb , using two 12 SG screws and build-in the other end.

2.1.12.2.3 Fixing bolts

(a) Secure frames to concrete walls with bolts at 900 mm (maximum) centres with the upper and lower bolts 300 mm (maximum) centres from the ends of the jamb as fixed in accordance with the manufacturer's recommendations.

2.1.12.2.4 Water bar

(a) Bed water-bar in water proofing cement mortar leaving no gaps.

2.1.12.2.5 Curtain track

(a) Fix curtain track in accordance with the manufacturer's recommendations including runners at the rate of 13 Nos. per metre and all other accessories including bracket, stopped ends and overlap set. When specified, install cord sets and leave in proper working order.

2.1.12.2.6 Curtain rail

(a) Plug and screw end flanges of curtain rail to brick or concrete wall with stain less steel screws.

2.1.12.2.7 Towel rail

(a) Plug and screw end flanges or brackets of towel rail to brick or concrete wall with stainless steel screws.

2.1.12.3 Architectural ironmongery

2.1.12.3.1 Source

(a) Standard items of ironmongery may be supplied by the Employer except when it is specified that ironmongery shall be supplied by the Contractor.

2.1.12.3.2 Contractor's supply

(a) Supply ironmongery in accordance with the Contract documents. All ironmongery is shall be approved before orders are placed and shall be obtained from an approved manufacturer for that item and for the use intended.

2.1.12.3.3 Certification and samples

(a) Supply fully detailed catalogues, certificates of compliance or other documentary evidence to the satisfaction of the Engineer that the ironmongery complies with the specifications.

(b) Submit samples of all items of ironmongery for approval before placing order.

2.1.12.3.4 Ironmongery schedule

(a) Supply a door-by-door ironmongery schedule, including all other separate ironmongery items when samples have been approved. All components shall be identified by manufacturers' name and reference number and country of origin and cover the requirements of smoke stop and fire-rated doors, detail door thicknesses, handing, suiting and master keying. Upon approval, this schedule shall form the basis for confirming the requirements for ironmongery. No alteration to this schedule shall be permitted without prior approval.

2.1.12.3.5 Compatibility

(a) Ironmongery shall be properly matched, suited and obtained from one source.

2.1.12.3.6 Manufacturer's Instructions

(a) Provide one complete set of manufacturer's fixing and maintenance instructions prior to delivery.

2.1.12.3.7 Packing

(a) Supply ironmongery suitably boxed and delivered in sets where appropriate and marked in a manner to suit site installation requirements. When ironmongery is delivered in sets, each set shall be bagged and labelled with the door number to which it shall be fixed. Supply all items with appropriate fixing screws of a length and pattern to suit the construction to which the items shall be fixed. Screws shall be cross headed and packaged with their components.

2.1.12.3.8 Keys

(a) Provide a minimum of two keys for each lock, each fitted with a stainless steel split ring and a 25 mm diameter x 1.5 mm thick plastic disc engraved with the number of the lock or room number in figures a minimum of 5 mm high.

(b) Arrange with the Engineer for the safe storage and handling of keys and ensure their receipt by the Engineer on completion of the Contract. When master keying is specified the master keys shall be forwarded direct to the Engineer.

2.1.12.3.9 Materials and finishes

(a) Materials and finishes as specified shall comply with the following standards :-

i. Stainless Steel shall be to **BS EN 10029**.

ii. Electroplated coatings of nickel and chromium shall be to **BS EN ISO 1456:2009**

iii. Anodic oxidation coating on aluminium shall be to **BS EN ISO 7599:2010** Grade AA 10.

iv. Electroplated coatings of cadmium and zinc on iron or steel shall be to **BS EN ISO 2081:2008 and BS EN ISO 2082:2008.**

v. Phosphate treatment of iron and steel shall be to **BS EN 12476**.

vi. All concealed components including lock bodies shall be protected by the manufacturer's standard finish which shall, where applicable, comply with the above standards.

vii. Screws shall be stainless steel, brass or aluminium to **BS 1210** with countersunk heads unless otherwise specified to match the ironmongery being fixed.

2.1.12.3.10 Hinges

(a) Hinges shall be as follows :-

1. Class A1 - Extra heavy duty hinges shall be as follows :-

i. 4.50 mm nickel plated, brass butts with a stainless steel pin made non-removable by a set screw and complete with four permanently attached ball bearings.

ii. 3.30 mm satin finish stainless steel, 18/9 quality, with four sets of anti-friction bearings and non-removable stainless steel pin.

2. Class A - Heavy duty hinges shall be as follows :-

i. 3.90 mm brass butts to **BS EN 1935** with four sets of stainless steel washers and non-removable stainless steel pin finished as specified.

ii. 2.50 mm satin finish stainless steel, 18/9 quality, at least two sets of anti-friction bearings and non-removable stainless steel pin.

3. Class B - Standard duty hinges shall be as follows :-

i. 3.9 mm brass butts as Class A.

ii. 3.9 mm brass lift off, or removable pin hinge finished as specified.

iii. 2.0 mm satin finish stainless steel, 18/9 quality with four nylon bushed bearings.

iv. Special hinges i.e. falling or rising butts, parliament or other hinges shall be from the supplier's range manufactured in solid brass or stainless steel or anodized aluminium with hardened bearing surfaces finished as specified.

4. Class C - Light duty hinges shall be as follows :-

i. 2.35 mm brass butts shall be to **BS EN 1935** with four sets of stainless steel washers, stainless steel pin and finished as specified.

ii. 1.6 mm satin finish stainless steel, 18/9 quality.

iii. Special hinges i.e. backflap hinges, continuous or other hinges shall be from the supplier's product range manufactured in solid brass or stainless steel finished as specified.

2.1.12.3.11 Floor springs

(a) The thickness of hinges shall be measured adjacent to the knuckle.

(b) Hinges shall be countersunk drilled and fixed with matching screws as follows :-

i. Hinges Class A1, A & B - Each hinge shall be drilled to take eight 12 SG screws with the screw holes staggered for fixing to timber of template drilled for fixing to metal frames and doors. Where required, hinges may be drilled half for metal screws and half for wood screws. Hinges shall be supplied complete with 12 SG matching screws 32 mm long for wood fixing and 12.5 mm long for fixing into metal. A smaller gauge screw will be acceptable for 2 mm thick hinges.

ii. Hinges Class C - Each hinge shall be drilled to take six 6 SG screws with the screw holes staggered or template drilled as required. Hinges shall be supplied complete with 6 SG matching screws of a length to suit the fixing application. No hinges using nylon or plastic washers or bearings may be used in fire doors or access panels with fire rated requirements.

(c) Single and double action floor springs shall be hydraulic check spring mechanisms sealed into an oil or hydraulic fluid box complete with a loose protected steel box for fixing within a concrete floor, a detachable cover plate with waterproof seal. Adjustment within the box shall provide full horizontal movement for door alignment, final positioning and height adjustment.

(d) The position of the floor spring within the loose box shall be adjustable after installation. The non-adjustable bottom strap shall be designed to suit the type, size and weight of the door but shall not be less than 160 mm long with holes for four screws. The top centre for double action floor springs shall be adjustable. If specified, a hydraulic back check shall be incorporated effective for the opening angle of the floor spring.

(e) On single action floor springs, the bottom strap and top centre shall be offset.

(f) Where floor springs shall be fitted to a fire door, the floor spring shall have been tested in conjunction with an appropriate fire door and passed the integral fire door test in accordance with **BS 476:Part 22**.

(g) In the event that the spring is to be fitted to metal doors, the specification shall be the same exc ept that a non-ferrous strap shall be provided to suit the profile of the bottom rail of the door and the top centre shall suit the top rail of the door.

- Class A - Floor springs shall be certified as tested to 500,000 cycles.
- Class B - Floor springs shall be certified as tested to 300,000 cycles.

Sizes of floor springs shall relate to the minimum closing moment expressed in Table 2.1.12.1.

Table 2.1.12.1: Minimum closing moments for floor springs and door closers

Nominal closer size	Minimum Closing Moment (Nm)	
	15.75 mm	90 degree
2	10	2.5
3	17	5
4	27	9
5	37	13
6	48	17

(h) Exposed parts shall be finished to the same standard as the rest of the ironmongery unless stated otherwise in contract requirements. The top plate shall be satin finish stainless steel, 18/10/3 quality unless stated otherwise in contract requirements.

2.1.12.3.12 Overhead door closers

(a) Overhead door closers shall be capable of being fitted on either hand of the door and shall close the door positively. Regulation of the closing speed and latch angle shall be undertaken by one or more control valves. The closing speed of the closer through the latch angle (50-300 mm from the fully closed position) shall be capable of being adjusted independently to the closing speed.

(b) Ensure that Pull-to fittings are installed where space limitations could hinder standard operation.

(c) Where the door closer shall be fitted to a fire door, minimum rating half hour, the closer shall have been part of a door and door frame and ironmongery which successfully passed the test in accordance with **BS 476: Part 22**.

(d) All closers shall be of the horizontal pattern from the manufacturer's standard range and shall be fitted with a regular arm for face fixing with all parts and fixings of closer arms in stainless steel, unless specified otherwise.

i. Class A - Shall be certified as tested to 500,000 cycles, minimum angle of opening 175 degrees, capable of controlling the door from a minimum opening angle of 115 degrees down to the closed position.

ii. Class B - Shall be certified as tested to 500,000 cycles, minimum angle of opening 90 degrees, capable of controlling the door from a minimum opening angle of 70 degrees down to the closed position.

iii. Class C - Shall be certified as tested to 300,000 cycles, minimum angle of opening 90 degree and control the door from a minimum opening angle of 45 degrees down to the closed position. Regulation of the closing speed and latch angle shall be undertaken by one or mo re control valves. The closing speed of the closer through the latch angle (50 mm - 300 mm from the fully closed position) shall be capable of being adjusted independently to the closing speed.

(e) Certification shall be made that testing has been undertaken in accordance with **BS EN 1154**. If testing has been undertaken in accordance with different standards, then these shall be submitted in English for assessment along with material samples.

(f) Sizes of door closers shall relate to the minimum closing moment expressed in Table 2.1.12.1:.

(g) Closers shall be finished as follows:-

a. Finish 1: The body and arm shall be finished to the same standard as the rest of the door ironmongery. Where closers are supplied with a separate cover, the cover shall be of steel
protected against rust, plated and finished to the same standard as the rest of the door ironmongery. Where covers are supplied, the body may be to the manufacturer's standard finish.

b. Finish 2: As Finish 1 except that the arm may be to the manufacturer's standard finish. Subject to the agreement and acceptance of the Engineer.

2.1.12.3.13 Security locks

(a) Security locks shall have a minimum of five levers or, if pin or disc, mechanisms shall have a minimum of six pin or disc tumblers or more than one row of pins and rollers, such rows shall not be in the same plane.

(b) Forends shall be of double thickness and each lock shall be capable of being fitted to fully rebated doors with 12.5 mm or 25 mm deep rebate by the addition of a rebating set.

(c) Keys shall be registered in the name of the Employer and duplicates only obtainable through the manufacturer. Prior to ordering, agree with the Engineer the method of ordering, supplying and fixing to ensure the maintenance of security. Master keying shall not be permitted.

(d) Class A - Security locks shall be to **BS 3621**.

(e) Class B - Locks manufactured in accordance with the requirements of **BS 3621** but have, in addition to the security bolt, other features which come within the scope of **BS EN 12209** shall comply with the relevant performance requirements of Category B of BS EN 12209. Note: - the addition of a Turn on the inside invalidates certification to BS 3621 but will be acceptable on the grounds of ease of escape in case of fire.

(f) Exposed parts shall be satin finish stainless steel 18/10/3 quality. Rebating set shall be nickel plated brass to match.

2.1.12.3.14 Locks and latches

(a) Locks and latches shall be to **BS EN 12209**.

(b) Lever locks shall have a minimum of 3 levers and 2,000 differs. Cylinder locks shall have at least standard section 5 pin cylinders.

(c) Locks shall be capable of being fitted to fully rebated doors with 12.5 mm or 25 mm deep rebates by the addition of a rebating set.

(d) Locks shall be stamped with the lock number as agreed with the Engineer.

(e) Locks and latches requiring lever or knob furniture to complete the function shall be compatible with **BS EN 1906**, Category 1. If the springing system within the lock is incapable of sustaining the requirements of **BS EN 1906** then the handles shall be spring loaded. If, in order to attain the requirements of **BS EN 1906**, the handles require bolting through the lock, then the lock shall be holed at 38 mm horizontal or vertical centres to accommodate these bolts.

(f) Where specified, locks shall be master keyed.

(g) Class A - Locks and latches shall conform to **BS EN 12209**, Category B, meeting the performance specifications up to 500,000 operations for locks and 1,000,000 operations in conjunction with lever handles.

(h) Class B - Locks and latches shall conform to **BS EN 12209**, Category A, and shall meet the performance specification of 300,000 operations for locks, latches, bored locks or latch sets and 150,000 operations for cylinder rim night latches. They shall meet the dimensional standards set out in **BS EN 12209**.

(i) Locks and latches shall be finished as follows:-

i. Forend and strike plate shall be satin stainless steel 18/10/3 quality. Rebating set shall be satin finished stainless steel or nickel plated brass.

ii. Plated and finished to the same standard as the rest of the ironmongery.

2.1.12.3.15 Lock and latch fittings

(a) Lock and Latch fittings shall be knobs or lever handles with rose or backplate to standards to **BS EN 1906**.

(b) The knobs or lever handles shall be spring loaded to return the fitting to its original position after use, without the assistance by the lock or latch spring unless the lock is specially designed or adapted to meet the above standards.

(c) Centres for keyholes and spindle shall be 57 mm. The spindle shall be 7.6 mm or 8 mm square and shall project a minimum of 12 mm into each lever or knob.

(d) Unless the spindle system is satisfactory by itself for transmitting loads described within **BS EN 1906**, the fitting shall be bolted through the door and lock at 38 mm centres.

(e) Knob or lever handles shall be fixed to fire rated doors, minimum half hour fire rating, shall be fitted with aluminium or similar low-melting alloy inserts for fixing, or spindle housings to prevent the spread of fire by the melting of the insert to prevent the lever or knob operating and the door being opened accidentally.

(f) The style of the lock or latch furniture shall be as specified from an approved standard range.

(g) Class A - Lock and latch furniture shall be to **BS EN 1906**, suitable for heavy duty use and shall have been successfully tested to a min imum of one million operations.

(h) Class B - Lock and Latch furniture shall be to **BS EN 1906**, Category 2, suitable for general residential use and shall have been successfully tested to a minimum of 300,000 operations.

(i) Knob or lever handles shall be finished as follows:-

i. Stainless steel 18/10/3 quality.

ii. Satin anodised aluminium.

(j) Other finishes specified in the Contract and/or to the requirements of the Engineer.

2.1.12.3.16 Knobsets

(a) Knobsets shall be to **BS EN 12209**.

(b) Knobsets shall have a minimum backset of 70 mm but, if specified, this shall be increased to 127 mm by use of an adaptor. Knobsets shall be designed to suit the door thickness and blocking out shall not be permitted. Knobsets with latches shall have an anti-thrust action (automatic deadlocking) in the latch. The style of the knobs shall be as specified from an approved standard range.

(c) Class A - Knobsets shall conform to **BS EN 12209**, Category B meeting the performance specification of up to 500,000 operations.

(d) Class B - Knobsets shall conform to **BS EN 12209**, Category A meeting the performance specification of up to 300,000 operations.

(e) Finishes on exposed parts shall be as follows:-

i. Satin finish Stainless steel 18/10/3 quality.

ii. Satin anodised aluminium.

2.1.12.3.17 Panic bolts and latches

(a) Panic fittings shall be provided ensuite to match the door hardware.

(b) Panic fittings shall include appropriate locksets and handles for key access from the other side of the door unless specified otherwise.

(c) All panic fittings shall comply with **BS EN 1125** with the activating bar horizontally across the inside face of the door operating when pushed anywhere along its effective length in the direction of the exit and/or moved in a downwards arc. Where panic fittings have vertical shoots, they shall have an automatic catch holding the bolts in a withdrawn position when the doors are opened and automatically releasing the bolts on the closing of the door. Panic fittings where capable of being opened from the other side of the door, anywhere locked, the locking operation shall not interfere with exit from the inside. Panic fittings shall be complete with anti-thrust devices to prevent operation by other means than those described above.

i. Class A - For use on fire rated doors, shall be certified by the manufacturer as suitable for use on fire doors.

ii. Class B - For use on other doors.

(d) Panic fittings shall be finished as follows :-

i. Satin finished stainless steel, 18/10/3 quality.

ii. Satin anodised or silver enamelled aluminium bolt box, bar pivot boxes, guides and locking attachment. Steel push bars and bolt shoots sprayed and stoved silver finish.

(e) Ancillary fittings and trim hardware shall be provided ensuite to match the door hardware in a co-ordinated range.

1. Pull handles and push plates shall be secured as follows :-

   i. Face fixed with a minimum of four screws per handle.

   ii. Bolted through by 6 mm diameter (minimum) bolts and stabilised by a face fixing or semi-recessed washer on one side of the door.

   iii. Fixed in pairs by bolting through the door.

2. Flush or surface bolts - shall be supplied with either a holed shoot, plate or keeper at the head and dust-excluding socket at the floor. In wet areas, easy clean floor sockets shall be used. Surface bolts shall be straight barrel bolts. Flush bolts shall be lever action. Bolts shall have a 9.5 mm (minimum) diameter shoot.

3. Indicating bolts - shall allow for emergency operation by coin.The indicator shall be red/green.

4. Push plates, kick plates - shall be manufactured to allow not more than 4 mm gaps to the edge of the door or door frame. Satin stainless steel plates shall not be less than 1.6 mm thick. Satin anodised aluminium plates shall not be less than 3 mm thick. Plates shall be drilled and countersunk at not less than 225 mm centres for 8 gauge screws for kick plates and 6 gauge screws for push plates. Plates shall have corners radiused and all sharp arrises removed. Kick plates shall be 400mm high.

5. Door stops - Floor mounted door stops shall have more than one fixing or plug within the floor to prevent rotation or bending of single fixing point. Wall mounted door stops shall be concealed fixing and project sufficiently to prevent damage to doors and applied ironmongery.

6. Door Holders - shall be floor mounted and allow for replacement of the spring mechanism and be capable of opening for cleaning.

7. Cabin Hooks - shall have the staples properly welded or brazed to backplates.

8. Limit Stays, Friction Stays - shall be capable of limiting the opening of the door and retaining it in the open position.

9. Door selectors - the size of selector shall suit the depth of rebate and width of door leaves. On external doors opening outward, screwed under the frame pattern shall be used.

10. Door chains - shall be in stout metal complete with No. 10 x 30 mm wood screws to match, two number screws to chain plate, four number screws to anchor plate. The chain assembly shall be secured by a bridged plate passing through the end link of the chain. The device in the fixed position shall be capable of withstanding a gradually applied tensile load of 2KN so that when tested, the staple and chain are subject to direct tension and the anchor plate to shear where the staple and plate are securely screwed to Grade 'A' timber in pre-bored partly drilled holes.

11. Door viewers - shall have viewing angle not less than 180 degrees.

12. Hat and coat hooks - shall be fixed with a minimum of two screws.

13. Indicating sign plates - shall be as for push plates, but satin anodised aluminium plates shall not be less than 1.6 mm thick. Self-luminous exit signs to comply with **BS 5499: Part 2**.

14. Fire safety signs, notices and graphic symbols - shall be as for push plates, manufactured to the standards laid down in **BS 5499: Part 1**.

2.1.12.3.18 Fittings to drawers and cupboards

(a) Fittings to drawers, cupboards and other joinery fittings shall be of a quality to match the door hardware in a co-ordinated range.

i. Hinges shall be stainless steel or chromium plated brass as Clause 2.1.12.3.10 Class C.

ii. Standard drawer locks shall be cast zinc with a brass, or chromium plated brass cap approximately 22 mm diameter with a four tumbler cylinder and a 4 mm thick brass bolt. Locks for cash drawers shall be fitted with a brass spring loaded bolt.

iii. Flush or surface bolts shall have a minimum of a 6 mm diameter shoot.

iv. Bales catches shall have a 9.5 mm diameter ball mounted in a face plate complete with matching striking plate.

v. Magnetic door catches shall have a plastic casing with overall length not less than 45 mm.

vi. Flush pulls shall be 100 x 50 x 18 mm deep fixed with four countersunk screws.

vii. Drawer pulls shall be 7.5 mm diameter rod twice bent to form handle 100 x 25 mm overall each leg fitted with 3 mm threaded rod one end drilled and tapped at least 15 mm into the leg and the other end fitted with two flat washers and a nut.

(b) Fittings shall be finished as follows :-

i. Stainless steel

ii. Satin anodised aluminium

iii. Chromium plated brass

(c) Ironmongery shall be fitted and fixed in accordance with the manufacturer's recommendations.

(d) All morticing of doors and frames shall be carefully done to ensure that mortices are not oversize and that items are securely fitted, especially items morticed into half hour doors and frames where their fire-rated performance may be invalidated. Items morticed into one hour doors and frames must be protected by intumescent materials. For locks and latches, this protection shall comprise a layer of approved intumescent sheet on each side of the lock or latch case; any other morticed items shall be painted with intumescent paint before being fitted.

(e) Screws shall be properly inserted to drilled pilot holes with a correctly sized screwdriver. Screws must not be hammered even part of the way in.

(f) Items when fixed where the screw head is burred shall have the screws replaced. Where required, screw or bolt threads shall be plugged to suit the construction to which the item is fixed.

(g) Ironmongery shall be oiled and adjusted where required and left in perfect working order.

2.1.12.4 References and Standards

BS EN 10029 (2010): Hot-rolled steel plates 3 mm thick or above. Tolerances on dimensions and shape

BS EN ISO 1456 (2009): Metallic and other inorganic coatings. Electrodeposited coatings of nickel, nickel plus chromium, copper plus nickel and of copper plus nickel plus chromium

BS EN ISO 7599 (2010): Anodizing of aluminium and its alloys. General specifications for anodic oxidation coatings on aluminium

BS EN 12329 (2000): Corrosion protection of metals. Electrodeposited coatings of zinc with supplementary treatment on iron or steel.

BS EN ISO 2082 (2008): Metallic coatings.Electroplated coatings of cadmium with supplementary treatments on iron or steel.

BS EN 12476 (2000): Phosphate conversion coatings of metals. Method of specifying requirements.

BS 1210 (1963): Specification for wood screws

BS EN 1935 (2007+A2:2012): Building hardware. Single-axis hinges. Requirements and test methods

BS 476: Fire tests on building materials and structures

BS EN 1154 (1997): Building hardware. Controlled door closing devices. Requirements and test methods.

BS 5499-10 (2006): Safety signs, including fire safety signs. Code of practice for the use of safety signs, including fire safety signs

BS 3621 (2007+A2:2009): Thief resistant lock assembly. Key egress

BS EN 12209 (2003): Building hardware. Locks and latches. Mechanically operated locks, latches and locking plates. Requirements and test methods

BS EN 1906 (2012): Building hardware. Lever handles and knob furniture. Requirements and test methods

BS EN 1125 (2008): Building hardware. Panic exit devices operated by a horizontal bar, for use on escape route. Requirements and test methods.

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BS EN 912 (2011): Timber fasteners. Specifications for connectors for timbers

BS EN ISO 2081 (2008): Metallic and other inorganic coatings. Electroplated coatings of zinc with supplementary treatments on iron or steel

BS EN ISO 2082 (2008): Metallic coatings. Electroplated coatings of cadmium with supplementary treatments on iron or steel

2.1.13 BS EN ISO 9717 (2013): Metallic and other inorganic coatings. Phosphate conversion coating of metals.MASONRY

2.1.13.1 Materials

2.1.13.1.1 Stone

(a) Stone for masonry shall be local granite of consistent colour, free from defects and ferrous materials that will will adversely affect the strength or appearance and comply **BS EN 1996-1, BS EN 1996-2 & BS EN 1996-3**.

2.1.13.1.2 Mortar

(a) Cement mortar for masonry shall be as stated in Clause 2.1.8.2.1

2.1.13.1.3 Wall ties

(a) Wall ties between masonry walls and concrete shall be copper, bronze or stainless steel complying to **BS EN 845-1(2003:2008);** the ties shall be at least 40 mm wide, 3 mm thick and 150 mm long and shall be fanged at both ends.

2.1.13.1.4 Damp proof course

(a) Damp proof course for masonry shall be as stated in Clause 2.1.9.2.5.

2.1.13.2 Submissions

2.1.13.2.1 Samples of materials

(a) Samples of the following proposed materials for masonry shall be submitted to the Engineer for approval of the source and type of each material at least 14 days before the masonry work starts:

i. each type of stone,

ii. wall ties, and

iii. damp proof course.

2.1.13.3 Trial panels

2.1.13.3.1 Trial panels

(a) A trial panel shall be constructed for each type of masonry as stated in earlier for brickwork and blockwork.

2.1.13.4 Handling and storage of stone

2.1.13.4.1 Handing and storage of materials

(a) Stone for ashlar stone walling shall be transported with the minimum amount of handling and shall be stacked in the vehicle using packing pieces to prevent damage.

(b) The stone shall be stored in stacks on battens and protected from exposure to rain.

(c) Provide adequate lifting plant to unload and handle stones into position.

2.1.13.5 Rubble stone walling

2.1.13.5.1 Preparation of stone for rubble stone walling

(a) Stones for random rubble walling shall be irregular in shape and roughly cut to between 75 mm and 300 mm high, at least 75 mm deep and between 75 mm and 600 mm long on bed. The length or depth on bed of each stone shall be greater than the height.

(b) Stones for squared rubble walling shall be trimmed roughly square to between 75 mm and 300 mm high, varying in 75 mm stages. Each stone shall be between 100 mm and 150 mm deep and between 100 mm and 600 mm long on bed. The length or depth on bed of each stone shall be greater than the height.

(c) Stones for square coursed rubble walling shall be trimmed roughly square as stated in (b) to suit courses of regular height varying from 150 mm to 250 mm.

2.1.13.5.2 Laying and jointing rubble stone walling

(a) Stones in rubble stone walling shall be laid dry on a full even bed of cement mortar; all joints shall be filled and shall be between 5 mm and 15 mm wide.

(b) Stones of random shapes and sizes in random rubble walling shall be bonded together over each face of the wall. Stones shall be selected and rough dressed to keep joint widths to a minimum. At least one bonding stone of minimum size 450 mm x 150 mm shall be provided and carried through the full thickness of the wall per square metre. Not more than 3 stones shall be provided adjacent to a vertical joint.

(c) Roughly squared stones of random sizes in square rubble walling shall be bonded together with continuous straight horizontal joints. The number of vertical joints shall be kept to a minimum.

(d) Roughly squared stones in square coursed walling shall be laid as stated above but brought up to courses at centres not exceeding 750 mm to line up with quoin and jamb stones.

(e) Squared rubble walling exceeding 300 mm thick and faced one side shall be constructed in accordance with the following requirements:

(f) Roughly squared stone at least 300 mm thick shall be provided with a backing of random rubble.

(g) At least two bonding stones per square metre shall be regularly spaced and carried through the full thickness of the wall or at least 450 mm into the backing, whichever is less.

(h) Squared rubble walling exceeding 300 mm thick and faced both sides shall be constructed in accordance with the following requirements:

(i) Roughly squared stone at least 150 mm thick shall be provided with a core of random rubble.

(j) Bonding stones shall be provided as stated above but shall be carried through the full thickness of the wall or 450 mm into the core.

2.1.13.5.3 Pointing rubble stone walling

(a) Joints in rubble stone walling shall be raked out to a depth of 15 mm as the work proceeds. The joints shall be pointed in cement mortar on completion with a flush, weathered or recessed joint as required.

2.1.13.6 Ashlar stone walling

2.1.13.6.1 Preparation of stone for ashlar stone walling

(a) The exposed faces and joint faces of each stone for ashlar stone walling shall be dressed square and true, free from hollows or rough areas.

(b) Exposed faces shall be finished to a finely squared dressed surface. Stones shall be at least 300 mm high. Each stone shall be clearly marked to indicate its position in the finished work.

2.1.13.6.2 Laying and jointing ashlar stone walling

(a) Stones in ashlar stone walling shall be laid on a full, even bed of mortar consisting of cement and fine crushed stone in the proportions 1:3 by volume. All joints shall be filled and shall be 5 mm wide. Stones shall be laid to bond together throughout the wall, and to the backing, using projecting bonding stones.

2.1.13.6.3 Pointing ashlar stone walling

(a) Joints in ashlar stone walling shall be raked to a depth of 15 mm as the work proceeds and shall be pointed with a flush joint on completion using bedding mortar.

2.1.13.7 Protection of masonry

2.1.13.7.1 Protection of masonry

(a) Newly erected masonry shall be protected from exposure to conditions which may adversely affect the masonry. Arrises, projections and similar features shall be covered with protective sheeting lapped and securely held in position. Facework shall be kept clean at all times.

2.1.13.8 Wall ties for masonry

2.1.13.8.1 Wall ties for masonry

(a) Wall ties in masonry which is to face an existing or newly constructed wall shall be fixed at a rate of 5 per m^2. Ties shall be fixed 100 mm into the wall and 75 mm into the masonry.

(b) Wall ties shall be fixed between the ends of walls and concrete or brickwork at centres of at least 450 mm vertically and shall project 250 mm into the masonry.

2.1.13.9 Tolerances

2.1.13.9.1 Tolerances masonry

(a) Rubble stone walling shall comply with the following requirements:

i. The position on plan shall be within 25 mm of the specified position.

ii. The length shall be within 25 mm of the specified length.

iii. The height shall be within 25 mm of the specified height.

iv. The level of bed joints shall be within 25 mm of the specified level in any 5 m length.

v. The walling shall be straight to within 25 mm in any 5 m length.

vi. The walling shall be vertical to within 20 mm in any 3 m height.

(b) Ashlar stone walling shall comply with the following requirements:

i. The position on plan shall be within 15 mm of the specified position.

ii. The length shall be within 15 mm of the specified length.

iii. The height shall be within 10 mm of the specified height.

iv. The level of bed joints shall be within 10 mm of the specified level in any 5 m length.

v. The walling shall be straight to within 15 mm in any 5 m length.

vi. The walling shall be vertical to within 15 mm in any 3 m height.

2.1.13.10 References and Standards

BS EN 845-1 (2013): Specification for ancillary components for masonry. Ties, tension straps, hangers and brackets

BS EN 1996-1-2 (2005): Eurocode 6. Design of masonry structures. General rules. Structural fire design

BS EN 1996-2 (2006): Eurocode 6. Design of masonry structures. Design considerations, selection of materials and execution of masonry.

BS EN 1996-3 (2006): Eurocode 6. Design of masonry structures. Simplified calculation methods for unreinforced masonry structures.

2.1.14 WATER PROOFING

2.1.14.1 Materials

(a) All products that are recommended by manufacturer are to be fully compatible with indicated substrates, including modification by bituminous additives (asphalt as needed) and similar proven compounding provisions.

(b) In addition to primary waterproofing materials, provide the following:

Surface Conditioner: A cut back solvent type asphaltic primer complying with **ASTM D41/D41-11(2010)** specifically recommended for use in conjunction with system by the membrane manufacturer.

Flashing: Manufacturer's recommended 1.524 mm (60 mil) uncured neoprene flashing.

Bonding Adhesive: Manufacturer's one-component neoprene base contact adhesive specifically recommended for applying sheet flashing to vertical surfaces.

Splicing Cement: Manufacturer's synthetic rubber-base polymer adhesive specifically recommended for securing vertical laps in sheet flashing.

Lap Seal: Manufacturer's EPDM or synthetic rubber sealant specifically recommended for sealing lap joints in sheet flashing.

Water Block Mastic: Manufacturer's recommended mastic for bedding flashing anchors.

Protection Course: Premolded, 6.35 mm thick, semirigid board consisting of mineral-stabilized asphalt core sandwiched between layers of asphalt-saturated felt, surface-coated with asphalt and sealed to core under heat and pressure, and provided with polyethylene film facings.

(c) Accessories:

Counterflashings and Reglets.

Cap Bars: Type 302 or 304 stainless steel, 3.18 mm thick minimum, predril or punched 200 mm o.c. for mechanical fastener attachment to substrate.

Flashing Pipe Clamping Rings: Waterproofing membrane manufacturer approved, stainless steel adjustable wormgear pipe clamping rings; size appropriate to installation.

(d) Reinforcing Fabric: Continuous filament needle-punched spun bond polyester bonded with an acrylic binder; or other product as recommended by the roofing membrane manufacturer complying with the above as a minimum and accepted by Engineer.

2.1.14.2 Workmanship

2.1.14.2.1 General

(a) Do not proceed with waterproofing work during inclement weather (or when weather forecasts are unfavorable) unless manufacturer's require ents and instructions will be complied with, and unless warranties for the work will be provided without additional reservations.

(b) Concrete substrates shall be completely cured and free of all moisture detrimental to the placing of waterproofing. Drying required due to wetting of substrate by inclement weather and/or adjacent wet construction shall be in accordance with waterproofing manufacturer's recommendations.

(c) Proceed with waterproofing operations only after substrate construction and penetrating work have been completed. Placing of waterproofing shall constitute acceptance of substrate conditions.

(d) Deliver materials in manufacturer's original unopened containers clearly labeled with manufacturer's name, brand name, instructions for use and all identifying numbers. Store materials in a clean, dry area protected from water. Replace materials which have been damaged or are otherwise unfit for installation.

(e) Protect the building during waterproofing construction period from damage resulting from spillage, dripping and dropping of materials. Prevent waterproofing materials from entering and clogging drains and rain water conductors. Repair and restore or replace other work which is soiled or damaged in connection with the placement of the waterproofing work.

(f) Upon completion of each major area of waterproofing work, provide proper procedures for surveillance and protection of waterproofing work during the remainder of the construction period, so that the waterproofing will be without any indication of deterioration or damage at the time of acceptance by the Engineer.

(g) Contractor must submit a 2-year warranty agreeing to repair or replace defective work (materials or workmanship) which has failed to provide a watertight system signed by the Contractor and waterproofing installer. Upon notification of such defective work, within the warranty period make the necessary repairs and replacements at the convenience of the Employer. Repairs and replacements shall include all necessary removal and replacement of finish materials, without cost to Employer.

Manufacturer's Warranties:

1. Prior to commencing work submit manufacturer's letters of intent stating that upon their review of the waterproofing system they agree to warrant their respective materials for a period of five (5) years as follows:

    i. Membrane, to remain watertight and not to deteriorate or fail in any way.

. Upon completion of the work submit waterproofing membrane manufacturer's warranty agreeing to warrant their respective materials for a period of five (5) years as follows:

ii. Membrane, to remain watertight and not to deteriorate or fail in any way.

2.1.14.2.2 Execution

(a) Clean substrate of debris and deleterious materials which would impair the Work.

(b) Do not proceed with the installation of the waterproofing work until all defects have been corrected and the following have been completed:

i. All curbs, drains, and other penetrations through the deck have been completed and flashed.

ii. All surfaces are dry, smooth, free of depressions, spalled areas, laitence, voids (holes, cavities, and honeycombs), clean and free of unapproved curing compounds, form release agents and other surface contaminants. Voids shall be filled and struck flush in accordance with manufacturer's directions utilizing materials recommended by the manufacturer of the waterproofing membrane system to be applied thereon. All high spots shall be cut off and ground smooth.

(c) Thoroughly sweep the horizontal substrates to receive the hot fluid applied waterproofing. After sweeping blow substrates clean of remaining loose debris using an air compressor.

(d) Protect adjoining surfaces outside of the areas to receive the waterproofing work from overspray or spillage of liquid components of the waterproofing membrane systems.

(e) Install the hot fluid applied waterproofing membrane system in accordance with the manufacturer's instructions, except where more stringent requirements are shown or specified.

(f) Apply surface conditioner to all surfaces indicated to receive hot fluid applied waterproofing
membrane in accordance with the recommendations of the hot fluid applied waterproofing membrane manufacturer. Surface conditioner shall tan the surface, not blacken it. Allow surface conditioner to thoroughly dry prior to the membrane application.

Do not apply surface conditioner to previously installed hot fluid applied waterproofing unless otherwise permitted by the hot fluid applied waterproofing membrane system manufacturer.

(g) Heat membrane in a double jacketed, oil bath melter with mechanical agitation, specifically designed for the preparation of a rubberized asphalt membrane. Heat membrane in accordance with the membrane manufacturers recommendations.

(h) Provide treatment at control joints, cracks, and penetrations and with such materials and designs specified, and shown, unless more stringent requirements are recommended by the
manufacturer of the hot fluid applied waterproofing membrane system.

(i) Install specified flashing materials and accessories and tie into the hot fluid applied waterproofing membrane.

(j) Set metal flanges in hot fluid applied waterproofing membrane. Prime flanges of metal accessories, strip flange with specified flashing materials and tie into hot fluid applied waterproofing membrane.

(k) Extend hot fluid applied waterproofing membrane down to the flashing ring on drains, and onto concrete deck a minimum of 300 mm. Over the hot fluid applied waterproofing membrane install flashing extending a minimum distance of 150 mm onto the concrete deck and centered over drain flashing ring. Install drain clamping ring. Cut out center of flashing over drain bowl. Cover the flashing with hot fluid applied waterproofing membrane.

(l) Install flashing at all joints and cracks, exceeding 1.5 mm, as recommended by the membrane manufacturer. Use longest lengths of flashing practicable at all joints and cracks. Flashing shall be placed while membrane is still hot and shall extend a minimum of 150 mm on either side of joint and lap at ends a minimum of 75 mm. After placing flashing, apply a second coat of membrane 3.18 mm thick over sheet and carried 100 mm beyond edge of sheet.

(m) Install flashing to vertical surfaces, allowing 150 mm of flashing to extend onto concrete deck. Nail at top with stainless steel roofing nails into cap bars at 200 mm o.c. Adhere flashing to vertical surfaces by applying bonding adhesive from 75 mm above the deck to the full height of flashing. Vertical laps in flashing shall be 100 mm minimum, secured with
splicing cement. Seal edge of lap seam with continuous bead of lap seal.

i. The unbonded flashing on the vertical and horizontal surfaces shall be placed into the hot fluid applied waterproofing membrane while it is still hot. After placing flashing, apply a second coat of membrane 3.18 mm thick over the horizontal flashing surface.

(n) Pipe Penetrations: Flash all pipes, conduits, sleeves, and other projections passing through membrane and provide tight construction throughout. Use prefabricated boots or field fabricated boots, fitted coverings, and other accessories as required. Where pipes or conduits pass through areas to be waterproofed or where drains occur in such areas, apply hot fluid applied waterproofing membrane only after flashing around pipes, conduits and drains is in place. Lap pipe penetration flashing into the membrane.

(o) Apply the fluid applied waterproofing membrane at a rate to provide a continuous, monolithic, coating having a uniform minimum thickness of 2.29 mm (90 mils). Fully embed a layer of reinforcing fabric while membrane is still hot, followed by a second layer of fluid applied waterproofing membrane with a minimum thickness of 3.17 mm (125 mils); resulting in a total minimum fluid applied waterproofing membrane system thickness of 5.46 mm (215 mils) at any location. Overlap adjoining reinforcing fabric sheets a minimum of 50 mm.

(p) Embed protection course, with asphalt-saturated felt side down, into all applications of hot fluid applied waterproofing membrane while it is still hot. Form a continuous protective layer for the hot fluid applied waterproofing membrane. Butt edges tightly, stagger end joints and cut to fit at all intersecting surfaces and penetrations.

(q) No membrane shall be permitted to remain exposed at the conclusion of any working day.

2.1.14.3 Special project warranties

2.1.14.3.1 General

(a) The Contractor should submit a 2 year warranty agreeing to repair or replace defective work (materials or workmanship) which has failed to provide a watertight system signed by the Contractor and waterproofing installer. Upon notification of such defective work, within the warranty period make the necessary repairs and replacements at the convenience of the Employer. Repairs and replacements shall include all necessary removal and replacement of finish materials, without cost to the Employer.

(b) Prior to commencing work submit manufacturer's letters of intent stating that upon their review of the waterproofing system they agree to warrant their respective materials for a period of five (5) years as follows:

i. Membrane, to remain watertight and not to deteriorate or fail in any way.

Upon completion of the work submit waterproofing membrane manufacturer's warranty agreeing to warrant their respective materials for a period of five (5) years as follows:

ii. Membrane, to remain watertight and not to deteriorate or fail in any way.

2.1.14.3.2 Quality Assurance

(a) Employ only skilled tradesmen who are thoroughly trained with the materials and equipment to be used in the work. Maintain a full time supervisor/foremen who is on job site during times that waterproofing work is in progress and who is trained in installing waterproofing systems similar to type and scope required for this Project.

(b) The manufacturer shall provide evidence indicating that the specified hot fluid applied waterproofing membrane materials have been manufactured by the same source and successfully utilized on a yearly basis for a minimum of 10 years on projects of a similar scope to that shown and specified for this Project.

(c) Obtain primary waterproofing materials of each type required from a single manufacturer. Provide secondary products as recommended by manufacturer of primary products to use with the waterproofing systems selected.

(d) As soon as possible after award of hot fluid applied waterproofing work, but no later than 2
weeks before the installation of the waterproofing work, meet with Contractor and Engineer.

(e) Review foreseeable methods and procedures related to waterproofing substrates, including but not limited to, the following:

i. Tour representative areas of waterproofing substrates, inspect and discuss condition of substrate, slope, drainage, membrane application, flashing details, drains, curbs, penetrations, and other preparatory work.

ii. Review structural loading limitations of the structural deck.

iii. Review waterproofing system requirements: drawings, specifications, and other contract documents.

iv. Review required submittals, both complete and incomplete.

v. Review required inspection, testing, and certification procedures.

vi. Review weather and forecasted weather conditions and procedures for coping with unfavorable conditions.

vii. Discuss waterproofing system protection requirements for construction period extending beyond waterproofing installation.

(f) Record discussion and furnish copy of recorded discussions to each attendee.

2.1.14.4 References and Standards

ASTM D41/D41M – 11 (2010): Standard Specification for Asphalt Primer Used in Roofing, Dampproofing, and Waterproofing

2.1.15 ROOFING AND RAINWATER DISPOSAL

2.1.15.1 Coverings and flashing

2.1.15.1.1 Materials

(a) Sheet lead shall be to **BS EN 12588**, 1.8 mm thick Code No. 4, Colour Blue.

(b) Sheet copper shall be to **BS EN 1172, BS EN 1652, BS EN 1653** and **BS EN 1654**.

(c) Sheet aluminium shall be to **BS EN 485**, 0.9 mm thick grade S199.99.

2.1.15.1.2 Workmanship

(a) Fix sheet lead shall be in accordance with **BS 6915**.

(b) Flashings shall be let into walls a minimum of 25 mm, secured with lead wedges and pointed in cement mortar. Flashing shall be lapped a minimum of 100 mm and the lower edge secured with lead tacks at 750 mm centres.

(c) Fix sheet copper shall be in accordance with **CP 143: Part 12**.

(d) Fix sheet aluminium shall be in accordance with **CP 143: Part 15**.

(e) Flashings shall be let into walls a minimum of 25 mm, provided with a turn back, secured with folded aluminium wedges and pointed in cement mortar.
Flashings shall be lapped and single lock welted and the lower edge folded under for additional stiffness.

(f) Aluminium in contact with mortar shall be coated with bituminous paint after bending.

(g) Avoid contact in the completed work between the following metals:-

- Aluminium alloys and copper alloys, nickel, lead or stainless steel.
- Iron or steel and copper alloys.
- Zinc (including galvanising) and copper alloys or nickel.

(h) Where unavoidable, coat contact surfaces with bituminous paint, protective tape or other approved means.

2.1.15.2 Bitumen felt built-up roofing

2.1.15.2.1 Materials

(a) Bitumen felt shall be in accordance with **BS EN 13707**, and shall be as follows :-

(b) Underlayer to consist of one or more layers, as specified, of fine granule surface felt Type 1B (nominal weight 1.8 or 2.5 kg/m^2).

(c) Top layer shall be one of the following :-

- mineral surfaced felt Type 3E, (nominal weight 2.8 kg/m^2).
- fine granual surfaced felt Type 1B (nominal weight 2.5 kg/m^2) with surface dressing.

(d) Rolls shall be delivered to Site bearing the trade mark and certification as to BS type.

(e) Bitumen primer shall be selected to suit the type of bonding compound.

(f) Bonding compound shall be bitumen based.

(g) Bitumen dressing compound shall be cut-back bitumen to **BS 3690**, grade 50 secs.

(h) Stone chippings shall be light coloured, hard and free from brown or partially decomposed stone. Chippings shall be graded from 5 mm to 3 mm.

(i) Nails for fixing felt to timber decks shall be galvanised steel or non-ferrous metal with 3 mm diameter shank and 11 mm diameter clout head and 20 mm long.

2.1.15.2.2 Workmanship

(a) Lay bitumen felt roofing generally in accordance with **BS 8217** and **BS 8218**.

(b) Lap felt 75 mm at joints and 100 mm at ends of length. Lay successive layers to break joint.

(c) Provide thermometers to check the work and do not heat any layers or material to more than 220^{o}C. Lay evenly at a sufficiently high temperature to obtain a satisfactory bond (normally 180^{o} to 200^{o}C).

(d) Bonding compound shall be used in accordance with the manufacturer's recommendations. The Contractor shall ensure that workers are protected against the risk of exposure to substances considered to be hazardous to health. Toxicological information, exposure control, personal protection and first aid measures extracted from the manufacturer's material safety data sheets shall be kept in a register on the Site.

(e) Ensure that the base is clean and dry, before starting work.

(f) Rolls of felt shall be laid in the following directions.

- On flat roofs, lay the first layer of felt starting at, and parallel to, the lower edge or eaves.
  Lay subsequent layers in a similar manner to ensure that the laps in the built up roofing do not obstruct the flow of water.

- On sloping roofs, lay the felt in the direction of the slope. Lap sheets with the exposed laps away from the prevailing wind.

(g) Lay bitumen felt roofing as follows :-

- On concrete roofs, brush on a coat of bitumen primer, and allow to dry.

- Partially bond the first layer to the base at the perimeter and in spots or strips, with hot bonding compound at the rate of 0.5 kg/m^2. Roll with a 70 kg (minimum) roller while the bonding compound is still hot. Remove any surplus compound squeezed out at the edge.

- Fully bond subsequent layers with a continuous even coating of hot bonding compound applied to the previous layer at the rate of 1.5 kg/m^2. Roll and remove any surplus compound as specified above.

- On timber roofs, nail the first layer at 50 mm centres along the laps, 20 mm in from the edges with additional nails in rows at 150 mm centres staggered at 300 mm centres.

(h) Secure subsequent layers by full bonding as specified in Clause 2.1.15.2.1 (a).

(i) Dress surface with bitumen compound applied at the rate of 3 kg/m^2 dressed immediately with stone chippings, lightly rolled in at the rate of 15 kg/m^2.

(j) Remove any loose chippings.

(k) Provide skirtings as follows :-

- To concrete roofs, provide a triangular cementitious internal angle fillet at bottom 75 mm wide on splay. Carry up underlayers of felt to form skirting 150 mm (minimum) high above roof level. Cover with a mineral felt flashing (Type 3E) with one edge tucked into 25 mm groove in wall, wedged at 600 mm centres and pointed with mastic and seal to face of skirting with bonding compound.

- To timber roofs, provide a 200 mm timber upstand with angle fillet at bottom fixed securely to roof deck and carry up roofing felt over it. Provide a lead apron flashing over. The lead flashing code and weight shall be confirmed by the Engineer.

(l) At verges, gutters and the like :-

- Provide and fix a non-ferrous trim fixed with compatible screws or nails, bonded between layers of built up roofing to form drip or dressed into gutter.

- Form a welted drip.

(m) All roof falls shall be aligned to direct water towards outlets :-

- Dress all layers into proprietary roof outlets and seal with bonding compound.

- Provide and fix 1.8 mm lead slate size 450 mm x 450 mm perforated for and with a 150 mm long outlet soldered on to suit the bore of the pipe and dress between layers of built up roofing.

(n) Cut and fit roofing around pipes passing through roof, dress flange or collar between second and third layers, and seal in hot bonding compound, using :-

- Lead slate size 450 mm x 450 mm perforated for and with 150 mm high collar soldered on to suit bore of pipe.

- Proprietary moulded plastic or rubber collar.

2.1.15.3 Bituminous emulsion roofing

2.1.15.3.1 Materials

(a) Bituminous emulsion for roofing shall be "Flintkote" or other approved compound. Use in accordance with the manufacturer's recommendations.

(b) Glass fibre membrane shall be a woven material with a thread count of 8 x 8 mm per 10 mm square (minimum).

2.1.15.3.2 Workmanship

(a) Ensure that the base is clean and dry before starting work. Wire brush rust patches on steel sheet roofing.

(b) Apply bituminous emulsion evenly by brush. Ensure that previous coat is dry before applying the next coat.

(c) Wash coat to consist of "Bitumen Emulsion No. 3" and water 1:1 by volume.

(d) Priming coat to consist of "Bitumen Emulsion No. 3" and water 5:1 by volume.

(e) Lap glass fibre membrane 75 mm at joints. Press into last coat of emulsion while still wet.

(f) Treat concrete flat roofs as follows :-

- Apply wash coat and priming coat.

- Apply one coat of "Bitumen Emulsion No. 3" at the rate of 0.7 litre/m^2.

- Apply one layer of glass fibre membrane.

- Apply three coats of "Bitumen Emulsion No. 3" at the rate of 0.5 litre/ m^2 per coat.
- Apply two coats of "Bitumen Emulsion No. 3" at the rate 0.5 litre/ m^2 per coat.

(g) Treat cracks in existing felt covered roofs as follows :-

- Cut out cracks exceeding 5 mm wide, where ordered.
- Apply wash coat and primer to grooves.
- Fill grooves with compound consisting of "Bitumen Emulsion No. 3" and sand 1:3 by volume.

(h) After making good cracks, treat the entire roof area as follows:-

- Apply "PF 4 Solution" at the rate of 0.2 litre/ m^2 .
- Apply two coats of "Bitumen Emulsion No. 5" at the rate of 0.7 litre/ m^2 per coat.

(i) Treat joints of steel corrugated sheet roofing in a strip 150 mm wide to cover the joint, as follows :-

- Point joint with "Bitumen Emulsion No. 7".
- Apply "PF 4 Solution" at the rate of 0.14 litre/ m^2.
- Apply "Bitumen Emulsion No. 3" at the rate of 0.7 litre/ m^2.
- Apply one layer of glass fibre membrane.
- Apply two coats of "Bitumen Emulsion No. 3" at the rate of 0.7 litre/ m^2 per coat.

(j) Finish surface with :-

- A dressing of clean, sharp sand.
- Two coats of "Alubit" protective coating at the rate of 0.11 litre/ m^2 per coat.
- Two coats of "Decoralt" coloured finish at the rate of 0.16 litre/ m^2 per coat.
- One coat of compound consisting of cement, "Bitumen Emulsion No. 3" and sand 1:8:32 by volume, trowelled on 3 mm or 5 mm thick, as specified.

2.1.15.4 Tile roofing

2.1.15.4.1 Materials

(a) Tiles shall be red in colour, sound, well-burnt unglazed clay, whole, and free from cracks and blemishes. Approximate sizes shall be :-

- Plain tiles 225 mm x 225 mm
- Roll tiles 165 mm long, and tapered
- Valley tiles 300 mm x 225 mm

(b) A sample of the tiles shall be approved before ordering and comply to BS EN 490 (concrete tiles) and **BS 5534** (clay tiles).

(c) Mortar shall be cement/lime mortar, as Clauses 2.1.8.2.1 .

(d) Nails shall be aluminium or galvanised steel nails at least 2 mm diameter 30 mm long and with plain heads.

(e) Roll tiles to be left exposed shall be specially selected and semi circular in section. Glazed tiles shall be obtained from an approved manufacturer.

2.1.15.4.2 Workmanship

(a) Lay tiles to roofs as follows :-

- A single layer of plain tiles to the gauge specified with roll tiles to 120 mm gauge.
- A double layer, each layer as (a) above.

(b) Lay Plain tiles to a gauge exceeding 75 mm and not exceeding 115 mm.

(c) Bed corners of tiles in mortar dabs. Lay roll tiles to lap 50 mm, bed both edges in mortar, and cover with similar mortar 15 mm (minimum) thick, trowelled smooth.

(d) On wood battened roofs, drive nails into battens and leave projecting 15 mm as key for mortar dabs and neatly point underside if exposed.

(e) Finish with a mortar fillet, trowelled smooth.

(f) Form ridge or hips with rows of inverted tiles, with rows of roll tiles over.

(g) Lay valley tiles up the valley to the gauge specified. Cut roof tiles to rake and finish both sides with mortar, trowelled smooth.

(h) Single layer tiling - finish eaves with double course of tiles where specified.

(i) Double layer tiling - finish eaves with roll tiles or tile slips placed centrally between rolls to form weep hole, and fill edge with mortar, trowelled smooth.

(j) Cut and fit tiling at abutments and around pipes, etc., and finish with a mortar fillet, trowelled smooth.

(k) Roll tiles to be left exposed shall be bedded and pointed in cement mortar.

(l) Glazed tiles shall be fixed in accordance with the manufacturer's recommendations.

2.1.15.5 Mastic asphalt (rock asphalt) roofing

2.1.15.5.1 Generally

(a) Mastic asphalt (rock asphalt) roofing shall not be used for new works.

(b) All asphalt roofing for repair works to existing asphalt roofs shall be laid and executed complete by an approved contractor for asphalt roofing or tanking.

2.1.15.5.2 Material

(a) Mastic asphalt shall be as follows :-

- Mastic asphalt (limestone aggregate) to **BS 6925**, type R988 manufactured with asphaltic cement specified under Table 1 column B (100% Bitumen)

- Mastic asphalt (limestone aggregate) to **BS 6925**, type R988 manufactured with asphaltic cement specified under Table 1 column T25 75% Bitumen and 25% Lake Asphalt.

(b) Sampling and testing shall be carried out in accordance with BS 5284. Deliver samples to the approved laboratory as directed by the Engineer. Results shall be in accordance with **BS 6925**.

(c) Black sheathing felt shall be to **BS EN 13707**, Class 4A(i) and weighing not less than 17 kg per roll 25 mm long.

(d) Bitumen dressing compound shall be cut back bitumen to **BS 3690**, Grade 25 secs. or other approved grade.

(e) Sand finishing shall be fine, clean and the particles of which must mostly pass a 600 □m mesh BS sieve and be retained on a 300 μm mesh BS sieve.

(f) Granite chippings shall be best quality grey granite free from brown and partially decomposed stone graded to pass a 5.00 mm mesh BS sieve and be retained on a 2.36 mm mesh BS sieve.

(g) Reflective paint shall be approved bituminous based aluminium paint or an approved paint compatible with bituminous surfaces.

(h) Reinforcement shall be bitumen coated "plain expanded" metal lathing to **BS EN 13658-1** and not less than 10 mm short way of mesh and not lighter than 0.46 mm thickness.

2.1.15.5.3 Workmanship

(a) Lay mastic asphalt roofing in accordance with **BS 8218**.

(b) Break the blocks into pieces of suitable size, carefully stack in an approved cauldron or mixer and gradually heat to a temperature at no time exceeding 230°C. Whilst heating agitate the asphalt continuously to prevent local over-heating. Remove the asphalt from the cauldron or mixer by means of buckets which have been coated with a fine inert dust or cement. Do not use ashes or oil for this purpose.

(c) The Contractor shall provide suitable thermometers to ensure that the asphalt is heated to correct temperature.

(d) Cauldrons shall be sited so as to cause minimum inconvenience and nuisance to occupied premises considered to be air sensitive receivers as determined under EPD's guidelines for air quality assessment.

(e) Lay black sheathing felt lapped 75 mm at joints, laid dry and not sealed to the structure on all surfaces not exceeding 30° from the horizontal.

(f) Skirtings, covering to curbs and the like on concrete exceeding 300 mm high sloping surface sand all finishes on timber shall be reinforced with metal lathing securely plugged and stapled.

(g) Lay asphalt with coats breaking joint at least 150 mm, on a perfectly clean and dry base. Lay horizontal asphalt to wood or metal gauges to ensure the correct thickness of each coat. Thickness shall be as follows :-

- Horizontal roof surfaces and on slopes not exceeding 30^{o} - two coats of equal thickness to a total thickness of not less than 20 mm.
- Skirtings, upstands and drips and on slopes exceeding 30^{o} - two coats of equal thickness to a total thickness of not less than 13 mm.
- Skirting, upstands and drips higher than 300 mm, three coats of equal thickness to a total thickness to a total thickness of not less than 20 mm.

(h) Should "blows" be formed whilst laying, due to the entrapment of moisture or air, pierce the affected part and make good whilst the surrounding asphalt is warm.

(i) Form internal angles between horizontal and vertical surfaces with stout asphalt fillets, in two coat work, not less than 50 mm on face and continuous with those surfaces.

(j) Maintain the full thickness of asphalt specified at external angles between horizontal and vertical surfaces or between sloping surfaces.

(k) Unless otherwise required, form skirtings not less than 150 mm high above roof finish with top edge splayed and tucked into a groove not less than 25 mm deep.

(l) Neatly dress asphalt roofing into rainwater outlets including sealing as necessary. Prior to applying asphalt prime flanges of roof outlets with bitumen solution.

(m) Flashings to rainwater outlets shall be carefully embedded in the first coat of the asphalt and the second coat dressed over it.

(n) Neatly dress asphalt reinforced as Clause 2.1.15.5.3 (f) 150 mm (minimum) high around sleeves to pipes passing through roofs with a stout asphalt angle fillet at bottom. Prior to apply asphalt thoroughly clean metal surfaces and prime with bitumen solution.

(o) Expansion joints shall be constructed strictly as indicated on the drawings.

(p) Pointing shall be in accordance with the specification in Clause 2.1.8.15

(q) Flashings and coverings shall be in accordance with the specification for leadwork in Clauses 2.1.15.1.1 (a) and (b).

(r) Immediately after the completion of laying, rub roof surfaces well with a clean wood float using fine clean sand.

(s) Solar protection shall be provided as indicated.

- Dress surface with bitumen compound applied at the rate of 3 kg/m^2 dressed immediately with stone chippings lightly rolled in at the rate of 15 kg/m^2, remove any loose chippings.
- Apply two coats of reflective paint at rates recommended by the manufacturer.
- Lay precast concrete or insulating tiles in accordance with the specification for Rigid Tile or Slab Finishes in Clauses 2.1.17.7.

2.1.15.6 Steel sheet roofing and cladding

2.1.15.6.1 Materials

(a) Steel corrugated sheets shall be hot-dipped galvanised corrugated sheets to BS 3083 and to be at least 0.6 mm thick, with corrugations 76 mm wide and 19 mm deep.

(b) Profiled steel sheets to **BS 5427** shall be obtained from approved manufacturer of profile, thickness, finish and colour as specified.

(c) Accessories for steel sheets shall be made from 0.6 mm (minimum) thick galvanised steel sheet or to be approved proprietary fittings. Accessories for colour coated sheets shall be obtained from the approved manufacturer of the sheets.

(d) Hook bolts and nuts, drive screws, washers, self-tapping screws, roofing bolts, nuts and clips, roofing screws and sheeting clips shall be galvanised steel to **BS 1494:Part 1** or electro -plated to **BS 7371** and of the sizes and finishes specified.

Alternatively, recommended specialist fixings from an approved manufacturer of the roofing sheets.

Bolts and screws shall be fitted with large washers compatible with sheets and shall be capable of withstanding up-lift under typhoon conditions.

Where coloured roofing sheets are used, fixing heads shall be covered with plastic caps to match the colour of the sheets.

Rivet fixings may only be used with the permission of the Engineer, and then only for vertical flashings

2.1.15.6.2 Workmanship

(a) Fix steel sheeting generally in accordance with **CP 143: Part 10**.

(b) Drill fixing holes in the crown of corrugations for roofing, and in the trough of corrugations for cladding. Drill holes 2 mm larger than bolts or screw, and not less than 40 mm from edges of sheets .

(c) Remove all drilled cast material from around holes, leaving holes flat and smooth prior to any bolt or other fixing.

(d) Make good damage to zinc coatings and galvanising, treat cut ends of galvanized sections with two coats of metallic zinc-rich priming paint as Clause 2.1.15.1.

(e) Lay sloping sheets with minimum end laps of 150 mm. Vertical sheets shall be fixed with minimum laps of 75 mm. All laps shall be located over a supporting member.

Lay sheets with side laps of one and a half corrugations.

Where specified, seal laps with approved lap sealant.

Fix to steelworks with stainless steel self tapping screws designed for fixing to steel. Fix to timber with self tapping screws designed for fixing to timber.

Fixings for two rows around the perimeter of the roof, to any projecting areas, verges or open areas and at all end lapsshall be at 300 mm (maximum) centres.

Cut, fit and dress steel sheet accessories to fit corrugations or profiles and fix with approved fixings in accordance with the manufacturer's recommendations.

Provide movement joints in all lengths of roofing or cladding over 45 m, with one joint for lengths up to 75 m and one for every additional 30 m.
Cover with a movement joint cover fixed to sheets at one side only.

Fix sheets in accordance with the manufacturer's recommendations. Sheets shall be sheared and not cut with circular saws or abrasive wheels. Make good damages as Clause 2.1.15.2.2 (l).

(f) Sheets required shall be bent to a radius for use on curved roofs shall be bent by means of a proper profiling or crimping machine.

(g) Treat joints of steel corrugated sheet roof according to Clause 2.1.15.3.2 (i).

2.1.15.7 Aluminium sheet roofing and cladding

2.1.15.7.1 Materials

(a) Aluminium corrugated and profiled sheets shall be to **BS 4868**. Corrugated sheets shall be at least 0.6 mm thick with corrugations 76 mm wide and 19 mm deep. Profile sheets shall be of the profile, thickness, finish and colour as specified.

(b) Accessories for profiled aluminium sheets shall be made from aluminium flat sheet at least 0.6 mm thick and of similar finish and colour to the profiled sheets or to approved proprietary fittings. Accessories for colour coated sheets shall be obtained from the approved manufacturer of the sheets.

(c) Fixings for aluminium profiled sheets as Clause 2.1.15.6.1.

2.1.15.7.2 Workmanship

(a) Fixing of aluminium sheet shall be similar to that for steel sheeting. See Clauses 2.1.15.6.2.

(b) To prevent electro-chemical corrosion, direct contact with other metals (particularly copper) shall be avoided. Fixings must be of, or compatible with, aluminium. Where unavoidable, coat contact surfaces with bituminous paint, protective tape or other approved means.

2.1.15.8 Profiled glass-fibre reinforced plastic (GRP) sheets

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2.1.15.8.1 Materials

(a) Profiled glass-fibre reinforced plastic (GRP) sheets shall be to **BS 4154**. The resin system, as regards physical properties, shall be to **BS 3532**. The profile, thickness, translucency and colour shall be as specified.

(b) Where fire protection requirements apply, the GRP sheets shall be tested in accordance with **BS 476:Part 3** and Part 7 and the fire performances achieved by the samples shall be stated.

(c) The sheets shall be marked with the name or trademark of the manufacturer, the **BS 4154** and the designation of the test samples of the translucent sheet in accordance with **BS 476:Part 3**, where so claimed by the manufacturer.

(d) Fixings for glass-fibre reinforced plastic sheets as Clauses 2.1.15.6.2..

2.1.15.8.2 Workmanship

(a) Fixing of glass-fibre reinforced plastic sheets shall be similar to that for steel sheeting. See Clause 2.1.15.6.2.

2.1.15.9 Profiled unreinforced rigid pvc sheets

2.1.15.9.1 Materials

(a) Profiled unreinforced rigid PVC sheets shall be **BS 4203**. The profile, thickness, colour and transparency shall be as specified. The sheets shall be marked with the name or trademark of the manufacturer, the date of manufacture and the number of the BS and the type.

(b) Fixings for PVC sheets as Clause 2.1.15.6.2.

2.1.15.9.2 Workmanship

(a) Fixing of PVC sheets shall be similar to that for steel sheeting. See Clause 2.1.15.6.2.

(b) Lay sloping sheets with minimum end laps of 225 mm. Vertical sheets shall be fixed with minimum laps of 75 mm. All laps shall be located over a supporting member.

(c) Lay sheets with side laps of one and a half corrugations.

(d) Where specified, seal laps with approved lap sealant.

2.1.15.10 Profiled compressed particle sheets

2.1.15.10.1 Materials

(a) Profiled compressed particle sheets and accessories shall be as specified and not to contain asbestos materials of any kind.

(b) Fixings for compressed particle sheets as Clauses 2.1.15.6.2.

2.1.15.10.2 Workmanship

(a) Fixing of compressed particle sheets shall be similar to that for steel sheeting. See Clause 2.1.15.6.2.

2.1.15.11 Proprietary roofing systems

2.1.15.11.1 Generally

(a) Proprietary roofing systems shall be laid by specialist contractors included as agents or applicators on the list of Acceptable Specialist Roofing Materials Contractors.

2.1.15.11.2 Materials

(a) All waterproof Roofing Covering Materials shall be materials of the acceptable specialist's roofing system and which are subdivided into four groups as follows :-

- Type 'A1' Roofing Sheet Material requiring Protection.
- Type 'A2' Roofing Sheet Materials with self finishes.
- Type 'B1' Liquid Applied Roofing Materials requiring Protection.
- Type 'B2' Liquid Applied Roofing Materials with self finishes.

(b) Submit samples of the roofing materials which shall be installed and copies of the manufacturer's technical data and instructions to the Engineer for approval.

(c) Before commencing work, the contractor shall demonstrate on Site that all adhesives and materials are fully compatible and shall be certified by the suppliers/manufacturers in writing.

2.1.15.11.3 Workmanship

(a) Lay the roofing system comprising the approved roofing material, insulation and roof finishes onto the roof, including priming, sealing, crack filling and other preparation where necessary all in accordance with the manufacturer's specification and recommendations, and in accordance with the details and sequence as approved by the Engineer.

(b) Particular care shall be taken to ensure that all junctions, joints around pipes, rainwater outlets and the like are properly executed.

(c) Take necessary measures when carrying out the works so that disturbances, including noise and vibration, to the occupants and users of the premises are kept to the minimum. Noisy works, which in the opinion of the Engineer, will affect the occupants and users will not be permitted.

(d) Chutes for removal of Construction and Demolition waste shall be erected at approved locations, designed to withstand high winds, with hopper heads to ensure that no materials fall outside the chutes, and discharge at low level, preferably into skips or bunkers, to prevent the spread of debris and to minimize dust generation. Chutes shall be demolished and removed off the Site after use and all disturbed areas and surfaces shall be made good to match existing.

(e) Prevent dust arising from debris generated by removal of existing roofing systems by approved dust control methods. Debris shall be regularly removed from the Site.

(f) Prior to laying of the roofing system inspect and repair as required to provide proper surfaces to receive waterproofing.

Remove all contaminants such as grease, oil, etc., from the surfaces. Clean surfaces to remove dust, dirt, loose stone and debris.

(g) High pressure water cleaning of substrates shall not be permitted.

(h) When specified for repair or maintenance work, take up and remove existing tiles, existing layers of felt or other protective covering, to expose existing asphalt or roof membrane; lay a cement and sand screed, minimum 25 mm thick or self-leveling screed as approved by the Engineer, to produce an even surface to approved falls to receive the new roofing system. The Contractor shall take the responsibility for repairing and making good the existing roof slab.

(i) No work shall be carried out when there is surface moisture.

(j) The whole roof shall be left watertight when no work is in hand.

Where coverings have been removed and not yet replaced, the Contractor shall provide covering (ropes and hold-fasts to hold down the coverings) by means of tarpaulin or other sheeting to cover all areas of roofs. Overlaps must be sealed with tape and sheets effectively dressed into outlets.

Other methods of protection may be employed as approved by the Engineer.

During working hours, all roofing outletsshall be protected to prevent debris falling into rainwater pipes. The outlets shall be opened and cleared at the end of the working day and the roof swept clean to ensure effective drainage.

Protect all pipework, ducting and other services running on top of the existing roof, including provision of new pipe supports as necessary.

Any accidental damage to water supply pipes shall be reported to the Engineer immediately.

(k) Adhesive, if required, shall be applied strictly in accordance with the manufacturer's recommendations. All manufacturer's data about the shelf-life of adhesives shall be noted, and no attempt shall be made to use materials which are no longer fit for use. The spreading of adhesive over large areas and subsequent setting before placing of sheets shall be prohibited.

Ensure that workers are protected against the risk of exposure to substances considered to be hazardous to health. Toxicological information, exposure control, personal protection and first aid measures extracted from the manufacturer’s material safety data sheets shall be kept in a register on the Site.

(l) If bubbles form in the membrane, the affected area shall be cut open and made good as far as the manufacturer's technical literature specifically allows. Otherwise, the whole area shall be stripped, cleared and the surface shall be prepared again and the work shall be re-executed.

(m) When specified, apply a light-reflective paint or similar finish applicable to the particular roofing system.

(n) When specified, the roofing system shall be designed to allow for increased wear due to frequent foot traffic or shall be protected by precast concrete tiles, (laid on cement and sand mortar) or other materials approved by the Engineer.

(o) Do not allow traffic on roof until 4 days after completion of tiling and subsequently permit only light traffic for a further 10 days.

(p) When specified, position and fix approved proprietary roof vents in accordance with the manufacturer's recommendations and ensure that the roofing contractor or specialist makes good the roof covering up to and around them.

(q) Insulation shall either have integrally bonded hard surfaces on both sides or be protected by inert hard sheeting or reinforced screed.

(r) Moisture testing equipment shall be available on Site to monitor the moisture content of the roof structure and the various elements of the roof system; all necessary precaution shall be taken to ensure the full integrity of the roofing system.

(s) Records of tins of adhesive, liquid membrane or amount of sheeted membrane material shall be kept upon their arrival on site. The number consumed per day and the number cleared away shall be evaluated to check the actual spreading rate of the proprietary material against the manufacturer's technical data. Tins and packages may be marked on arrival and again when consumed.

(t) Keep a register of all dangerous substances including those hazardous to health, which are delivered to and stored for use on the Works. The register shall include information on physical and chemical properties, hazards, safe handling and storage, precautionary measures to be taken, first aid measures, disposal of containers and surplus or waste materials, and measures to be taken in case of accidents.

(u) Inform the Engineer upon the completion of each layer of the roofing system for an inspection before the execution of next layer.

2.1.15.12 Non-destructive test

(a) The test shall include sealing all outlets and if necessary constructing dams to compartmentalize large roofs. Flood the roof for 24 hours. After flooding, all outlet blockages and dams shall be removed to drain the roof. Do not permit any debris to enter into the drainage pipework.

(b) At a period between 24 and 48 hours from release of the water, an infra-red scan shall be carried out by an independent specialist contractor to establish if there has been penetration through the membrane. The report shall be sent directly by the infra -red scanning contractor to the Engineer.

2.1.15.13 Warranty

(a) Upon completion of the work, submit one maintenance manual, identified with project name, location and date, type of coating system applied and surface to which system was applied, and sketches where necessary.

(b) Recommendations for periodic inspections, care and maintenance shall also be included. Identify common cause of damage with instructions for temporary patching until permanent repair can be made.

(c) Duly executed warranty shall be submitted by the Contractor in accordance with the Contract. The completed installation shall be guaranteed against defects of materials and

workmanship by the Contractor for a period of 10 years from the date of completion stated in the certificate of completion with respect to the Works for use as an exposed roof membrane in Kenya.

(d) The system shall be designed to withstand the conditions of the Kenya climate. The warranty shall cover the roofing system in its entirety. The warranties shall be extended to cover all aspects of the roofing project executed by the Contractor including adhesion and structural integrity of materials used.

2.1.15.14 References and Standards

BS EN 13707 (2004+A2:2009): Flexible sheets for waterproofing. Reinforced bitumen sheets for roof waterproofing. Definitions and characteristics

BS EN 490 (2011): Concrete roofing tiles and fittings for roof covering and wall cladding. Product specifications

BS 5534 (2003+A2:2010): Code of practice for slating and tiling (including shingles)

BS 8217 (2005): Reinforced bitumen membranes for roofing. Code of practice

BS 8218 (1998): Code of practice for mastic asphalt roofing.

BS EN 12588 (2006): Lead and lead alloys. Rolled lead sheet for building purposes.

BS 6915 (2001): Design and construction of fully supported lead sheet roof and wall coverings.Code of practice.

CP 143-10 (1973):Code of practice for sheet roof and wall coverings. Code of practice for sheet roof and wall coverings. Galvanized corrugated steel. Metric units

CP 143-12 (1970): Code of practice for sheet roof and wall coverings. Code of practice for sheet roof and wall coverings. Copper.Metric units.

CP 143-15 (1973): Code of practice for sheet roof and wall coverings. Code of practice for sheet roof and wall coverings. Aluminium.Metric units.

BS EN 1172 (2011): Copper and copper alloys. Sheet and strip for building purposes.

BS EN 1652 (1998): Copper and copper alloys. Plate, sheet, strip and circles for general purposes.

BS EN 1653 (1998): Copper and copper alloys. Plate, sheet, strip and circles for boilers, pressure vessels and hot water storage units.

BS EN 1654 (1998): Copper and copper alloys. Strip for springs and connectors.

BS EN 485-1 (2008+A1:2009): Aluminium and aluminium alloys. Sheet, strip and plate. Technical conditions for inspection and delivery

BS 6925 (1988): Specification for mastic asphalt for building and civil engineering (limestone aggregate):.

BS 3690-3 (1990): Bitumen for building and civil engineering. Specification for mixtures of bitumen with pitch, tar and Trinidad lake asphalt

BS EN 13658-1(2005): Metal lath and beads. Definitions, requirements and test methods. Internal plastering

BS 1494-1(1964): Specification for fixing accessories for building purposes. Fixings for sheet, roof and wall coverings.

BS 5427-1 (1996): Code of practice for the use of profiled sheet for roof and wall cladding on building. Design

BS 7371-12 (2008): Coatings on metal fasteners. Requirements for imperial fasteners

BS 4868 (1972): Specification for profiled aluminium sheet for building.

BS 4154-2 (1985): Corrugated plastics translucent sheets made from thermo-setting polyester resin (glass fibre reinforced).Specification for profiles and dimensions.

BS 3532 (1990): Method of specifying unsaturated polyester resin systems.

BS 4203-1 (1980): Extruded rigid PVC corrugated sheeting. Specification for performance requirements

BS EN 490 (2011): Concrete roofing tiles and fittings for roof covering and wall cladding. Product specifications

BS 5534 (2003+A1:2010): Code of practice for slating and tiling (including shingles)

BS 4203-2 (1980): Extruded rigid PVC corrugated sheeting. Specification for profiles and dimensions

2.1.16 METAL WORK

2.1.16.1 Materials

2.1.16.1.1 Steel

(a) Steel shall be as generally described for Structural steel. See Section 2.1.19.

2.1.16.1.2 Galvanized steel sheet and coil

(a) Hot dipped galvanized plain steel sheet and coil shall be to **BS EN 10143**.

2.1.16.1.3 Steel mesh

(a) Welded wire mesh shall be steel wire of the specified diameter welded to form a square or oblong mesh as specified and shall be hot dip galvanized after manufacture as specified.

(b) Expanded steel mesh shall be to **BS 405**.

2.1.16.1.4 Steel tubing

(a) Steel tubing shall be to **BS EN 10255:2004** "medium" grade and galvanized.

2.1.16.1.5 Slotted steel angle

(a) Slotted steel angle shall be self-finished angle to **BS 4345**. Fittings to be cadmium plated steel.

2.1.16.1.6 Cast iron

(a) Cast iron shall be grey cast iron to **BS 1561** Grade 150.

2.1.16.1.7 Aluminium alloy

(a) Aluminium alloy plate; sheet and strip shall be to **BS EN 485**, **BS EN 515**, **BS EN 573-3:2009, BS EN 573-1:2004** and **BS EN 573-5:2007**of required alloy designation.

(b) Aluminium alloy bars, extruded tube sections and hollow sections shall be to **BS EN 573-3:2009** alloy designation 6063.

(c) Aluminium sections for structural purposes shall be to **BS 1161**.

(d) Aluminium alloy drawn tubes shall be to **BS EN 515**, **BS EN 573-3:2009, BS EN 573-1:2004 and BS EN 573-5:2007** and **BS EN 754** alloy designation 6063.

2.1.16.1.8 Brass rods and sections

(a) Brass rods and sections shall be to **BS EN 12163**, **BS EN 12164**, **BS EN 12167** designation CZ 106 condition M.

2.1.16.1.9 Stainless steel

(a) Stainless steel plate, sheet and strip shall be of grade 316 or 304 to **BS EN 10029 and BS EN ISO 18286: 2010** mill finish and polish finish, or otherwise as required. Where welding is required, the steel shall be grade 316S13 or 304S11. The chemical composition of the steel as determined by cast analysis, shall comply with the following table:

	Grade 304	**Grade 316**
Chromium content	17% to 19%	16.5% to 18.5%
Nickel content	8% to 12%	10.5% to 14.5%
Carbon content	0.07% max	0.07% max
Manganese content	2% max	2% max
Molybdenum content	0%	2% to 3 %
Phosphorus content	0.045% max	0.045% max
Sulphur content	0.03%	0.03% max.
Silicon content	1% max max	1% max.

(b) Stainless steel tubes for structural and general engineering purposes shall be to **BS EN 10296**, composition and finish shall be as above.

(c) Stainless steel fasteners to follow steel grade of members shall be connected and to **BS EN 10263-1 & BS EN 10263-5**.

(d) Stainless steel anchors and inserts shall be of grade 316S31, A4 to **BS EN ISO 3506**.

2.1.16.1.10 Fixings generally

(a) Fixings generally shall be of the same material and finish as the material to be fixed.

2.1.16.1.11 Metal insert channels for concrete

(a) Concrete insert channel shall be an approved galvanised steel channel, with expanded polystyrene temporary filler. Provide matching sliding fixing devices.

2.1.16.1.12 Adhesive for metal

(a) Adhesive for bonding metal to metal shall be an approved proprietary brand.

2.1.16.2 Workmanship

2.1.16.2.1 Samples

(a) Submit samples for approval, as required.

2.1.16.2.2 Prototypes

(a) Obtain approval of prototypes before starting fabrication of repetitive components.

2.1.16.2.3 Fabricating generally

(a) During fabrication, protect all surfaces that shall be visible in the finished work.

(b) Mitre junctions of identical sections.

(c) Assemble moving parts to move freely and without binding.

(d) Remove all burrs and sharp arrises which shall be visible after fixing or a hazard to the user.

2.1.16.2.4 Welding generally

(a) Remove grease, dirt, moisture, oxide and scale from the edges to be welded.
Ensure accuracy, using clamps or jigs where practicable. Use tack welds for temporary attachment where jigs are not practicable.

(b) Joints shall be fully fused throughout with no holes, pores or cracks.

(c) Prevent weld splutter falling on self-finished surfaces visible in the completed work.

(d) Butt welds, visible in completed work, shall be ground smooth and flush and fillet welds to be ground smooth, if required.

(e) Ensure complete removal of flux residue and slag.

(f) Welding of aluminium alloy shall be by inert-gas arc welding to **BS EN 1011-4** or other method subject to approval.

(g) Welding of steel shall be by manual metal-arc we lding to **BS EN 1011-2**. Welding of stainless steel shall be by inert-gas arc welding to **BS EN 1011-3** or other method subject to approval.

2.1.16.2.5 Brazing

(a) Brazing shall be to **BS EN 14324: 2004.**

2.1.16.2.6 Metal articles

(a) Metal articles which are to be coated shall be designed in accordance with the recommendations of **BS 4479**.

2.1.16.2.7 Finishing to steel

(a) Finishes to steel shall be as follows :-

i. Bare to receive painted finish.

ii. Electroplated coating of zinc shall be to **BS EN 12329** and **BS EN ISO 2082**.

iii. Zinc sprayed coating shall be to **BS EN IS0 2063 –** nominal thickness 0.2 mm unless otherwise specified.

iv. Galvanising shall be hot-dip galvanising to **BS EN ISO 1461** with a minimum thickness of 85µm. Components shall be galvanised after fabrication, if required.

v. No zinc sprayed coated or hot-dip galvanised items shall be welded or drilled and any subsequent cutting is defined as damage which shall be subsequently made good after coating or galvanising.

vi. Make good damage to zinc coatings and galvanising, treat cut ends of galvanised sections with two coats of metallic zinc-rich priming paint to **BS 4652** Type 2.

2.1.16.2.8 Finishes to aluminium

(a) Finishes to aluminium alloy shall be as follows :-

i. Mill.

ii. Polished.

iii. Polished and treated with a protective lacquer.

(b) Clear anodised shall be to **BS EN 12373-1** and of the thickness grade and surface texture as follows:-

(c) Interior work AA/15.

(d) Exterior work AA/20.

(e) Colour anodised shall be to **BS 3987** average 25 □m thick.

(f) Approved proprietary hardcoat anodic finish with better wearing qualities than standard anodising of the required thickness.

2.1.16.2.9 Chromium plating

(a) Chromium plating shall be to **BS EN 1254**, for "service condition No. 3", with "bright", "dull" or "satin" finish.

2.1.16.2.10 Protection

(a) Protect all decorative finishes to metalwork against damp, scratching and other damage. Apply a strippable coating or masking tape to all stainless steel, anodised aluminium or similar surfaces and only remove as and when necessary for construction or just prior to inspection for handover. Remove surplus adhesive with non-damaging solvent and wash down.

2.1.16.2.11 Contact of aluminium and concrete etc.

(a) Avoid contact in the completed work between aluminium and concrete, mortar, plaster, or similar materials. Where unavoidable, paint one coat of bituminous paint on aluminium surfaces, or use approved tape.

2.1.16.2.12 Contact of dissimilar metals

(a) Avoid contact in the completed work between the following metals :-

i. Aluminium alloys with copper alloys, nickel, lead or stainless steel.

ii. Iron and steel with copper alloys.

iii. Zinc (including galvanizing) with copper alloys or nickel.

(b) Where unavoidable, coat contact surfaces with bituminous paint, protective tape or other approved means

2.1.16.2.13 Galvanized steel tubing

(a) Carefully notch, fit and weld galvanized steel tubing to produce accurate joints which shall be ground smooth and treated with two coats of zinc rich priming paint to **BS 4652** Type 2.

2.1.16.2.14 Castings

(a) Castings shall be sound free from bubbles, cracks or other defects and to include the construction of patterns and moulds as required.

2.1.16.2.15 Slotted steel angle

(a) Cut slotted steel angle square and securely bolt together using nuts bolts and washers and angle braces as necessary.

2.1.16.2.16 Fixing steel mesh

(a) Fix steel mesh at 75 mm centres as follows:-

i. To steel framing by,

- Tack welding.
- Tying with 2 mm galvanised tying wire.

ii. To wood framing with 1.8 x 25 mm galvanised staples.

2.1.16.2.17 On completion

(a) Lubricate and adjust moving components, and leave in perfect working order on completion.

2.1.16.3 Metal windows and doors

2.1.16.3.1 Steel windows and doors

(a) Steel windows and doors shall be obtained from an approved manufacturer and constructed to **BS 6510** and in accordance with the following :-

i. When fixed in position, windows and doors shall be designed to withstand a wind load calculated in accordance with the **BS 6399-2** with a minimum pressure of 3kPa and a permissible maximum deflection of 1/180th of the length of the member under consideration. Calculations shall be required to be submitted for approval.

ii. Frames shall be square and flat with mitred, welded corners and with glazing bars machine tenoned and/or welded to frames.

iii. Water bars shall be welded to the frames for the complete width of the windows or doors.

iv. When weather bars are specified, weld same to the frames for the complete width of the windows or doors.

v. Provide all slotted adjustable lugs and screws necessary for building in the windows and doors and ensure that lugs project 60 mm (minimum) beyond the metal frames.

vi. Provide loose mullions and transomes of total length to suit window or door openings together with additional 75 mm at each end for building in.

vii. Provide sufficient mastic and bolts for assembly of all composite units and assemble same at Site, including bedding mullions and transomes in mastic with all interstices completely filled.

viii. Windows and doors shall be suitable for external glazing unless otherwise specified. Provide rolled steel heavy channel section glazing beads size as specified for windows and doors, mitred at corners and fixed with galvanised mild steel flat headed countersunk screws at 225 mm centres (maximum) and tap frames to receive screws.

ix. All members shall be hot-dip galvanized or zinc sprayed as specified in Clause 2.1.25.2.2 (a) and Clause 2.1.16.2.7(iii).

x. When specified, provide an approved chloroprene rubber or polyvinyl chloride weatherstrip securely fixed into the dovetail groove in the section to provide a continuous contact between the opening casement and the fixed frame.

xi. Window and door fittings and furniture shall be approved and as follows:-

xii. Steel hinges with brass pins and welded or riveted to frames. Projecting hinges to side-hung casements where windows shall be cleaned from the inside.

xiii. All fittings including friction grip pivots, casement fasteners, spring catches, brackets, slide arms, shoes, slip bolts, cabin hooks and eyes and handles, all of manganese brass with bronze finish. All to retain the opening parts rigidly in both the open and closed positions.

xiv. Handle plates, round headed stay brackets welded to the fixed frames with interchangeable handles and stays.

xv. Windows and doors shall be hung to open as indicated and fitted with the following fittings and furniture:-

- Side-hung casement and vertically centre-hung ventilator – a two-point nose fastener or a two throw casement fastener with mild steel adjustable connecting rod and a 250 mm peg stay or bronze sliding stay, as specified.

- Projecting casement - bronze sliding shoes, pivots and friction side arms and one spring catch with ring for hand or pole operation and two square-shank barrel bolts.

- Top-hung ventilator - 200 mm peg stay with round-headed stay bracket welded to the fixed frame and with a second peg to secure the stay firmly and horizontally against the first peg when the ventilator is closed.

- Bottom-hung ventilator - a spring catch and fanlight roller stay to limit opening and to permit the ventilator to swing free for cleaning.

- Horizontally centre-hung ventilator with a spring catch, with ring and eye for cord or pole operation.

- Doors - sliding bolts of suitable length, striking plates at top and bottom, cabin hooks and eyes of suitable length, three-lever mortice lock with two

keys, lever handles and escutcheon plates, as specified.

xvi. When specified, provide extruded aluminium flyscreens having plastic covered fibre -glass mosquito gauze with 7 x 7 mesh per 10 mm square.

xvii. Where flyscreens are provided, side hung casements shall have a locking handle and an opening and closing mechanism consisting of a bronze cam handle and bronze roto operator, and top hung casements to have bronze "through-the-frame" type stays.

xviii. When specified, high openable windows in inaccessible locations shall be fitted with remote control gear.

xix. Provide temporary steel clamps at the top and bottom of all opening lights of casements prior to transportation from factory till fixed in position.

xx. Paint surfaces: as specified in Section 2.1.17.11. Metal windows and doors shall be delivered to site unprimed.

2.1.16.3.2 Aluminium windows and doors

(b) Aluminium windows and doors shall be obtained from an approved manufacturer and constructed in accordance with the following: -

i. When fixed in position, windows and doors shall be designed to withstand a wind load calculated in accordance with the **BS 6399-2** with a minimum pressure of 3 kPa and a permissible maximum deflection of 1/180th of the length of the member under consideration. Where necessary use mild steel cores, anchors, brackets, etc. as stiffeners. Calculations shall be required to be submitted for approval. Cores, anchors and brackets etc. shall be finished to Clause 2.1.16.3.2 (xvi)

ii. Sections shall be extruded aluminium alloy to **BS EN 485**, **BS EN 515,BS EN 573-3:2009, BS EN 573-1:2004 and BS EN 573-5:2007** British alloy designation 6063 with a minimum wall thickness of 2.0 mm and dovetail grooved for weatherstrip.

iii. Aluminium sections shall be as follows:-

Clear anodised to **BS EN 12373-1** AA/20.

Colour anodised to **BS 3987** average 25ɑm thick.

Approved proprietary hardcoat anodic finish with better wearing qualities than the above.

iv. Frames shall be mechanically jointed of mortice and tenon construction to provide rigid and secure connections. Mechanically joint and mitre sash members to develop the full strength of members using solid block angle pieces and provide a neat weather-tight joint. Provide adequate drainage in bottom members.

v. Provide galvanized steel fixing lugs spaced at 300 mm centres (maximum) for outer frames of each unit. Where specified, fix lugs with rag bolts or approved proprietary stud anchors fixing bolts.

vi. Provide water bars of galvanized steel for the complete width of the windows or doors where the design of the window requires.

vii. Assemble all composite units at Site, including provision of all necessary bolts, screws etc. and sealing all joints with an approved sealant.

viii. Unless otherwise specified, provide an approved chloroprene rubber, polyvinyl chloride or nylon pile weatherstrip securely fixed into the dovetailed groove in the window or door sections to provide a continuous contact between each opening part and its fixed frame.

ix. Windows and doors shall be suitable for internal glazing unless otherwise specified. Provide an approved glazing system and aluminium beads. Securely clip beads to the frame or use beads which shall be an integral part of the frame.

x. Use aluminium alloy, stainless steel or nylon for all exposed fixings including screws, nuts, bolts, washers and rivets and match up with finish where possible. Use galvanized on cadmium-plated steel for all concealed fastening devices.

xi. Window and Door fittings and furniture shall be approved and as follows:-

1. Friction pivots and sliding stays - stainless steel. To provide a maximum opening of 100 degree and a minimum clearance of 100 mm between frame and window for cleaning purposes.

2. Casement fasteners, locking handles, spring catches, casement stays, brackets, slip bolts and the like:-

   - diecast zinc alloy to **BS EN 1774** suitably coloured to match the anodised window or door metal.

   - Moulded stainless steel with satin finish.

3. Locks cadmium plated steel with stainless steel or brass shoots etc.

4. Pull handles anodized aluminium.

5. Rollers, guides etc. cadmium plated steel with nylon or brass rollers to suit weight of door or window. To be adjustable after installation.

xii. Remote control gear shall be hand operated shaft and lever or conduit and cable remote control system with bronze or diecast zinc alloy bevel gear boxes, adjustable arms and keyed shafts.

xiii. Windows and doors shall be hung to open as indicated and fitted with the following fittings and furniture:-

xiv. Side and top hung windows - Friction pivots and sliding stays and casement fastener (dual if necessary) or pull handle and locking handle (dual if necessary).

xv. When flyscreens are specified, they shall be located on the inside.
The frames shall be extruded aluminium with plastic covered mosquito gauze of 7 x 7 mesh per 10 mm square. Screens shall be fixed to window frames by turn buckles. The windows shall be fitted with locking handles and an opening and closing mechanism comprising cam handles and roto operator.

xvi. Prime with zinc chromate primer and paint two coats of bituminous paint on all

steel framework, cores, anchors and brackets.

xvii. Paint one coat of bituminous paint on concealed aluminium or stainless steel surfaces which may come into contact with wet mortar, cement, plaster or similar materials.

xviii. Apply a strippable coating or masking tape to all exposed aluminium or stainless steel surfaces. (NOTE: The anodised surface may be permanently damaged by contact with wet cement and plaster) Wrap all window and door units and other associated materials in stout waterproof paper or polythene to protect against damp and scratching and do not make premature delivery to Site.

xix. Return to site on completion of building work, carefully remove protective coating and leave clean.

2.1.16.3.3 Fixing metal windows and doors

(a) When fixing metal windows and doors :-

i. Avoid distortion during handling and storage.

ii. Ensure tightness and clearance between sash and frame of all opening lights which shall be fixed until glazed.

iii. Avoid having construction access through window openings and/or placing scaffolding, boards etc. directly onto the window frames. If window openings must be used, then window frames at that opening location shall not be fixed until after completion of the related internal works and the through-route is no longer required.

iv. Assemble composite units including the provision of all necessary bolts screws etc. and seal joints with an approved one pack gun type polysulphide sealant to **BS EN ISO 11600**.

v. Position, plumb, level and square.

vi. Form pockets in heads, jambs, cills etc. to receive fixing lugs, build in lugs and made good and screw to frames or plug and screw frames using packing pieces where necessary. Do not distort frames when tightening fixings.

vii. Bed steel frames in mortar as used for adjacent work, leaving no gaps.

viii. Bed aluminium frames in butyl mastic bedding compound, leaving no gaps.

ix. Rake out the joints around external edge of steel window and door frames to the approval of the Engineer and point with an approved oil based mastic sealant to form a smooth, flat joint. Remove excess sealant from adjoining surfaces and leave clean. Mask adjoining surfaces which would be impossible to clean if smeared with sealant.

x. Rake out the joints around external edge of aluminium window and door frames to the approval of the Engineer and point with an approved one-pack gun type polysulphide sealant to **BS EN ISO 11600**, sealant to form smooth, flat joint. Remove excess sealant from adjoining surfaces and leave clean. Mask adjoining surfaces which would be impossible to clean if smeared with sealant.

xi. Avoid contact with concrete, mortar, plaster, or similar materials.

2.1.16.3.4 Adjustable steel louvre frames

(a) Fixed louvres and frames shall be all hot-dip galvanized unless permitted otherwise by the Engineer. Adjustable metal louvre frames and weatherstrips shall be obtained from an approved supplier and constructed in accordance with the following :-

i. Frames and clips shall be of 1.2 and 0.9 mm (minimum) steel sheet respectively. Clips shall be suitable for receiving 100, 150 or 230 mm wide and 6 mm thick glass blades, as required. Aluminium frames and aluminium or plastic clips may be supplied subject to approval.

ii. Frames shall be designed for hand or pole operation, as required, with single control and to automatically lock when closed.

iii. Weatherstrips shall be shaped metal strips of an approved design and thickness.

iv. Steel frames, clips and weatherstrips shall be hot-dip galvanized or electro-zinc plated on all surfaces prior to assembly.

v. Where specified, provide 45 x 10 mm galvanized steel sub-frames for single side louvre frames, with necessary slotted adjustable lugs and screws for building in.

vi. Provide matching rustless screws, bolts and spacers etc. for coupling adjacent frames to form mullions, where required.

vii. Provide samples and obtain approval.

(b) State manufacturer's name and country of origin.

(c) Fix adjustable steel louvre frames as follows :-

i. Avoid distortion during handling and storage.

ii. Position plumb, level and square.

iii. Where required, form pockets to receive fixing lugs, build in lugs and
iv. screw to sub-frames or plug and screw sub-frames using packing pieces where necessary.

v. Bed sub-frames in mortar as used for adjacent work, leaving no gaps.

vi. Where required, screw single side louvre frames to sub-frames at 225mm centres. Do not distort frames when tightening fixings.

vii. Where required, plug and screw louvre frames and weather strips.

2.1.16.3.5 Roller shutters and doors

(a) The design of roller shutters and doors, including boxes, hoods, guides and all other parts shall be carried out by the Contractor in accordance with the requirements stated in the Contract.

(b) The following particulars of the proposed materials and methods of construction for metal windows and doors shall be submitted to the Engineer:

- name and address of manufacturer,

- manufacturer's literature, and
- tree sets of working drawings.
- The particulars shall be submitted to the Engineer at least 14 days before fabrication of the window or door starts.

(c) Samples of materials for metal windows and doors, including fittings and furniture, shall be submitted to the Engineer at the same time as particulars of the windows or doors are submitted. Details of the samples to be provided shall be as agreed by the Engineer.

(d) Two copies of instruction manuals shall be provided for motorised roller shutters and doors. The manuals shall include detailed operating and maintenance instructions, including wiring and schematic drawings, a schedule of component parts and a priced list of recommended spares. The manuals shall be provided at the same time as the particulars of the roller shutters and doors are submitted.

2.1.16.3.6 Vehicle access doors

(a) Vehicle access doors to be sectional, electrically operated overhead doors, Plastisol HP200 colour coated externally. Colour – Grey.

i. The door leaf shall be constructed from individually hinged composite panels in 600 mm high sections. The panel shall be galvanized steel inner and outer face infilled with high density polyurethane foam.

ii. Sizes shall be as indicated on the drawings.

iii. All doors shall be complete with draught/weather seals all round and cable breakage systems.

iv. All doors to be complete with external locking system and internal shoot bolt. Hardware to be galvanised steel withy nylon track rollers.

v. A single row of double glazed, acrylic vision panels 600mm high shall be provided where indicated.

(b) Submittals

i. Product Data: Submit manufacturer's product data, roughing-in diagrams, and installation instructions for each type and size of overhead coiling door. Provide operating instructions and maintenance information, inclusive of parts lists.

ii. Shop Drawings: Submit shop drawings for special components and installations which are not fully dimensioned or detailed on manufacturers data sheets.

iii. Guarantee: Submit copies of a written guarantee, signed by the Manufacturer agreeing to repair or replace all component parts of the doors which have shown defects or failure of manufactured product, shall be rectified without cost to the Employer for a period of 1 year from the date of acceptance of the project.

(c) Quality assurance

i. Furnish each overhead coiling door as a complete unit produced by one manufacturer, including hardware, accessories, mounting and installation

components.

ii. Each overhead coiling door shall be provided in place and in full operative condition by an Installer trained in the type of installation required.

iii. Inserts and Anchorages: Furnish inserts and anchoring devices which must be set in concrete or built into masonry for installation of units. Provide setting drawings, templates, instructions and directions for installation of anchorage devices. Coordinate delivery with other work to avoid delay.

iv. See concrete and masonry sections of these specifications for installation of inserts and anchorage devices.

(d) Product handling

i. Deliver doors and accessories completely identified for installation procedure. Use care in handling to prevent damage. Store all equipment clear of grade and protected from damage and deterioration.

(e) Products

i. Manufacturer: The drawings and specifications indicate the minimum clearances and performance requirements of the following product lines (Basis of Design) manufactured by **Kaba Door Systems**, other products and manufacturers will be considered subject to the acceptance of the Engineer.

ii. Door Curtain: Fabricate overhead coiling door curtain of interlocking slats designed to withstand required wind loading, of continuous length for width of door without splices. Unless otherwise indicated, provide slats of material thickness recommended by door manufacturer for performance, size, and type of door indicated, and as follows:

iii. Steel Counter Door Curtain Slats: Structural quality, cold-rolled galvanized steel sheets complying with **ASTM A653/A653M** with G90 zinc coating, and phosphate treated before fabrication.

- Furnish manufacturers standard F-128 "flat face" slats
- Slat Thickness: Not less than 0.7 mm thick.

iv. Endlocks: Malleable iron castings galvanized after fabrication, secured to curtain slats with galvanized rivets. Provide locks on alternate curtain slats for curtain alignment and resistance against lateral movement.

v. Bottom Bar for Counter Door: Consisting of 1 angle, galvanized.

vi. Curtain Jamb Guides for Counter Door: Fabricate curtain jamb guides of extruded aluminum box type with sufficient depth and strength to retain curtain loading.

vii. Locking Mechanism: Provide manufacturer's standard cylinder locking mechanism, operable from inside only, to provide positive locking of doors.

viii. Counterbalance doors by means of adjustable steel helical torsion spring, mounted around a steel shaft and mounted in a spring barrel and connected to door curtain with required barrel rings. Use grease-sealed bearings or self-lubricating graphite bearings for rotating members.

ix. Counterbalance Barrel: Fabricate spring barrel of hot-formed structural quality carbon steel, welded or seamless pipe, of sufficient diameter and wall thickness to support roll-up of curtain without distortion of slats and limit barrel deflection to not more than 0.8 mm per 300 mm of span under full load.

x. Provide spring balance of one or more oil-tempered, heat-treated steel helical torsion springs. Size springs to counterbalance weight of curtain, with uniform adjustment accessible from outside barrel. Provide cast steel barrel plugs to secure ends of springs to barrel and shaft.

xi. Provide extended life (100,000 cycle) springs for all doors.

xii. Fabricate torsion rod for counterbalance shaft of case-hardened steel, of required size to hold fixed spring ends and carry torsional load.

xiii. Provide extra heavy duty shaft and bearings at all doors.

xiv. Brackets: Fabricate brackets of minimum 4.76 mm thick steel plate with sufficient depth and strength to support counterbalance, curtain and hood, galvanized after fabrication. Secure to wall framing as recommended by door manufacturer.

xv. Hood: Form to entirely enclose coiled curtain and operating mechanism at opening head. Contour to suit end brackets to which hood is attached. Roll and reinforce top and bottom edges for stiffness. Provide closed ends for surface-mounted hoods, and any portion of between-jamb mounting projecting beyond wall face. Provide intermediate support brackets as required to prevent sag.

xvi. Fabricate steel hoods for doors of not less than 0.5 mm thick hot-dip galvanized steel sheet with G 90 zinc coating, complying with **ASTM A653/A653M**. Phosphate treat before fabrication.

xvii. Shop clean and prime ferrous metal and galvanized surfaces, exposed and unexposed, except faying and lubricated surfaces, with door manufacturer's standard rust inhibitive primer.

(f) Execution

i. Do not begin installation until openings have been properly prepared.

ii. Verify wall openings are ready to receive work and opening dimensions and tolerances are within specified limits.

iii. Verify electric power is available and of correct characteristics.

iv. If preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

v. Clean surfaces thoroughly prior to installation. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

vi. Install door and operating equipment complete with necessary hardware, jamb and head mold strips, anchors, inserts, hangers, and equipment supports in accordance with final shop drawings, manufacturer's instructions, and as specified herein.

vii. Coordinate installation with adjacent work to ensure proper clearances and allow for maintenance.

viii. Anchor assembly to wall construction and building framing without distortion or stress.

ix. Securely brace door tracks suspended from structure. Secure tracks to structural members only.

x. Fit and align door assembly including hardware.

xi. Coordinate installation of electrical service. Complete power and control wiring from disconnect to unit components.

xii. Upon completion of installation including work by other trades, lubricate, test and adjust doors to operate easily, free from warp, twist or distortion and fitting weathertight for entire perimeter.

(g) Protection

i. Do not permit construction traffic through overhead door openings after adjustment and cleaning.

ii. Protect installed products until completion of project.

iii. Touch-up, damaged coatings and finishes and repair minor damage before Practical Completion.

2.1.16.3.7 Sound reduction

(a) Sound reduction performance reqirements for doorsets between a noise source and a sensitive area shall be as follows:

Adjacency Mean	**Sound Level Difference**
Normal Offices	N/A
Private Offices	30 - 35 dB

Element	**Maximum (MSLD)**
Standard Door	25 - 30 dB
Up rated door with seals	30 - 35 dB
Up rated door with seals	35 - 40 dB

Space	**Desired (MSLD)**
Meeting Rooms, Offices	35 dB
Toilet & Shower facilities	35 dB
Food prep facilities	28 dB
Reception spaces	28 dB
Office Corridors	28 dB
Workshops/ Stores	28 dB

2.1.16.4 References and Standards

BS EN 10143 (2006): Continously hot-dip metal coated steel sheet and strip. Tolerances on dimensions and shape.

BS 405 (1987): Specification for uncoated expanded metal carbon steel sheets for general purposes.

BS EN 10255 (2004): Non-alloy steel tubes suitable for welding and threading. Technical delivery conditions

BS 4345 (1968): Specification for slotted angles.

BS 1561(1966): Specification for silver anodes and silver salts for electroplating.

BS EN 485-1 (2008+A: 2009): Aluminium and aluminium alloys. Sheet, strip and plate. Technical conditions for inspection and delivery.

BS 4479 (1990): Design of articles that are to be coated.

BS EN 12329 (2000): Corrosion protection of metals. Electrodeposited coatings of zinc with supplementary treatment on iron or steel.

BS EN ISO 2082 (2008): Metallic coatings.Electroplated coatings of cadmium with supplementary treatments on iron or steel.

BS EN ISO 1461 (2009): Hot dipped galvanised coatings on fabricated iron and stell articles. Specifications and test methods.

BS 4652 (1995): Specification for zinc-rich priming paint (organic media).

BS 1474 (1987): Specification for wrought aluminium and aluminium alloys for general engineering purposes: bars, extruded round tubes and sections.

BS 1161 (1977): Specifiication for aluminium alloy sections for structural purposes.

BS EN ISO 7599 (2010): Anodizing of aluminium and its alloys. General specifications for anodic oxidation coatings on aluminium

BS 3987 (1991): Specification for anodic coatings on wrought aluminium for external architectural applications.

BS EN ISO 1456 (2009): Metallic and other inorganic coatings. Electrodeposited coatings of nickel, nickel plus chromium, copper plus nickel and of copper plus nickel plus chromium

BS 6510 (2010): Steel-framed windows and glazed doors.Specification

BS EN 10029 (2010): Hot-rolled steel plates 3 mm thick or above. Tolerances on dimensions and shape

BS EN 10296-1 (2003): Welded circular steel tubes for mechanical and general engineering purposes. Technical delivery conditions. Non-alloy and alloy steel tubes

BS EN 10263-1(2001): Steel rod, bars and wire for cold heading and cold extrusion. General technical delivery conditions

BS EN 10263-5 (2001): Steel rod, bars and wire for cold heading and cold extrusion. Technical delivery conditions for stainless steels

BS EN ISO 3506 (2009): Mechanical properties of corrosion-resistant stainless steel fasteners.

BS EN 1011-1(2009): Welding. Recommendations for welding of metallic materials. General guidance for arc welding

BS EN 1011-2 (2001): Welding. Recommendations for welding of metallic materials. Arc welding of ferritic steels

BS EN 1011-3 (2000): Welding. Recommendations for welding of metallic materials. Arc welding of stainless steels

BS EN 1011-4 (2000): Welding. Recommendations for welding of metallic materials. Arc welding of aluminium and aluminium alloys

BS EN ISO 11600 (2003+A1:2011): Building construction. Jointing products. Classification and requirements for sealants

BS EN 515 (1993): Aluminium and aluminium alloys. Wrought products. Temper designations.

BS EN 573-3 (2009): Aluminium and aluminium alloys. Chemical composition and form of wrought products. Chemical composition and form of products

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BS EN 12163 (2011): Copper and copper alloys. Rod for general purposes.

BS EN 12164 (2011): Copper and copper alloys. Rod for free machining purposes.

BS EN 1774 (1997): Zinc and zinc alloys. Alloys for foundry purposes. Ingot and liquid

BS EN ISO 2063 (2005): Thermal spraying. Metallic and other inorganic coatings. Zinc, aluminium and their alloys

BS EN 754 (2008): Aluminium and aluminium alloys. Cold drawn rod/bar and tube.

BS EN 1991-1-4 (2005+A1:2010): Eurocode 1. Actions on structures. General actions. Wind actions

ASTM A653/A653M- 11 (2011): Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process

BS EN 573-1 (2004): Aluminium and aluminium alloys. Chemical composition and form of wrought products. Numerical designation system

BS EN 573-5 (2007): Aluminium and aluminium alloys. Chemical composition and form of wrought products. Codification of standardized wrought products

BS EN 12167 (2011): Copper and copper alloys. Profiles and bars for general purposes

BS EN ISO 18286 (2010): Hot-rolled stainless steel plates. Tolerances on dimensions and shape

BS EN 14324 (2004): Brazing. Guidance on the application of brazed joints

2.1.17 BS EN ISO 2081 (2008): Metallic and other inorganic coatings. Electroplated coatings of zinc with supplementary treatments on iron or steelFINISHES

2.1.17.1 Materials

2.1.17.1.1 Materials

(a) Ordinary Portland Cement shall be to **BS EN 197-1:2000**

(b) Water shall be as of Clause 2.1.1.19

(c) Sand for mixes not incorporating lime shall be clean hard durable crushed rock or clean sand free from salt to conform to the grading limits set out in Table 2.1.17.1

Table 2.1.17.1

Grading

B.S. Sieve	Percentage by weight passing B.S. Sieve
5.00 mm	100
2.36 mm	90 - 100
1.18 mm	70 - 100
0.60 mm	40 - 80
0.30 mm	5 - 40
0.15 mm	5 - 40

(d) Sand for mixes incorporating lime shall be clean natural sand free from salt to conform to the
grading limits set out in the Table 2.1.17.2

Table 2.1.17.2

Grading

B.S. Sieve	Percentage by weight passing B.S. Sieve
2.36 mm	100
1.18 mm	90 - 100
0.60 mm	55 - 100
0.30 mm	5 - 50
0.15 mm	0 - 10

(e) Lime shall be hydrated lime to **BS EN 459**, delivered in sealed bags bearing the manufacturer's name or brand.

(f) Lime putty shall be prepared as **PD CEN/TR 15123, BS 8481 & BS EN 13914-2** by adding hydrated lime to water, and mix to a thick, creamy consistency. Leave undisturbed for 16 hours (minimum) before use.

(g) Pigments for colouring cement and concrete shall comply with **BS EN 12878,**.

(h) Accelerators, retarders, normal water-reducing admixtures and combinations of these shall comply with **BS EN 480 (1-12)**.

(i) Bonding agent shall be compatible with background and finish, designated to be suitable for internal or external use and shall be an approved proprietary brand.

(j) The approved proprietary bonding agent shall be used in strict accordance with the manufacturer's technical specifications and recommendations, including and not limited to the valid shelf life of the product. The expiry date shall be clearly indicated with label and stamp for necessary inspection by the Engineer.

2.1.17.2 Workmanship

2.1.17.2.1 Generally

(a) Mix mortar or plaster shall be as Clause 2.1.9.2.7 (g)

(b) Provide sample panels of approximately 2 m^2 for textured or coloured finishes and tile or slab finishes including pointing and obtain approval before starting work. Apply these finishes to sample areas of the work as directed.

(c) Protect existing work with boards, dust sheets, and the like. Droppings on finished work shall be cleaned off immediately.

(d) Keep plant and tools clean and free of traces from previous mixes.

(e) Do not use mechanical coating methods of application without approval.

(f) Hack off extraneous concrete projections and fins.

(g) Remove efflorescence, laitance, oil, grease, all traces of release agents, dirt, and loose material by dry brushing or scraping.

(h) Protect surfaces from weather and ensure that they are completely compatible with the finish to be applied before starting work.

(i) At junctions between dissimilar solid backgrounds in the same plane which are to receive the same applied finish, fix a strip of steel galvanized lathing as Clause 2.1.17.3.1 (a) extending 150 mm (minimum) in width each side of the junction, nailed with 40 mm nails or stapled to plugs at 100 mm centres on both edges.

(j) Clean all laitance, dust, oil or any other such substances from the concrete surface.

(k) Spatterdash to consist of (1:2) cement : coarse sand with an approved bonding agent such as a styrene-butadiene rubber (SBR) latex, an ethyl vinyl acetate (EVA) emulsion or an acrylic emulsion.

(l) Apply spatterdash to concrete vertical surfaces and soffits within 48 hours after striking formwork.

(m) The mixture shall be applied by dashing it on the wall by a hand scoop or a trowel to give a complete coverage with a rough texture not exceeding 5 mm thickness. The surface shall be maintained moist for 24 hours.

(n) Allow to cure and harden for at least two days before applying rendering / bedding screed.

2.1.17.2.2 Preparation of hardened or existing concrete

(a) Where finish or screed shall be bonded to hardened or existing concrete wall or base:-

i. Shortly before applying finish or screed, thoroughly hack concrete to remove laitance and expose coarse aggregate.

ii. Thoroughly clean and wet surface before applying finish or screed and remove surplus water.

iii. Brush neat cement slurry into damp surface immediately before applying finish or screed, or Apply approved proprietary bonding agent in accordance with the manufacturer's recommendations.

2.1.17.2.3 Preparation of base for monolithic finish

(a) Where finish or screed shall be laid monolithically on concrete base:-

i. Spray surface with water and brush with a stiff broom whilst concrete is green to remove laitance and loose aggregate.

ii. Lay finish or screed within 3 hours of laying base.

2.1.17.2.4 Surface finishes

(a) Surface finishes shall be either:-

i. Smooth finish :- finish with a steel trowel or power float to a smooth surface, free from blemishes.

ii. Wood float finish :- finish with a dry wood float to give an even overall surface.

iii. Textured finish :- finish by stippling, scraping or other means to produce an approved textured surface.

iv. Rough cast finish :- throw onto the undercoat a wet mix of aggregate and cementitious material.

v. Machine applied textured finish :- apply in accordance with the manufacturer's recommendations.

2.1.17.2.5 Accuracy for wall and ceiling finishes

(a) Finish wall and ceiling finishes to a true plane and to correct line and level. Maximum deviation permitted in surfaces shall be 3 mm from a 1800 mm straight edge. Angles and corners shall be right angles unless otherwise required, with walls and reveals plumb and square.

(b) Prevent excessively rapid or localised drying out of wall and ceiling finishes by an approved means.

2.1.17.2.6 Curing of floor finishes

(a) Immediately after laying, protect surface of floor screeds or in-situ finishes from wind and sunlight.

(b) Cover surface, as soon as it is sufficiently hardened, with canvas, waterproof sheeting, mats, or a 50 mm layer of damp sand. Unless otherwise agreed by the Engineer, keep covered for 4 days.

2.1.17.2.7 Movement joints

(a) Movement joints shall be constructed at a maximum 4m centres in each joints direction equally spaced as directed by the Engineer to accord with dimensioned requirements.

2.1.17.2.8 Protection

(a) Protect screeds from wear and other damage until the floor finish is laid. Protect all finishes from discolouration or damage until completion.

2.1.17.3 Plastering and Rendering

2.1.17.3.1 Materials

(a) Steel lathing shall be to **BS EN 13658-1** from an approved manufacturer:-

i. Plain expanded type of 6 mm short way mesh coated with tight coat galvanising and weighing not less than 1.6 kg/m^2

ii. Ribbed expanded type similarly coated and weighing not less than 2.25 kg/m^2.

(b) Galvanised steel corner beads, plaster stops and mo vement joint beads shall have expanded metal wings and be from an approved manufacturer.

(c) Plastic corner beads shall be used if approved by the Engineer.

(d) Wire netting shall be to **BS EN 10223-2**, of 0.9 mm galvanised wire and 50 mm mesh.

(e) Staples to be galvanised steel wire staples.

(f) Tying wire shall be 1.25 mm annealed steel wire, galvanised to **BS EN 10244** .

(g) Gypsum plaster shall be Retarded hemihydrate gypsum plaster to **BS 13279-1 & 2**, Class B of the following types:-

Undercoat Plaster

Type a - 1 Browning plaster
2 Metal lathing plaster

Final Coat Plaster
Type b - 1 Finish plaster
2 Board finish plaster

(h) Gypsum plaster shall be delivered in sealed containers. Store in weather tight structures with a raised floor. Store different types of consignments separately, and use in the order of their delivery.

(i) Plasterboard shall be to **BS EN 520:2004+A1:2009**, "gypsum lath" or "gypsum baseboard" with square edges.

(j) Nails for "lath" or "baseboard"shall be 30 x 2.6 mm plasterboard galvanized steel nails, jagged shank type to **BS 1202:Part 1**.

i. 30 x 2.65 mm for plasterboard not exceeding 12.7 mm thick

ii. 40 x 2.65 mm for plasterboard 19 mm thick

(k) Reinforcement for joints in plasterboard shall be jute scrim cloth not less than 90 mm wide.

(l) Carry plasterboard on edge. Stack plasterboard flat on level surface, properly supported to prevent sagging or bending of boards off the ground and inside a building. Keep plasterboard dry, prevent mould growth, and programme deliveries to ensure that storage periods on site are kept to a minimum during periods of high humidity.

(m) Acoustic plaster shall be an approved proprietary brand free from asbestos, mixed and applied in accordance with manufacture's recommendations.

(n) Stone chippings for exposed aggregate rendering shall be granite, white stone or marble chippings, graded from 3 to 5 mm, and free from dust.

(o) Resin, epoxy, urethane and acrylic based decorative finishes shall be approved proprietary products applied by approved specialist contractors.

2.1.17.3.2 Workmanship

(a) Plastering and rendering generally shall be in accordance with **BS PD CEN/TR 15123, BS 8481 & BS EN 13914-2** and **BS EN 13914-1:2005** respectively**.**

(b) Dub out if necessary to correct any inaccuracies, in layers 10 mm (maximum) thick in same mix as the first coat. Allow to dry out before the next coat is applied. Total thickness of dubbing out or levelling shall not exceed 25 mm. Cross scratch each coat to provide key.

(c) Fix steel lathing as follows:-

i. Fix taut with the largest dimension of mesh running perpendicular to direction of supports.

ii. Apply one coat of bituminous paint to cut ends.

iii. Fix at 100 mm centres to wood with staples, to brickwork or concrete and to steelwork with tying wire at 75 mm centres.

iv. Lap 25 mm (minimum) generally, and 50 mm where end laps occur between supports. Secure laps with tying wire at 75 mm centres.

(d) Plasterboard fixing generally shall be to **BS 8212**.

Fix plasterboard to wood bearers as follows:-

i. Nail boards at each support, at 150 mm centres working out from the centres of the board, and 15 mm (minimum) from edges.

ii. Provide gap of 3 to 5 mm between edges.

(e) Treat joints, etc. in plasterboard as follows:-

i. Fill all joints, nail holes and other imperfections with board finish plaster.

ii. Press strips of joint reinforcement into the plaster, trowel flat and allow the plaster to set, but not dry out before general plastering commences.

(f) Allow 3 days for undercoats to dry out thoroughly before applying next coat. Cross scratch undercoats to provide key for next coat.

(g) Apply cement rendering consisting of cement and sand 1:3 with surface finish required as follows:-

i. Rendering not exceeding 10 mm thick in one coat.

ii. Rendering exceeding 10 mm thick in two coats, with finishing coat 5 mm thick.

(h) Apply external rendering to spatterdashed surfaces consisting of cement and sand in two coats as follows:-

i. Undercoat 10 mm (minimum) thick --- mix 1:3

ii. Finishing coat 10 mm (maximum) thick --- mix 1:3, with textured finish. Total thickness of spatterdash & external rendering shall not exceed 20 mm.

Undercoat shall be thoroughly dry before application of the finishing coat.

Pulverised Fly Ash (PFA) shall not be used for external rendering.

(i) Apply internal lime plaster in two coats on solid backgrounds as follows:-

i. Undercoat shall be 1:3 cement : sand mix

ii. Finishing coats use lime plaster gauged (cement:lime: sand 1:2:6) with not more than 25% by volume of lime putty. Addition of paper-pulp is not allowed.

iii. Thickness of undercoat shall not exceed 10 mm to walls and 5 mm to soffits.

iv. Thickness of finishing coat to walls and soffits shall be at least 3 mm.

v. The drying out time for undercoats before the application of finishing coats shall be as specified in the Clause 2.1.17.3.2 (f).

vi. Metal plaster corner beads and stops shall be provided where specified shall be followed as Clause 2.1.17.3.2 (o).

Total thickness of plaster shall not exceed 15 mm to walls and 10 mm to soffit.

Pulverised Fly Ash (PFA) shall not be used for internal plastering.

(j) Apply internal lime plaster in three coats on steel lathing as follows:-

i. First and second coats, consisting of cement, lime and sand 1:2:6.

ii. Finishing coat shall be as Clause 2.1.17.3.2 (a) and (b).

Total thickness of plaster shall not exceed 13 mm measured from the outer face of the lathing.

(k) Apply gypsum plaster generally in two coats as follows:-

i. First coat consisting of Browning plaster and sand 1:2 or cement and sand 1:3.

ii. Finishing coat of neat finish plaster, or finish plaster with up to 25% of lime putty added, with smooth finish 5 mm max.

Total thickness of plaster shall not exceed 15 mm.

If approved by the Engineer, proprietary gypsum plaster can be used in strict accordance with the manufacturer's technical specifications and recommendations.

Where specified, bonding agents for use with gypsum plaster shall be as **BS 5270:Part 1**.

(l) Apply gypsum plaster in three coats on steel lathing as follows:-

i. First coat consisting of metal lathing plaster and sand 1:1.5.

ii. Second and finishing coats - as for first coat and finishing coat as Clause 2.1.17.3.2 (k) (i)-(ii)

Total thickness of plaster shall not exceed 13 mm measured from the outer face of the lathing.

(m) Apply gypsum plaster as one finishing coat 5 mm (maximum) thick on plasterboard trowelled to a smooth surface using as little water as possible.

(n) Arrises shall be square or pencil rounded, as required.

(o) Metal beads for internal plastering and dry lining shall be to **BS EN 13658-1(2005).**

Provide and fix metal corner beads, plaster stops and movement joints when specified including nailing, stapling or fixing with plaster dabs and trowel the finishing coat flush with the bead.

(p) Coved or moulded cornices shall be either:-

i. Formed with a backing of cement and sand 1:3 with finishing coat of same plaster used for adjacent surfaces, finished with a steel template to a smooth finish.

ii. Preformed cornices from an approved manufacturer fixed in accordance with manufacturer's recommendations.

(q) Apply exposed aggregate rendering in two coats as follows:-

i. First coat 10 mm thick, consisting of cement and sand 1:3.

ii. Finishing coat 10 mm thick, consisting of cement and stone chippings 1:1, with the chippings mixed in one of the proportions shown in Table 2.1.17.3. Before the finishing coat has set, scrub off the surface to expose the aggregate.

Table 2.1.17.3

Proportions of Chippings

Colour	Cement	Stone Chippings Dark Grey/Light Grey/White			Marble Chippings Black/White	
Dark	Ordinary	70	-	20	10	-

Medium	White	60	20	20	-	20
White	White	-	-	-	-	100

(r) Mix and apply acoustic plaster by special spray equipment in accordance with the manufacturer's recommendations to the thickness and number of coats specified.

2.1.17.4 Premixed Plaster

2.1.17.4.1 Materials

(a) Premixed plaster shall be factory-produced by weighted combination of plaster raw materials and chemicals and supplied to sites in bags. Mixing with clean water shall be required before application.

(b) There are two types of premixed plaster, cement based and gypsum based. Gypsum based is for internal use only.

(c) Cement based plaster contains mineral filler material as aggregate and portland cement as main binder, with additives for improved compressive strength and reduced shrinkage.

(d) Gypsum based plaster contains pre-mixed minerals; gypsum base rendering materials and additives which could be applied in one single thick application without cracking and separation from the substrate.

(e) The premixed plaster shall comply with **BS EN 13914-1:2005**, **PD CEN/TR 15123, BS 8481 & BS EN 13914-2** and **BS EN 13279-1 & 2**. The premixed plaster manufacturing company shall have acquired ISO certification in their manufacturing process of the premixed plaster product.

2.1.17.4.2 Workmanship

(a) Premixed plaster and clean water shall be mixed on site with portable electrical mixer or other equipment according to manufacturer's recommendations. Accurate amount of water shall be used to ensure effective mixing and consistent quality.

(b) Bagged premix mortar shall be stored separately by types, off the ground in dry, well-ventilated and covered space. Use in order of delivery and within manufacturer recommended time limit.

(c) Tolerance of evenness of substrate shall be 5 mm for internal concrete.Tolerance of wall, block wall and beams, and 3 mm for internal ceiling soffit.

(d) Substrate shall be clean; free from dust, contamination, paint, oil and loose scale. Dampen dry substrate before plastering.

(e) Premixed plaster may require the substrate to be treated with spatterdash or to be keyed before application depending on manufacturer's recommendations.

(f) Do not use mixes after initial set has taken place and do not re-temper or reconstitute mixes unless permitted by the manufacturer's instructions.

(g) Premixed plaster shall be carried out by experienced applicators. All the workers and supervisory staff employed for the work shall be fully instructed and trained on the

method of preparation and application in accordance with the manufacturer's recommendations.

(h) Cement based premixed plaster shall be applied with trowel or spraying machine in several coats. Application method, thickness, number of coats and drying time between coats shall be strictly in accordance with manufacturer's recommendations.

(i) Gypsum based premised plaster shall be applied with trowel or spraying machine in single coat of thickness in accordance with manufacturer's recommendations.

(j) Half-set plaster shall be leveled with featheredge, scraped off surplus material and worked from bottom to top of wall.

(k) Allow drying time of 30-60 minutes in accordance with manufacturer's recommendations; sprinkle surface with clean water and smooth with a hard sponge float to remove trowel and featheredge marks in circular motion.

2.1.17.5 Screeds

2.1.17.5.1 Materials

(a) Aggregate for lightweight screeds shall be as follows:-

i. 5 mm exfoliated vermiculite to **BS EN 13055-1**.

ii. Approved proprietary lightweight beads or granules.

(b) Air entraining agent for lightweight screed shall be an approved admixture which will produce screeds with a dry density not more than 1,200 kg/m^2.

(c) Vapour barrier shall be 0.08 mm polythene sheet.

2.1.17.5.2 Workmanship

(a) Floor screeds generally shall be in accordance with **BS 8204: Part 1-5** and **BS 8000: Part 9** and wall screeds to **BS 5385**:Part 1 and **BS 8000**:Part 10 respectively.

(b) Screeds generally shall consist of cement and sand 1:3. Use the minimum water consistent with workability.

(c) For floor screeds over 40 mm thick, mix shall be 1 part cement, 1.5 parts sand or granite fines and 3 parts coarse aggregate graded 10 mm down with at least 75% being retained on a 5 mm B.S. sieve.

(d) Use granite fines instead of sand, when required to avoid efflorescence on the surface of the finish.

(e) Thickness of wall render shall be 10 mm (minimum) with surface scratched to form key.

(f) Thickness of floor screeds shall be as follows:-

i. Laid monolithically with the base : 15 mm (minimum) thick. (for preparation of base, see Clause 2.1.17.2.3 .

ii. Bonded to a hardened concrete base : 20 mm (minimum) thick. (For preparation of base, see Clause 2.1.17.2.2).

iii. Not bonded to the base : 50 mm (minimum) thick including tile finish.

iv. Floating : 65 mm (minimum) thick including tile finish.

(g) Lay monolithic and bonded screeds in one coat.

Lay and compact screeds level or to falls, as required.

(h) Lay screeds in bays of 15 sq. m (maximum) with length not more than 1.5 times the width in chequerboard pattern. Allow 24 hours (minimum) between laying adjoining bays.

(i) Lightweight aggregate screeds shall consist of cement and lightweight aggregate 1:8 for roofs and 1:6 for floors unless contrary to the manufacturers' recommendations.
Air entrained screeds shall have a dry density of not more than 1,200 kg/m^3.

Lightweight screeds shall be 50 mm (minimum) thick, excluding topping.

Finish lightweight screeds with cement and sand or granite fines 1:4 topping 15 mm (minimum) thick laid monolithically with the screed.

When specified lay vapour barrier under lightweight roof screeds. Lap 150 mm at joints.

(j) The surface of screeds shall be finished with one of the following surface finishes, level, to falls as specified:-

i. Steel trowel or power float to give a smooth untextured surface.

ii. Wood float to give an even textured surface.

iii. Stiff brush to give a slightly roughened texture.

The finish shall be in accordance with manufacturer's recommendations for the finish to be applied or laid.

(k) Where pipes of less than 50 mm diameter pass through flat roofs:-

i. Form cement and sand or granite fines 1:3 surround 150 x 150 mm around pipe sleeve, to project 150 mm above finished roof level.

ii. Finish top to slope.

iii. For groups of pipes, form combined surrounds.

2.1.17.6 In-Situ floor and wall finishes

2.1.17.6.1 Materials

(a) Stone aggregate shall be crushed grey granite or white stone to **BS EN 12620**, graded from 10 to 3 mm and free from dust.

(b) Marble aggregate shall be angular crushed marble, free from dust, and of the colour required.

(c) Surface hardener shall be an approved proprietary liquid hardener and dust proofer.

(d) Hardening admixture shall be an approved proprietary make.

(e) Dividing strip shall be aluminium, brass, stainless steel or plastic strip 3 mm thick and to the full depth of the screed. Plastic strip shall be of the colour required.

Form key as one of the following:-

i. Generally sides of section shall be grooved.

ii. Metal strip : one edge shall be cut and bent at 150 mm centres, to form lugs.

iii. Plastic strip : to have 5 to 10 mm holes at 150 mm centres with plastic pins inserted to form dowels.

(f) Non-slip strip insert shall be 25 x 15 mm slightly curved on top and consisting of :-

i. A compound of cement and carborundum dust 1:1, or

ii. A proprietary insert strip.

2.1.17.6.2 Workmanship

(a) In-situ floor finishes generally shall be to **BS 8204: Part 1-5.**

(b) Unless otherwise specified, minimum thickness of in -situ floor and wall finishes shall be as Table 2.1.17.4.

Table 2.1.17.4: Thickness of finish

Granolithic				Terrazzo	
Location	**Plain**	**Coloured Finish**			
		First coat	**Finishing coat**	**First coat**	**Finishing coat**
Floors laid monolithically	15 mm	-	15 mm	-	-
Floors	20 mm	10 mm	10 mm	10 mm	15 mm
Walls and Dadoes	20 mm	10 mm	10 mm	10 mm	10 mm
Treads	20 mm	-	20 mm	-	25 mm
Risers	15 mm	-	15 mm	-	15 mm

(c) Lay floor finishes as Clause 2.1.17.5.2 (g) and (h)

(d) Finish shall be composed of cement and sand 1:3

(e) Granolithic finish shall be mixed in the following proportions as Table 17.5

Table 2.1.17.5

Granolithic Finishes

Type	Cement	Sand	Granite aggregate	White stone	Surface finish

A	2	1	4		Trowelled or rubbed
B	2	1		4	
C	1		2		Washed
D	1			2	

(f) Finish surface as Clause 2.1.17.5.2 (k) as soon as compaction is completed. Do not bring excessive laitance to the surface and remove any which appears. Do not wet the surface. Repeat trowelling process or power floating at least three times at intervals within 10 hours of laying.

(g) Form the following alternative finishes as on granolithic, as required:-

i. Trowelled : smooth or wood float finish as Clause 2.1.17.2.4 (a).

ii. Rubbed : after trowelled finish has set, rub down with fine carborundum stone to form a smooth finish and to expose the aggregate.

iii. Washed : before trowelled finish has set, brush off the surface to expose the aggregate.

(h) Where coloured cement and sand and coloured granolithic finish are to be coloured finish laid in two coats the coats shall be as follows:-

i. First coat with ordinary cement and sand as Clause 2.1.17.6.2 (d) and

ii. Finishing coat as Clause 2.1.17.6.2 (d) or Clause 2.1.17.6.2 (e) and 5 mm thick (minimum) for cement and sand finish and 10 mm thick (minimum) for granolithic finish using coloured cement. Apply the finishing coat before the first coat has set.

(i) Where terrazzo is to be laid in two coats, the coats shall be as follows:-

i. First coat of cement and sand 1:3

ii. Finishing coat mixed in one of the proportions shown in Table 2.1.17.6. Apply the finishing coat before the first coat has set.

Table 2.1.17.6
Terrazzo

Type	Coloured cement	Marble aggregate	Grade of aggregate (mm)
A	1	2	5 to 3
B	1	2.5	10 to 5
C	1	3	10

Minimum thickness of first and finishing coat shall be as Table 2.1.17.4.

Divide terrazzo work into panels of 1 m^2 (maximum).

Grind surface to expose the aggregate and produce a smooth finish.

Fill any voids with matching cement.

Apply one coat of wax polis h to wall finishes. Floor finishes shall not be highly polished, or wax polished.

(j) Bed dividing strip through the total thickness of the base and finishing coat. Strips shall not be haunched prior to laying the base.

(k) Fill non-slip compound or bed non-slip into groove, and finish to project 3 mm above finished surface.

(l) Form granolithic or terrazzo aprons strings and skirtings to edge of stairs as drawings.

2.1.17.7 Rigid Tile or Slab Finishes

2.1.17.7.1 Materials

(a) Submit samples of tiles, and obtain approval.

(b) Plain concrete or granolithic concrete floor tiles shall be to **BS 1197:Part 2**, of the required colour and surface finish.

(c) Ceramic floor tiles including corresponding accessories shall be to **BS EN 14411**.

Ceramic floor tiles shall be Group A I or B I: water absorption not exceeding 3%.

Floor quarries shall be to Group A IIb of **BS EN 14411**: water absorption of 6% < E =< 10%.

Where ceramic floor tiles or clay floor quarries are described as "including specials" the full range of BS fittings shall be required. Elsewhere mitred angles of coved skirtings and the like shall be permitted.

All tiles and fittings shall be from the same manufacturer and shall match in colour and texture.

Where tiles are described as anti-slip, they shall be suitably embossed or treated with carborundum or similar grit to comply with relevant standards, e.g. Germany DIN standard or other recognised international standards to provide an anti-slip surface.

(d) Terrazzo floor tiles shall be to **BS EN 13748-1** and **BS EN 13748-2** and of the required colour and surface finish.

(e) Porcelain stoneware tiles shall be to **BS EN 14411**, Group B1a. Tiles are to be non-lip with floor sizes 300 x 300 x 10.5mm or 600 x 600 x 10.50.

(f) Concrete roofing tiles and fitting shall be to **BS EN 490** and **BS EN 491**.

(g) The tiles shall be flat tiles 30 mm thick and 300 mm square or 35 mm thick and 400 mm square.

(h) Insulating roofing tiles shall be 40 mm thick and 300 mm square or 400 mm square with a density of 1,250 kg/m^3. m ±10%. The upper surface shall be hard and suitable for pedestrian traffic. Five legged tiles shall not be permitted.

(i) Glazed ceramic wall tiles shall be to **BS EN 14411** and in Group A IIa or B IIa with a water absorption not exceeding 6%.

Tiles shall be glazed, white or coloured as required and with cushion edge and with inclusive spacer lugs as required by Engineer.

(j) External facing tiles shall be of the specified type from an approved manufacturer.

(k) Unless otherwise specified mosaic tiles shall be from an approved manufacturer and as follows:-

i. Glass mosaic tiles shall be fully vitrified glass tile size 20 x 20 mm and 4 mm thick, regular in shape, free from cracks or sharp edges and uniform in colour and texture.

ii. Glazed ceramic mosaic tiles shall be similar to glazed wall tiles but size 18 x 18 mm or 25 x 25 mm and 5 mm thick and with square edges.

iii. Unglazed vitreous mosaic tiles shall be size 18 x 18 mm or 18 x 38 mm or 38 x 38 mm and or 5 mm thick with matching coved tiles and from the colour range specified.

(l) Stone slabs for paving or wall facings or fittings shall be of the quality and colours specified on drawings or as selected by the Engineer and free from flaws and defects throughout. Unless otherwise specified, slabs for wall facings shall not be less than 20 mm thick and slabs for paving surfaces shall not be less than 32 mm thick.

Stones shall be jointed so as to be dressed to match stone by stone.

No stone shall be offered by quarries where variety is expected to develop or which deviates from the selected stone.

Marble shall be true metamorphic limestone.

(m) Precast concrete paving blocks shall be to **BS EN 1338 and BS 7533-3:Part 3** and of the size, colour and surface textured specified.

(n) Adhesive for tiles or mosaics shall be compatible with background and finish and shall be an approved proprietary brand.

The approved proprietary adhesive shall be used in strict accordance with the manufacturer's technical specifications and recommendations, including and not limited to the valid shelf life and the setting time of the product.

The expiry date and the setting time shall be clearly indicated with label and stamp for necessary inspection by the Engineer.

(o) Slurry shall be plain or coloured cement and water mixed to creamy consistency.

(p) Grouts mixed with plain or coloured cement shall be :-

i. For floor tiling generally : cement and sand 1:3, mixed to a paste with the minimum of water.

ii. For mosaic tiling or glazed wall tiling : cement and powdered limestone 1:3.

iii. For external facing tiles : cement and sand 1:3.

If agreed by the Engineer, approved proprietary brands of grout may be used in strict accordance with the manufacturer's technical specifications and recommendations.

2.1.17.7.2 Workmanship

(a) Floor and wall tiling generally shall be :-

i. Floor tiling shall be to **BS 5385:Parts. 3 and 5**.

ii. Internal wall tiling shall be to **BS 5385:Part 1**, external wall tiling shall be to **BS 5385:Part 2.**

(b) Fix floor tiles as follows:-

1. Semi -dry method direct to concrete base (for preparation of base, see Clause 2.1.17.2.2 :-

i. Soak tiles in clean water and allow to drain.

ii. Lay semi -dry mix cement and sand 1:4 bed thoroughly compacted to the required thickness (20 mm minimum) finished to the required levels, falls and currents.

iii. Pour cement and sand slurry over bedding and spread and trowel to 3 mm (minimum) thick.

iv. Lay tiles, mixed from six boxes, and tamp firmly into bed with straight and even joints and 3 mm (minimum) wide.

v. Allow bedding to set.

vi. Grout up joints and clean surplus grout face of tiles as work proceeds.

2. Thick bed method to screed:-

i. Soak tiles in clean water and allow to drain.

ii. Damp the screed with clean water to reduce suction if required.

iii. Lay cement and sand 1:3 bed generally 15 mm thick but never thicker than the tiles.

iv. Coat back of tiles with slurry immediately before fixing.

v. Lay tiles mixed from six boxes and tamp firmly into bed with straight and even joints and 3 mm (minimum) wide.

vi. Allow bedding to set.

vii. Grout up joints and clean surplus grout from face of tiles as work proceeds.

3. Thin bed method:-

i. If approved fix floor tiles using a bed of adhesive in accordance with manufacturer's recommendations.

(c) Lay on roof, concrete or lightweight tiles as follows:-

ii. Bed and joint tiles in cement mortar (1:4).

iii. Lay tiles loose and fill with cold bitumen between joints and point.

(d) Allow for expansion with a 75 mm space around perimeter and 25 mm joints per 9 m^2 cut through joints and fill with cold bitumen or approved sealant.

(e) Do not allow traffic on floors or roofs until 4 days after completion of tiling and subsequently permit only light traffic for a further 10 days.

(f) Fix tiles to wall render as follows:-

1. Thick bed method:-

i. Sort and remove tiles with uneven colour or dimensions. Soak tiles in clean water for 30 minutes (minimum). Stack to drain and fix as soon as the surface water has drained off.

ii. Damp the wall render with clean water sufficiently to prevent it absorbing water from the bedding mortar.

iii. Butter the back of each tile with cement slurry and tap firmly into position so that the bed is solid throughout. Thickness of finished bed shall be 5 to 15 mm.

iv. Joints shall be 2 mm (minimum) wide, and maximum 3.5 mm wide unless specified otherwise.

v. Make any adjustment to tiles within 10 minutes of fixing.

vi. Clean tiles and joints before bedding hardens.

vii. Grout up joints 24 hours (minimum) after fixing tiles. Clean off surplus grout as work proceeds.

viii. Clean tiles at completion.

Thick bed method shall not be used for fixing wall tiles with water absorption value lower than 0.5%.

2. Thin bed method:-

i. Apply wall render of cement : sand (1:3) to the concrete or substrate surface. Build up the render to the required thickness of 15 mm in layers. Thickness of each layer shall not exceed 10 mm. Allow the wall render to dry off thoroughly.

ii. Fix wall tiles, mixed from six boxes, to the wall render using an approved proprietary adhesive in accordance with the manufacturer's recommendations.

iii. Grout up joints using an approved grout or a proprietary grout as specified.

(g) Fixing of external wall tiles shall be thin bed method as follows:-

i. Apply wall render of cement : sand (1:3) to the substrate surface. Build up the render to the required thickness of 15 mm in layers. Thickness of each layer shall not exceed 10 mm. Allow the wall render to dry off thoroughly.

ii. Fix wall tiles to the wall render using an approved proprietary adhesive in accordance with the manufacturer's recommendations.

iii. Grout up joints using an approved grout or a proprietary grout as specified.

(h) Carry out infra-red thermographic scanning by an approved specialist and submit report within 4 months upon completion of external tiling. Should the report indicate that any part of the wall tiling has not been affixed properly, the Contractor shall carry out approved remedial measures at his own expense and carry out further infra-red thermographic scanning to the satisfaction of the Engineer.

(i) Fix mosaic tiles as follows:-

1. Thick bed method direct to concrete slab as follows:-

i. Lay semi -dry mix cement and sand 1:4 bed thoroughly compacted to the required thickness (20 mm minimum) finished to the required levels and falls.

ii. Pour cement and sand slurry over the bedding and spread and trowel 3 mm thick.

iii. Coat back of sheets of mosaic tiles with cement slurry immediately before fixing. Slurry shall be of the same colour as the final grout.

iv. Fix sheets of mosaic tiles and tamp firmly into bed, maintaining straight and regular joints, and ensuring that joints between sheets are equal to tile joints.

v. Remove backing paper, complete final straightening and rub surface with grout, coloured as required, to fill joints, cleaning surplus grout from face of tiles as work proceeds.

2. Thick bed method to wall render as follows:-

i. Damp the wall render with clean water sufficiently to prevent it absorbing water from the bedding mortar.

ii. Apply bedding coat of mortar 10 mm (maximum) thick consisting of cement and sand (1:3).

iii. Coat surface of wall render and back of sheets of mosaic tiles with slurry immediately before fixing. Slurry shall be of the same colour as the final grout.

iv. Fix sheets of mosaic tiles and tamp firmly into position maintaining straight and regular joint, ensuring that joints between sheets are equal to joints between tiles.

v. Remove backing paper, complete final straightening and rub surface with grout from face of tiles as work proceeds.

3. Thin bed method:-

i. If approved, fix mosaic tiles using a bed of proprietary adhesive in accordance with the manufacturer's recommendations.

ii. Grout up joints using a proprietary grout as specified, which may be coloured in accordance with Engineer's requirements.

(j) Bed stone paving slabs with one coat of approved sealer at back of stone slab on screeds. Bedding shall be not less than 12 mm thick comprising cement, and finely screened sand 1:3. Finish with a perfectly level and even surface and with joints between slabs 2.5 mm thick, or as directed by the Engineer.

(k) Lay slabs minimum 50 mm thick on 25 mm minimum bed of lime and sand or sand/cement mortar 1:3. Lay slabs to an even surface, well pressed into bed, with no level differences between adjacent slabs.

(l) Joints shall be even and about 5 mm wide. Stagger joints to form bond as specified. Grout up with cement lime and sand or granite fines 1:3:6. Work well into joints. Clean off surplus grout from surface of slabs.

2.1.17.8 Flexible tile or sheet finishes

2.1.17.8.1 Generally

(a) Flexible tile and sheet finishes shall be of the best quality of approved type and colour, and in accordance with the following specification. Sizes and thicknesses shall be as specified hereafter unless specifically ordered otherwise. The work shall be executed by an approved specialist contractor.

2.1.17.8.2 Materials

(a) Submit samples and obtain approval.

(b) Semi -flexible PVC tiles shall be to **BS EN 654**, size 225 x 225 or 300 x 300 and 2.5 mm thick.

(c) Unbacked flexible PVC (vinyl) tiles shall be to **BS EN 649**, size 225 x 225 or 300 x 300 and 2 mm thick.

(d) Unbacked flexible PVC (vinyl) sheet shall be to **BS EN 649**, 2.0 mm thick to floors and 1.2 mm thick to walls.

(e) Foam backed PVC (vinyl) sheet shall be to **BS EN 651:2011** and 3 mm thick overall. The wearing layershall be PVC (vinyl) sheet to **BS EN 649** 1.5 mm thick.

(f) Linoleum tiles and sheet shall be to **BS EN 12104:2000** and shall be 3.2 mm or 4.5 mm thick.

(g) Solid rubber tiles and sheet shall be to **BS 1711** and 4 mm thick.

(h) Adhesive shall be that recommended by the tile or sheeting manufacturer. Adhesive

(i) Polish shall be emulsion polish of approved type recommended by the tile or sheeting manufacturer.

(j) Store rolls after delivery, but before laying, in accordance with the manufacturer's instructions. Rolls which have deformed because of improper storage shall be rejected.

2.1.17.8.3 Workmanship

(a) Do not use tiles or sheets which have deteriorated in stock or which have a tendency to curl at the edges and corners.

(b) Thoroughly clean the screed or backing from grease, oil, wax, paint, dirt or dust and fill all cracks, minor holes and services with suitable filler recommended by the tile or sheeting manufacturer.

(c) Lay all tiles, floor and wall sheeting strictly in accordance with the manufacturer's instructions. If these instructions call for heating the tiles prior to laying, then apply such preheating to a temperature just sufficient to cause pliability. Preheat tiles in batches. Preheating single tiles shall not be permitted.

(d) Apply adhesive in a thin film and spread evenly with a notched or plain trowel, then even out with a roller as recommended by the manufacturer. If a notched trowel is used the notches shall be of the size recommended and shall be renewed periodically to ensure the correct spread of adhesive. Tiles or sheets shall be laid immediately after the adhesive is applied.

(e) Closely butt joints and cut accurately at right angles to the tiles or sheet surface to an agreed design and with only the minimum necessary jointing.

(f) Weld joints of PVC sheet to form a continuous surface with approved PVC welding rods coloured to match the sheeting.

(g) Relay any areas insufficiently bonded or showing an uneven surface.

(h) After laying, thoroughly clean the tiling or sheeting with water and a detergent recommended by the manufacturer. Apply two coats of non-slip, matt emulsion polish. Protect the floors with approved covering.

2.1.17.9 Carpet or textile floor coverings

2.1.17.9.1 Generally

(a) All carpet shall be of approved type and colour and in accordance with the following specification, of an approved brand, laid on screed treated with an approved sealant to reduce dust and pollution.

(b) Carpet shall be either of the following qualities as specified:-

- "General contract quality carpet" for use in single occupant offices, committee and

conference rooms, small libraries, staff quarters, light wear corridors and other areas as required.

- "Heavy contract quality carpet" for use in public rooms, general offices, reception areas, busy corridors and other areas as required.

(c) Carpet shall be manufactured by one of the following methods:

i. Single or face-to-face traditional loom.

ii. Needle insertion loom.

iii. Needle punch, fibre bonded, flocked or knitted.

iv. Other weaving machinery producing the quality of carpet to meet the performance requirements detailed in this specification.

2.1.17.9.2 Materials

(a) Submit samples of carpet and underlays together with relevant manufacturer's literature and submit test certificates for carpet to demonstrate that it complies with the requirements of Clauses 2.1.17.9.2 (f) and (g) and obtain approval.

(b) The composition of the pile yarn shall be fibres of one of the followings:-

Wool or wool blended with up to 20% nylon.

Nylon with antistatic properties for general use.

Polypropylene

Blend of fibres with antistatic properties for general use.

Blend of fibres formulated shall provide full antistatic properties to meet the requirements specified by International Business Machine (I.B.M.) or International Computer Company (I.C.L.) for computer floor coverings.

(c) The warp and weft, where applicable, shall be cotton, jute or polypropylene.

(d) The back coating where required shall be evenly spread with no build-up at the selvedges of the carpet and which gives fray-resistant finish to cut edges.

i. The quality and application of the back coating shall be such that:-

i. Its penetration shall assist tuft anchorage without wicking into the surface pile.

ii. The finish carpet may be seamed without gumming the needle and sewing thread, due to softening of the compound.

iii. Folding the carpet shall not cause permanent creasing.

ii. The backing coating shall:-

i. Not deteriorate substantially with age or low temperature.

ii. Not become sticky with temperatures and humidities experienced when laid or in transit thereto.

iii. Be capable of spot cleaning using dry cleaning solvents without serious deterioration.

iii. The backing compound may be loaded with 100 parts of filler to 100 parts of dry rubber.

(e) Carpets shall be dyed by a process employed strictly in accordance with the dyestuffs manufacturer's instructions that produces full and even penetration of the fibres with minimum degradation of the yarn.

(f) Colour fastness of carpet shall meet the requirements of Table 2.1.17.7:-

Table 2.1.17.7

Colour Fastness Related to	**Minimum Acceptable Grade**	**Method of Test**
Light	5	**BS 1006**
Wet and dry rubbing	4	Pile yarn assembled rubbing and tested in accordance with **BS2677**
Shampooing	4	Test on finished carpet in accordance with the recommendations of the Society of Dyers and Colourists
Organic solvents	4	**BS 3661**/20

(g) Physical properties of the finished carpet shall be in accordance with Table 2.1.17.8:-

Properties	**Requirements**	**Method of Test**
Total mass	Requirement as to mass shall depend upon construction of finished carpet and the amount of back coating applied to achieve the required tuft anchorage	**BS 4223** (method 12)
Number of tufts per 100 cm^2.	Minimum 1,000	**BS 4223** **(**method 8)
Thickness loss under dynamic loading	Thickness loss after 1,000 impacts not more than 25%	**BS ISO 2094** Using dynamic loading machine on original pile thickness
Thickness loss	Thickness loss after	**BS ISO 2094**

Properties	Requirements	Method of Test
Thickness; compression and recovery	Percentage compression recovery not less than 60%	**BS 4098** on original pile thickness
Dimensional stability; extension due to mechanical action	Mean non-recoverable not exceed Warp 1%, Weft 1%	**BS 4682:Part 2**
Dimensional change when immersed in cold water; to determine behaviour of the carpet when subjected to total saturation in cleaning or shampooing when excessive water is applied	Dimensional change not to exceed Warp 2%, Weft 2%	**BS 4682:Part 3**
Flammability	Shall not propagate flame after removal of nut and the charred area shall not exceed 35 mm radius	**BS 4790**
Moth proofing	The carpet shall be permanently moth proofed	**BS 4797**

(h) Although there is no standard laboratory test for resistance to wear, tenderers to must satisfy the Employer that their products will sustain the wear anticipated. For example, they may quote tests or reports illustrating the suitability of their products, or list locations, where their products have been laid for a period of at least 2 years, or produce satisfactory evidence from overseas to endorse their suitability.

(i) Foam backed carpets shall not be permitted unless the foam is expanded PVC.

(j) Carpet tiles shall be of the same size so that they could be easily interchanged, relocated or replaced.

Special tiles, with proper edging around, cut out to receive floor socket or outlet are required.

All carpet surfaces shall be "Scotch-guarded", or other approved protective treatment to be provided. No unraveling of yarn at edge of module is permitted.

All carpet tiles shall be dimensionally stable (resist shrinkage) in any circumstance.

(k) Carpet manufacturing company shall have acquired "ISO 14001:1996 – Environmental Management Systems" or "Eco-Management and Audit Scheme (EMAS) of Denmark" or similarly approved by the Engineer.

Carpets shall be completely free of Polyvinyl Chloride (PVC).

Carpet backings shall be PVC free; materials to be cotton, jute, resin or polyurethane.

Adhesives shall be free of synthetic latex, giving no volatile organic compound emission. Water-based adhesives or adhesive-free installation shall be used.

Metal complex dyes and acid dyes shall not be used for dyeing.

Carpets shall be long lasting, having a lifecycle not less than 10 years.

Carpets shall not contain harmful substances and odour. They shall pass the testing and labeling program run by "Carpet and Rug Institute's Indoor Air Quality Carpet Testing Programme" (U.S.A.) or "Danish Indoor Climate Labeling"(Denmark) or "GUT" (European association for environmentally friendly carpets) or similarly approved by the Engineer.

Carpets shall be capable of being reused, recycled or acceptable by landfill for disposal. When reused, the above requirements shall be followed. In case of recycle or landfill, the carpets shall not cause contamination to the surrounding environment.

(l) Provide underlay, where required, one of the following types to **BS 5808**:-

i. Felt
ii. Cellular
iii. Rubber crumb
iv. Composite underlay

(m) Carpet grippers shall have two rows of small angled pins at not less than 50mm centres projecting 4 mm from a preformed strip. Submit samples of carpet grippers and obtain approval.

(n) Adhesive for fixing carpet shall be as recommended by the carpet manufacturers and be compatible with the sub-base. Storage and use should be in accordance with the appropriate recommendations, e.g. the British Adhesive Manufacturers Association booklet "Safe Handling of Adhesives in Industry".

(o) Release bond agent shall be a proprietary release coating or other approved system and be used strictly in accordance with the manufacturer's instructions.

2.1.17.9.3 Workmanship

(a) Install carpets and underlays in accordance with **BS 5325**.

i. Install carpets so that they are flat and of even tension. Carpet shall not be displaced by movement of people or objects on the surface to the point where permanent slackness, rucking or rippling is caused.

ii. Closely fit edges to skirting, cover fillets or other perimeters. Joint carpet at doorway within the thickness of the closed door.

iii. Secure doorway terminations of carpet by sealing, whipping or binding before seaming or covering with cover strips where they abut dissimilar materials.

iv. No carpet jointing shall be permitted at right angles to a door location within 2 m of any door centre line unless accepted by the Engineer.

v. No fitting-out of areas with small pieces or offcuts shall be permitted.

vi. Carpet tiles on raised floor panels shall either be stuck down with double-sided tape or alternatively with some form of bonding agent integral with the backing of the tile with the approval of the Engineer.

(b) Provide underlays in all cases except as follows:-

i. Where foam or felt backing is an integral part of the carpet proposed.

ii. Where the carpet shall be fully adhered in accordance with the manufacturer's Recommendations.

iii. Where the manufacturer recommends that no underlay is required.

Ensure the base is smooth, clean, and dry and compatible with the underlay and carpeting. Similarly ensure any adhesive to be used is compatible with the base, underlay and carpet.

Lightly smooth the underlay by hand to ensure that it lies flat with no bubbles or wrinkles visible on the surface. Secure the underlay sufficiently to prevent movement when the carpet is laid over it.

(c) Plan the layout of the carpet to keep seams to the minimum practicable.
Seams shall be unobstructive and positioned such that, where possible:-

i. They run the length of the area.

ii. Traffic runs along the length rather than across the seams.

iii. Seams shall not be placed in areas subjected to heavier or twisting wear or in doorways or narrow accesses.

Seam or joint carpet by one of the following methods:-

iv. Machine or hand sewing; sew seams to the full length and properly lock off. Stitch to an even tension and ensure the seam lies flat after laying. Protect the raw edge of the pile where necessary, to prevent loss of pile along the seam.

v. Reinforced tape and adhesive (cold applied) ; ensure that the adhesive is dry before stretching.

vi. Heat bonded tapes; ensure that adequate penetration of adhesive is achieved by applying sufficient heat and pressure simultaneously.

vii. Seaming cement; Joint foam backed or unitary-backed carpets with a continuous bead of seaming cement to the full length of the primary backing and joint under compression.

(d) Secure carpets by using one of the following methods:-

1. Carpet gripper method (suitable for woven, tufted, and secondary backed bonded carpet) -

   i. Plug and screw or nail carpet gripper strip around the perimeter 6-8 mm from the skirting. Use recommended adhesives between screws and nail centres. Stretch carpet over the gripper using knee kickers, trim the edge of the carpet and ensure that it is securely trapped in the gap between the gripper and the skirting. Use power stretchers for installations over 7 m long or wide and use a double row of carpet grippers.

2. Fully adhering method (suitable for all types of carpet) -

i. Ensure that the floor is properly dry, free from dust, and contaminants which will affect the adhesion. Ensure that the adhesive is spread evenly and that only a sufficient area that can be properly bonded is laid at one time. Ensure that maximum adhesive contact is obtained by brushing or rolling in accordance with the manufacturer's instructions.

ii. Cut edges shall be seamed straight and square before adhesion in accordance with the manufacturer's instructions. Trim the carpet to the perimeter before the adhesive dries.

iii. Do not permit traffic or installation of furniture on adhered areas for at least 24 hours.

3. Release bonded method (suitable for all types of carpet) -

i. Apply the release agent before adhering generally in accordance with the Clause 2.1.17.9.3 (d)(2) above.

(e) Clear all carpet areas of tools and waste. Remove all pieces of partly loose warp or face yarn with napping scissors. Rectify any lumps, surface irregularities and areas of inadequate or uneven tension that are apparent.

i. Clean in an approved manner the installed carpet throughout the building once after completion prior to acceptance by the Engineer.

2.1.17.10 Raised accessed flooring

2.1.17.10.1 Materials

(a) The raised floor deck shall be fitted with fully removable load bearing panels, interchangeable, and supported on adjustable pedestals.

(b) The f loor system shall not contain materials which by direct contact could be detrimental to the safety and comfort of the users or which may emit abnormally toxic combustion materials and gases when burned.

(c) The floor system shall be sturdy, rigid and firm. The design of the system shall prevent vibration, rattles, rocking squeaks and other noises. Floor panels that are cut shall be supported by additional pedestals and shall have framing modified accordingly.

(d) All necessary accessories such as ramp s, stairs, railings, air grilles, skirting trims, vertical edging panels, shall be of a similar standard or quality to the main floor system.

(e) All panels shall be of the following dimensional requirements:-

i. They shall be removable and fully transferable in position and direction.

ii. A close fit to all perimeters is required and the maximum gap shall be 15 mm and the edge panels shall be located to prevent movement.

iii. Before application of load, the platform floor surface shall be level to ±1.5 mm over any 5 metre square or ± 6 mm over the entire floor.

iv. Height difference between adjacent panels without finish, shall not exceed 0.75 mm, before load application. Height difference between loaded and not loaded shall not exceed 3.25 mm.

v. Under no load condition, the concavity or convexity of the panel shall not exceed 0.75 mm when measured horizontally parallel to any edge or along the diagonal, and the deviation due to twist shall not exceed 1 mm.

vi. Panel deviation from square or work size shall not exceed ±0.5 mm.

vii. Panel edge strips if utilised, shall be firmly fixed and shall not peel or become detached or break. The edging shall resist a pull off strength of 5 N for 5 minutes. Edge stripping shall be dimensionally stable during the stated service life.

Edges of panels shall be chamferred at an angle of 5 degrees for easy removal of panels. Site-cut edges of panels shall be treated to resist fire, moisture, and attack by vermin etc.

viii. The dead load of the raised access floor system shall not exceed 1KN/ m^2.

(f) The platform floor system, including the pedestals, panels, floor covering and fixings shall withstand the following conditions, without any delamination or other forms of deterioration.

(g) The system shall comply with the following fire and safety requirements:-

i. It shall be non-inflammable and shall not sustain any combustion.

ii. It shall meet the fire requirements of **BS 6266** Section 4.4

iii. It shall achieve, within the cavity, Class 1 classifications when tested in accordance with **BS 476:Part 7** and an index of Performance (1) not exceeding 12 and a sub index (i) not exceeding 6 when tested in accordance with **BS 476:Part 6**.

iv. Panels which are constructed using combustible material shall be completely and securely clad on the underside in non-combustible material with a melting point of not less than 600°C. This cladding shall be securely fixed to ensure that flame or radiant heat do not come into contact with the combustible material.

v. All supporting structure shall be incombustible and shall have a melting point of not less than 600°C.

vi. It shall have a thermal property such that the mean temperature of the upper panel surface shall not increase by more than 140°C, when subject to the 1 Kg crib fire test.

(h) The system shall have the electrostatic properties such that the resistance between the surface of the floor covering and the main building earth continuity conductor shall be between 5 x100000 and 2 x $10^{10}\Omega$(ohms) at RH 50%.

All substantial metallic components of the floor system shall be capable of being electrically bonded.

(i) All materials shall be resistant to the growth of fungi and micro-organisms, and to the attack by insects.

The materials shall meet **BS 1982** method of test for fungal resistance and manufactured building materials made of or containing materials of organic origin.

(j) The system shall not contain any toxic materials which by physical contact or by inhalation of gases from such materials, could prove harmful to the occupants of the building.

(k) The materials used in the system shall not give off any odours which could be unpleasant to the occupants of the building.

(l) Materials used in the system shall not be vulnerable to attack by vermin. The design of the system should resist infestation by vermin.

(m) The system and the floor panels shall not create dust or contaminations which are likely to be harmful to personnel or equipment.

(n) The system supporting components and the floor panels shall have a minimum life of 25 years.

(o) All parts of the system shall be installed free of rust, corrosion, rot or any form of deterioration.

All parts shall be suitably finished to prevent deterioration under normal use in the environments. All finishes shall be clearly stated at the time of tender.

(p) Materials shall be non-combustible. They shall be compatible with all other materials used in the raised floor system.

For insulation, the conductivity shall not be more than 0.036 w/m deg. C at 24^{o}C.

2.1.17.10.2 Workmanship

(a) All areas shall be examined before the beginning of the work to determine that the structure is in a condition to receive the system. The area shall be broom-cleaned and uninterrupted for free movement of work flow.

(b) The surface of the floor and the void below shall be left clean and dust free.

(c) The raised floor system shall be adequately protected from damage and dirt before handover to others for the installation of floor coverings and/or other works.

2.1.17.11 Painting

2.1.17.11.1 Generally

(a) Unless otherwise approved by the Engineer, paint and associated materials in a coating system shall be obtained from the same manufacturer and shall be supplied in sealed containers marked to identify the contents, the manufacturer's brand label and recommendations for use. Paint and associated materials for general use shall be a proprietary type approved by the Engineer and shall be obtained from manufacturers approved by the Engineer.

(b) Paint and associated materials which will be applied to surfaces which may come into contact with potable or fresh water shall be a proprietary type approved by the Engineer.

(c) Undercoats and finishing coats shall be compatible with the primer and with each other and shall be obtained from the same manufacturer.

(d) Undercoats and primary finishing coats shall be of slightly different tints to each other and to the finishing coat.

(e) Flat finish undercoats shall be used for hard gloss finishes.

(f) Supply all proprietary brand materials in sealed containers each containing the manufacturer's brand label and printed instructions. Destroy the tins immediately after use of the contents.

(g) Where possible, all the materials in any coating system shall be obtained from the same manufacturer. Furnish the Engineer with two copies of the manufacturer's data sheets for the paints proposed to be used.

(h) Store materials on Site or in the Contractors' workshops, etc. in cool, well ventilated, covered storage space. Label tins of paint for "External use" and for "Internal Use", "Undercoating" and "Finishing" respectively.

(i) Where flammable paints or solvents are used, no smoking shall be permitted. Appropriate signs as required by the Engineer shall be displayed.

2.1.17.11.2 Materials

(a) Aluminium primer shall comply with **BS 4756**, Type 1.

(b) Zinc chromate primer and metallic zinc-rich primer Type 2 shall comply with **BS 4652**.

(c) Lead primer shall comply with **BS 2523**.

(d) Calcium plumbate primer shall comply with **BS 3698**.

(e) Bitumastic paint shall be quick drying Type B complying with **BS 1070**.

(f) Bituminous paint shall comply with **BS 6949**.

(g) Knotting shall comply with **BS 1336**.

(h) Stopping shall comply with **BS 544**.

(i) Rust inhibitor shall be a chemical agent which is capable of converting rust into iron phosphate.

(j) Sealers for plaster, masonry and similar materials shall be a stabilizing solution or oil based plaster sealer.

(k) Wood preservative shall be as stated in Clause 2.1.11.2.22 and 2.1.11.2.23.

(l) Polyurethane paint shall be a two-pack type.

(m) Cold cure epoxy paint shall be a two-pack type.

(n) Textured paint for external use shall be a heavy duty masonry paint incorporating a fine aggregate filler.

(o) Plastic emulsion paint shall be a vinyl or acrylic based emulsion incorporating a fungicide.

(p) Cement paint shall be a waterproof cement based paint supplied in drums and shall not be mixed with lime or similar materials.

(q) Synthetic gloss paint for internal and external use shall have an alkyd resin base combined with drying oils and pigments.

(r) White spirit shall be to **BS 245**.

(s) Linseed oil shall be to **BS EN ISO 2007**

(t) Fluorescent paint shall be water based or oil based, as specified. Use fluorescent paint in conjunction with white flat water or oil base undercoat, priming coat to suit the surface being painted.

(u) Selection of colours for paintwork

i. The colours of paintwork shall be provisionally selected by the Engineer from a catalogue showing the range of colours offered by the manufacturers; the catalogue shall be submitted to the Engineer at least 14 days before painting starts.

ii. Trial panels shall be painted in each of the colours provisionally selected by the Engineer. Each trial panel shall be 1 m x 1 m and shall be painted with the complete paintwork system.

iii. The Engineer shall select the final colour of paintwork from the trial panel.

iv. Trial panels shall be used as a means of comparison for the colour of the finished paintwork. Trial panels shall be protected from damage and shall be left in position until the Engineer instructs their removal.

2.1.17.11.3 Storage of paint and associated materials

(a) Paint and associated materials shall be stored in a dry weatherproof store; the store shall be maintained in a cool, well ventilated condition.

(b) Tins of paint shall be labelled as being for external use, internal use, undercoating and finishing, as appropriate, and shall be protected from exposure to conditions which may adversely affect the material.

(c) Paint and associated materials shall be stored in accordance with the manufacturers' recommendations and shall not be used after the recommended shelf life has been exceeded.

2.1.17.11.4 Preparation of surfaces for painting

(a) Surfaces which are to be painted shall be dry and clean, and deleterious and loose material shall be removed.

(b) Absorbent surfaces which are to be painted with cement paint shall be thoroughly dampened to provide even suction.

(c) Knotting shall be applied to knots in timber.

(d) Screws and nails in timber and building board surfaces shall be recessed or punched below the finished surface and the whole surface shall be stopped.

(e) Plaster, cement render, masonry, concrete and similar surfaces shall be stopped and sealed. Scale and rust shall be removed from non-galvanized steel and ironwork; the surface shall be painted with rust inhibitor at least 12 hours before priming or shall be blast-cleaned in accordance with the paint manufacturer's recommendations.

(f) Surfaces adjacent to paintwork shall be temporarily masked to prevent contamination during painting.

2.1.17.11.5 Type and number of coats for painting system

(a) The type and number of coats applied to different surfaces for each painting system shall be as stated in Table 2.1.17.9 below:

(b) Paint and associated materials shall be applied in accordance with **BS 6150** and shall be mixed and applied in accordance with the manufacturers' recommendations.

(c) Painting shall not be carried out in wet or misty weather, in direct strong sunlight, or if in the opinion of the Engineer there is excessive dust in the atmosphere.

(d) Paint and associated materials shall be applied with bristle brushes or rollers. If mechanical spraying is permitted by the Engineer the primer coat, or the first undercoat if a primer coat is not required, shall be applied by brush.

(e) Primer coats shall be thoroughly brushed into all surfaces including joints, angles and sawn ends. Primer coats shall be applied to surfaces which will be inaccessible before fittings are fixed in position.

(f) Paint and associated materials shall not be applied until the underlying surface has been rubbed down with fine glass paper and is clean and dry.

(g) Undercoats and finishing coats shall be applied in an even film free from brush marks, sags and runs. If two hard gloss finishing coats are to be applied, the second coat shall be applied within 48 hours after the first coat.

(h) Cement paint shall be applied within 1 hour after mixing; a minimum of 12 hours drying time shall be allowed between coats.

(i) "Wet Paint" signs in English shall be prominently displayed adjacent to newly painted surfaces.

Table 2.1.17.9 :Type and number of coats for painting systems

Type and number of coats for painting systems

Painting system	Surface type	Primer		No. of undercoats	Finishing coat	
		Type	No. of coats		Type	No. of coats
A	Internal woodwork	Aluminium primer	1	1	Hard gloss	1

Type and number of coats for painting systems

Painting system	Surface type	Primer		No. of undercoats	Finishing coat	
		Type	No. of coats		Type	No. of coats
B	Internal woodwork natural finish	Polyurethanne primer	1	1	Polyurethane paint	1
				1		
C	External woodwork	Aluminium primer	1	2	Hard gloss	1
D	Hidden surfaces of woodwork and rough sawn timbering				Wood preservative	2
E	Non-structural internal bright steel	Zinc chromate metallic zinc-rich or lead primer	1	1	Hard gloss	1
F	Non-structural external bright steel	Zinc chromate metallic zinc-rich or lead primer	1	1	Hard gloss	1
G	Internal galvanized steel	Calcium plumbate primer	1	1	Hard gloss	1
H	External galvanized steel	Calcium plumbate primer	1	1	Hard gloss	1
I	Galvanized steel adjacent to the coast or sewerage treatment works	Epoxy red oxide chromate primer	1	1	Cold cure epoxy paint	1
J	Ironwork			1 before fixing	Bitumastic paint	2
K	Internal walls and ceilings	Alkali resistant primer	1		Semi-gloss plastic emulsion paint	2
L	External walls without tile or similar finishes				Cement paint	2

Type and number of coats for painting systems

Painting system	Surface type	Primer		No. of undercoats	Finishing coat	
		Type	No. of coats		Type	No. of coats
M	Structural steelwork	as stated in Structural Steelwork Section				

2.1.17.11.6 Workmanship

(a) Painting generally shall be in accordance with **BS 6150** and **BS 8000:Part. 12** and as described in the following clauses:-

i. Do not carry out work in wet humid or foggy weather, direct sunlight, or on surfaces which are not thoroughly dry, or if there is excess dust in the air.

ii. Ensure that all holes, cracks and other defects in surfaces have been made good prior to painting.

iii. Brush each coat well into the surface so that every part, including joints, junctions, angles, etc., is adequately covered, but take care to avoid excessive or uneven thickness of paint film, particularly at edges, angles and junction.

iv. Before applying coatings check that the moisture content of the substrate shall not adversely affect the completed work.

v. Apply coatings only to clean, dry surfaces after any previous coatings have hardened, and rub down smooth with fine glass paper before the subsequent coat is applied.

vi. Successive coats of paint shall be of slightly differing tints, and the intercoating time shall not exceed the limits recommended by the paint manufacturers.

vii. Apply coatings with approved bristle brushes of suitable size. Flat wall brushes shall be not less than 150 mm wide.

viii. Do not use rollers, cloths or gloves unless ordered or approved by the Engineer.

ix. Do not use mechanical spraying machines unless ordered or approved by the Engineer. When mechanical spray painting is ordered or permitted, the priming coat (or first undercoat, if no priming coat) shall be applied by brush.

x. Where required, prime and paint prior to fixing surfaces which become inaccessible.

xi. Remove all articles of ironmongery, hardware, etc. before painting and replace with matching screws (and plugs, if required,) of suitable size, after completion.

xii. Leave everything clean and completely free from all paint stains, splashes, etc.

xiii. Do not paint weatherstripping on metal windows or doors.

xiv. Touch up coated surfaces on completion, where ordered.

xv. Carry out decoration in colours to **BS 4800** as selected by the Engineer.

xvi. Paint sample panels as ordered and obtain approval before carrying out work.

(b) General protection and cleaning

i. Protect surfaces, fittings, furniture, and the like by suitable and approved means.

ii. Protect freshly applied surface coatings from damage.

iii. Exhibit "Wet Paint, in English signs and provide protective barriers where necessary.

iv. Protect surfaces adjacent to those being coated.

v. Remove and clean off all splashes whilst work is in progress, make good any damage, and leave work, and all areas in which work is executed, clean and perfect on completion.

2.1.17.11.7 Preparatory work

Unless specifically stated to the contrary, the descriptions of "Painting" work shall be understood to include all preparatory work required and necessary to produce a first class finish, free from all blemishes, brush marks, blisters and weeping and the following definitions are to apply where preparation is to be carried out:-

(a) "Wash down" shall mean either:-

i. the removal with clean water of all dirt, etc. not absorbed into the surface of a material not previously decorated, or

ii. the removal with clean water of existing limewash, non-washable distemper or similar material not absorbed into the decorated surfaces, or

iii. the removal of dirt, etc. from and cleaning down of, existing washable distempered, cement painted, synthetic painted and similarly decorated surfaces with sugar soap powder mixed with water, followed by further applications of clean water.

(b) “Broom down” shall mean the thorough dry brushing of any surface with a stiff broom or brush so as to remove all cobwebs, dust or loose particles.

(c) "Scrape" shall mean the removal of all existing coats of paint, limewash, colourwash, distemper, etc. by scraping tools without the use of chemical solvents or heat and without damage to the underlying material. Any damage so caused shall be made good. The surface shall be washed down on completion.

(d) "Wire brush" shall mean the thorough brushing of the surface with a stiff wire brush.

(e) "Strip" shall mean the complete removal, without damage to the underlying surface, of all existing coats of limewash, distemper, paint or other decorative material by means of washing and scraping together with the use of chemical solvents or heat, if necessary. After the use of chemical solvents the surfaces shall be washed down and neutralised in accordance with the manufacturer's recommendation.

(f) "Stop" to plaster shall mean carefully trimming the edges of all holes, cracks or crevices of any description and filling with an approved proprietary brand of filler or with Plaster of Paris to produce an even, flat surface, and touching up all patches with a coat of sealer prior to
repainting.

(g) "Stop" to woodwork shall mean the cleaning out and filling of all holes, cracks and crevices, etc.

(h) "Knot" to metal pipes shall mean the application of one coat of patent knotting to surface of any bitumen coated pipe.

(i) "Knot" to woodwork shall mean the application of a sufficient number of coats of "knotting" over all knots in the timber to prevent the bleeding of resin, etc. through the subsequent decoration.

(j) "Rub down" shall mean the rubbing of newly prepared surfaces, or surfaces of existing paint remaining after preparation for redecoration, with approved waterproof glass paper, pumice stone or similar, to give a true and keyed surface for new paint.

(k) "Fill" shall mean filling of grain with approved surface filler.

2.1.17.12 Ceiling finishes

2.1.17.12.1 Demountable suspended ceilings

(a) Generally

i. All suspended ceilings shall be polyester painted steel tiles supported in a concealed clip-in grid system, to **BS EN 13964:2004 + A1:2006**.

ii. Suspended ceiling tiles shall be 600 x 600mm with a sheet thickness of minimum 0.6mm.

iii. Finish to tiles shall be electrostatically applied polyester paint. Colour to be RAL 9010 20% gloss.

iv. Acoustic Ceilings shall be provided to areas with sound reduction performance requirement between a noise source and a sensitive area.

(b) Design requirements

i. Design ceiling suspension systems in accordance with **ASTM C636** and manufacturer's printed directions.

ii. Design tile ceiling system for adequate support of electrical fixtures as required by the current bulletin of the Electrical Safety Authority. Acoustic panel system is not designed to carry the weight of electrical equipment.

iii. Design hanger anchor and entire suspension system static loading not to exceed 25% of their ultimate capacity including lighting fixture dead loads.

iv. Design tile suspension system to support weight of mechanical and electrical items such as air handling boots and lighting fixtures, and with adequate support to

allow rotation/relocation of light fixtures. Acoustic panel system is not designed to carry the weight of mechanical and electrical equipment.

v. Design subframing as necessary to accommodate, to avoid conflicts and interferences where ducts or equipment prevent regular spacing of hangers.

(c) Submittals

1. Shop drawings: Submit shop drawings indicating:
   i. Suspension system layout including hangers and supports for acoustic tile system.
   ii. Acoustic panel system including suspension system, hangers, supports and panel sizes and locations.
   iii. Conditions at abutting, intersecting, and penetrating construction.
   iv. Dimensioned locations of lighting fixtures, diffusers, sprinkler heads and other items that pierce the ceiling plane.

2. Samples: Submit the following samples:
   i. One full-size sample of each type of tile panels to be used.
   ii. One of each type of suspension system members.

3. Certificates: Submit written certification stating that suspended ceiling system is designed for adequate support of electrical fixtures .

(d) Site conditions

1. Do not install the Work of this Section until:
   i. Mechanical and electrical Work above the ceiling is complete.
   ii. Relative humidity is below 80 %.
   iii. Ventilation is adequate to remove excess moisture.
   iv. Areas are closed an protected against weather, and maintained at no less than 50°F.
2. Install temporary protection and facilities to maintain product manufacturer's, and above specification, environmental requirements 24 h before, during, and after installation.

(e) Maintenance

i. Submit extra acoustic ceilings amounting to 2% of gross ceiling area, allowing proportionately for each pattern and type specified to nearest full carton.
ii. Submit Products which are part of same production run as installed Products.
iii. Store maintenance Products as directed by Engineer.

(f) Delivery, storage and handling

i. Transport, handle and store material in manner to prevent warp, twist, damage to panel edges and surfaces in accordance with Manufacturer's recommendations.
ii. Any warped and/or damaged panels and trim shall be rejected and be replaced by new, straight, undamaged and acceptable material at no cost to Employer.
iii. Bent, twisted or otherwise damaged Tee grid suspension components shall not be used under any circumstances. Replace such damaged items with new undamaged material at no additional cost to Employer.
iv. Store material in warm, dry place away from water and the elements. Protect against undue loading stresses and shock.

v. All packaged material shall be delivered in original manufacturers wrappers and containers with labels and seals intact.

(g) Materials

i. Galvanized steel sheet: **ASTM A653/A653-M**, Z275; cold rolled, galvanized steel sheet.

ii. Main carrying channels: **ASTM C645**; Channels formed from galvanized steel sheet, 38 x 19 mm cold rolled.

iii. Subframing: **ASTM C645**; Channels formed from galvanized steel sheet, dimensions

iv. and spans as required.

v. Hangers: 2.6 mm minimum diameter, galvanized steel wire.

vi. Tie wire: 1.6 mm minimum diameter, soft annealed galvanized steel wire.

vii. Wall mouldings and accessories, including but not limited to, corner caps, edge mouldings, panel hold over clip, metal closures, and trim. Finish and colour: same as main tees.

viii. Exposed main, cross tees, and relocatable cross tees: **ASTM C635/C635M-07**, 38 mm high steel, bulb tee design double steel web, rectangular single spans without exceeding a deflection of 1/360 of the span. Splices to be integral and reversible; cross tee interlocking into main tee.

ix. Acoustic tile: **ASTM E1264**, type 3, Form 2, Pattern CE. Wet-formed mineral fiber with factory applied vinyl latex paint. 600 x 600 x 16 mm thick square edge as indicated on Finish Schedule.

x. Metal acoustic tile: Perforated aluminum panel with satin silver metallic finish and nonwoven acoustical backing adhered to panels. 600 x 600 x 0.8 mm thick with round perforations in diagonal pattern providing 21% open area.

xi. Wall mouldings: To match acoustical ceiling suspension system.

xii. Eggcrate light cove louvres: Aluminum 12 mm deep, 12 mm x12 mm grid, colour to match wall moulding. Use wall moulding on all 4 sides for eggcrate louvre support.

(h) Workmanship

1. Suspension system

i. Coordinate locations and openings of mechanical and electrical services support, and penetration through the acoustical ceilings. Coordinate field conditions, clearances, measurements, and mechanical and electrical services testing and commissioning, above the acoustical ceilings.

ii. Install hanger wires plumb and securely anchored to the building structural framing, independent of walls, pipes, ducts, and metal deck; install additional framing and hangers to bridge interference items.

iii. Install acoustical ceiling systems in accordance with manufacturer's written instructions, reviewed shop drawings, and **ASTM C636**, listed in order of precedence.

iv. Install hanger wires at 1200 mm maximum centres along carrying channels, not less than 25 mm, and not more than 150 mm from channel ends.

v. Install additional hangers at lighting fixture and air distribution ductwork locations. Do not attach hanger wires to mechanical or electrical equipment. Do not support mechanical and electrical fixtures and fitting on ceiling without the ceiling manufacturer's written acceptance.

vi. Install acoustical ceiling suspension system to a tolerance of 1:1200 of span and 0.25 mm maximum between adjacent metal members. Tolerances are not cumulative. Refer to Electrical Contract Drawings for fixture layout.

vii. Do not bend or twist hangers as a means of levelling. Form double loops tightly and lock to prevent vertical movement or rotation within the loop.

viii. Install edge moulding at intersection of ceiling and vertical surfaces.

ix. Centre acoustical ceiling suspension systems on room axis; install equal border pieces.

x. Install hangers onto the ends of main tee runners at not more than 150 mm from ends of runners, adjacent and perpendicular to walls.

xi. Support the suspension system independently of walls, columns, ducts, pipes and conduits.

xii. Install main runners in maximum available lengths. Layout joints in suspension members to avoid the perimeters of recessed fixtures. Lock grid members to form a rigid assembly.

xiii. Install additional tee, suspension system framing around recessed fixtures, diffusers, grilles and other items for a complete assembly.

2. Acoustic lay-in tiles

i. Install acoustic tile in grid system openings supported by bottom flanges of members.

ii. Provide special shapes and sizes to provide a complete installation by cutting tile to fit into openings. Fit tile moderately tight between upright legs of members.

iii. Carefully cut and trim acoustic tiles to accommodate items piercing the finished ceiling plane.

iv. Secure metal panels into grid opening with concealed hold down clips.

v. Install moulding continuous around perimeter and level.

vi. Install eggcrate light cove louvres with inconspicuous butt and mitred corner joints and seat evenly.

vii. Remove and replace acoustic tiles with broken edges, or damaged, marked, discoloured, soiled, or stained faces.

(i) Adjustments and cleaning

Clean soiled or discoloured surfaces of exposed work on completion of work.

Replace components which are visibly damaged, marred or uncleanable.

2.1.17.12.2 Plasterboard ceiling

(a) Plasterboard ceilings to non-fire rated areas shall be as British Gypsum's CasoLine MF Concealed grid MF suspended ceiling system with 1No layer 12.5mm Gyproc wallboard, taped and jointed to receive paint finish.Insulation as required to achieve acoustic requirements of Building Regulations Part E.

(b) Plasterboard ceilings to non-fire rated areas and requiring moisture resistance shall be as British Gypsum's CasoLine MF Concealed grid MF suspended ceiling system with 1No layer 12.5mm Gyproc moisture resistant board, taped and jointed to receive paint finish. Insulation as required to achieve acoustic requirements of Building Regulations Part E.

(c) Plasterboard ceilings to fire rated areas shall be as British Gypsum's CasoLine MF Concealed grid MF suspended ceiling system, with 30mm stone mineral wool slab (45 kg/m^3) laid over grid and 2No layers 15mm Fireline wallboard, taped and jointed to receive paint finish.

(d) Contractor shall allow for the incorporation and support of luminaries, grilles, speakers, etc and co-ordinate the installation of the ceilings and lighting system.

2.1.17.13 References and Standards

BS EN 197-1(2011):Cement.Composition, specifications and conformity criteria for common cements.

BS EN 13964 (2004+A1:2006): Suspended ceilings. Requirements and test methods

BS EN 490 (2011): Concrete roofing tiles and fittings for roof covering and wall cladding. Product specifications

BS EN 491(2011): Concrete roof tiles and fittings for roof covering and wall cladding. Test methods

BS 8204-1 (2003+A1:2009): Screeds, bases and in situ floorings. Concrete bases and cementitious levelling screeds to receive floorings. Code of practice

BS 8204-2 (2003+A2:2011): Screeds, bases and in situ floorings. Concrete wearing surfaces. Code of practice
.
BS 8204-3 (2004+A2:2011): Screeds, bases and in situ floorings. Polymer modified cementitious levelling screeds and wearing screeds. Code of practice
.

BS 8204-4 (2004+A1:2011): Screeds, bases and in situ floorings. Cementitious terrazzo wearing surfaces. Code of practice

BS 8204-5 (2004+A1:2011): Screeds, bases and in situ floorings. Mastic asphalt underlays and wearing surfaces. Code of practice

ASTM C636/ C636M -13: Standard Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-In Panels

ASTM A653/653M-11 (2011): Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process

ASTM C645-13: Standard Specification for Nonstructural Steel Framing Members

ASTM A635/A635M-09b (2009): Standard Specification for Steel, Sheet and Strip, Heavy-Thickness Coils, Hot-Rolled, Alloy, Carbon, Structural, High-Strength Low-Alloy, and High-Strength Low-Alloy with Improved Formability.

ASTM E1264-08e1 (2008): Standard Classification for Acoustical Ceiling Products

BS EN 459-1 (2010): Building lime. Definitions, specifications and conformity criteria

BS EN 13914-2 (2005): Design, preparation and application of external rendering and internal plastering. Design considerations and essential principles for internal plastering

BS 8481(2006): Design, preparation and application of internal gypsum, cement, cement and lime plastering systems. Specification

BS EN 12878 (2005): Pigments for the colouring of building materials based on cement and/or lime. Specifications and methods of test.

BS EN 480-4 (2005): Admixtures for concrete, mortar and grout. Test methods. Determination of bleeding of concrete

BS EN 13658-1(2005): Metal lath and beads. Definitions, requirements and test methods. Internal plastering

BS EN 10223-2 (2012): Steel wire and wire products for fencing and netting. Hexagonal steel wire netting for agricultural insulation and fencing purposes.

BS EN 10244-2 (2009): Steel wire and wire products. Non-ferrous metallic coatings on steel wire. Zinc or zinc alloy coatings

BS EN 13279-1 (2008): Gypsum binders and gypsum plasters. Definitions and requirements

BS EN 13279-2 (2004):Gypsum binders and gypsum plasters. Test methods

BS EN 649 (2011): Resilient floor coverings. Homegeneous and heterogeneous polyvinyl chloride floor coverings. Specification

BS EN 12104 (2000): Resilient floor coverings. Cork floor tiles. Specification

BS EN ISO 105-C06 (2010):Textiles. Tests for colour fastness. Colour fastness to domestic and commercial laundering

BS 2677

BS 3661

BS 1202-1 (2002): Specification for nails. Steel nails

PD CEN/TR 15123 (2005): Design, preparation and application of internal polymer plastering systems

BS EN 13914-1 (2005): Design, preparation and application of external rendering and internal plastering. External rendering

BS 8212 (1995): Code of practice for dry lining and partitioning using gypsum plasterboard.

BS 5270-1 (1989): Bonding agents for use with gypsum plasters and cement. Specification for polyvinyl acetate (PVAC) emulsion bonding agents for indoor use with gypsum plasters.

BS EN 13055-1(2002): Lightweight aggregates. Lightweight aggregates for concrete, mortar and grout

BS 8000-9 (2003): Workmanship on building sites.Cementitious levelling screeds and wearing screeds. Code of practice.

BS 8000-10 (1995): Workmanship on building sites. Code of practice for plastering and rendering.

BS 8000-12 (1989): Workmanship on building sites.Code of practice for decorative wallcoverings and painting.

BS 5385-1 (2009): Wall and floor tilingDesign and installation of ceramic, natural stone and mosaic wall tiling in normal internal conditions. Code of practice

BS 4223 (1989): Methods for determination of constructional details of textile floor coverings with yarn pile.

BS ISO 2094 (1999): Textile floor coverings. Determination of thickness loss under dynamic loading.

BS 4098 (1975): Method of determination of thickness, compression and recovery characteristics of textile floor coverings.

BS 4682-2(1988): Methods of test for dimensional stability of textile floor coverings. Determination of dimensional changes due to changes in ambient humidity

BS 4682-3 (1981): Methods of test for dimensional stability of textile floor coverings Determination of dimensional changes after exposure to heat.

BS 4790 (1987): Method of determination of the effects of a small source of ignition on textile floor coverings (hot metal nut method).

BS 4797 (1978, ISO 3998-1977): Method of test for textiles-determination of resistance to certain insect pests.

BS EN 12620 (2013): Aggregates for concrete

BS 1197-2 (1973): Specification for concrete flooring tiles and fittings.Metric Units.

BS EN 14411(2012): Ceramic tiles. Definitions, classification, characteristics, evaluation of conformity and marking

BS EN 13748-1 (2004): Terrazzo tiles. Terrazzo tiles for internal use

BS EN 13748-2 (2004): Terrazzo tiles. Terrazzo tiles for external use

BS EN 1338 (2003): Concrete paving blocks. Requirements and test methods

BS 7533-3 (2005+A1:2009): Pavements constructed with clay, natural stone or concrete pavers. Code of practice for laying precast concrete paving blocks and clay pavers for flexible pavements

BS EN 654 (2011): Resilient floor coverings. Semi-flexible polyvinyl chloride tiles.Specification

BS 5808 (1991): Specification for underlays for textile floor coverings.

BS 5325 (2001): Installation of textile floor coverings. Code of practice

BS 6266 (2011):Fire protection for electronic equipment installations. Code of practice

BS 476-6 (1989+A1:2009): Fire tests on building materials and structures. Methods of test for fire propagation for products.

BS 476-7 (1997): Fire tests on building materials and structures.Method of test to determine the classification of the surface spread of flame of products.

BS 1982 (1990): Fungal resistance of panel products made of or containing materials of organic origin.

BS 4756 (1998): Specification for ready-mixed aluminium priming paints of woodwork.

BS 4652 (1995): Specification for zinc-rich priming paint (organic media).

BS 2523 (1996): Specification for lead based priming paints.

BS 3698 (1964): Specification for calcium plumbate priming paints.

BS 1070 (1993): Specification for black paint (tar based).

BS 6949 (1991): Specification for bitumen-based coatings for cold application excluding use in contact with potable water.

BS 1336 (1971): Specification for knotting.

BS 544 (1969): Specification for linseed oil putty for use in wooden frames.

BS 245 (1976: 2000): Specification for mineral solvents (white spirit and related hydrocarbon solvents) for paints and other purposes.

BS EN ISO 150 (2007): Raw, refined and boiled linseed oil for paints and varnishes. Specifications and methods of test

BS 6150 (2006): Painting of buildings. Code of practice

BS 4800 (2011): Schedule of paint colours for building purposes.

BS 5385-1 (2009): Wall and floor tiling. Design and installation of ceramic, natural stone and mosaic wall tiling in normal internal conditions. Code of practice.

BS 5385-2 (2006): Wall and floor tiling. Design and installation of external ceramic and mosaic wall tiling in normal conditions. Code of practice.

BS 5385-3 (2007): Wall and floor tiling. Design and installation of internal and external ceramic and mosaics floor tiling in normal conditions. Code of practice.

BS 5385-5 (2009): Wall and floor tiling. Design and installation of terazzo, natural stone and agglomerated stone tile and slab flooring. Code of practice.

BS EN 520 (2004+A1:2009): Gypsum plasterboards. Definitions, requirements and test methods

BS EN 651 (2011): Resilient floor coverings. Polyvinyl chloride floor coverings with foam layer. Specification

BS 1711 (1975): Specification for solid rubber flooring

BS EN ISO 10595 (2012): Resilient floor coverings. Semi-flexible/vinylcomposition (VCT) poly(vinyl chloride) floor tiles. Specification

2.1.18 HANDRAILING, LADDERS, STAIRS AND FLOORING

2.1.18.1 Materials

2.1.18.1.1 Steel

(a) Steel for handrailing, ladders, stairs and flooring shall comply with the following:

Steel tubes and tubulars suitable for screwing to **BS 21** pipe threads :	**BS EN 10255:2004**
Hot rolled sections :	**BS 4: Part 1**
Hot rolled structural steel sections	
- equal and unequal angles :	**BS EN 10056-1**
- hollow sections :	**BS EN 10210-2**
Weldable structural steels :	**BS EN1027-2, BS 6131, BS EN 10029.**

2.1.18.1.2 Stainless steel

(a) Stainless steel for handrailing, ladders, stairs and flooring shall be grade 304 S 15 complying with **BS EN 10095** and **BS EN 10250-4**. Stainless steel tubes shall be longitudinally welded tubes complying with **BS EN 10296**, designation LW 21 GZF(S). Tubes for handrails shall be polished.

2.1.18.1.3 Aluminium

(a) Aluminium for handrailing, ladders, stairs and flooring shall be type H 30 TF and shall comply with the following:

Wrought aluminium and aluminium alloys for general engineering purposes	
- plate, sheet and strip :	**BS EN 485**
- drawn tube :	**BS EN 515**
- bars, extruded round tubes and sections :	**BS EN 573-3(2005 & 2007)**

(b) Aluminium shall be anodised to Grade AA 25 in accordance with **BS EN ISO 7599:2010.**

2.1.18.1.4 Bolts, nuts, screw, washers and rivets

(a) Bolts, nuts, screws, washers and rivets shall comply with the following:

ISO metric black hexagon bolts, screws and nuts :	**BS 4190**
ISO metric black cup and countersunk headbolts and screws with hexagon nuts :	**BS 4933**
Metal washers for general engineering purposes :	**BS 4320**
Rivets for general engineering purposes :	**BS 4620**
Wrought aluminium and aluminium alloys for general engineering purposes	
- rivet, bolt and screw stock :	**BS 1473**
Stainless steel fasteners :	**BS EN ISO 3506**

(b) The length of bolts shall be such that the threaded portion of each bolt projects through the nut by at least one thread and by not more than four threads.

(c) Rag, indented bolts, expansion bolts and resin bonded bolts shall be a proprietary type approved by the Engineer and shall be capable of withstanding the design working load.

(d) Galvanized bolts, nuts, screws, washers and rivets shall be used with galvanized handrailing, ladders, stairs and flooring and aluminium bolts, nuts, screws, washers and rivets shall be used with aluminium handrailing, ladders, stairs and flooring; stainless steel bolts, nuts, screws, washers and rivets shall be used with other types of handrailing, ladders, stairs and flooring. Bolts, nuts, screws and washers shall be insulated from aluminium by non-metallic washers and sleeves.

2.1.18.1.5 Cement mortar

(a) Mortar for grouting fixing bolts shall consist of 1 part of cement to 3 parts of sand together with the minimum amount of water necessary to achieve a consistency suitable for completely filling the bolt holes. The mix shall contain a non-shrink admixture.

(b) Resin grout shall be proprietary type approved by the Engineer and shall contain a non-shrink admixture.

(c) Mortar for building in curbs for metal flooring shall consist of 1 part of cement to 3 parts of sand together with the minimum amount of water necessary to achieve a consistency suitable for the work. The mix shall contain a non-shrink admixture.

2.1.18.2 Design by contractor

2.1.18.2.1 Design by Contractor

(a) Handrailing, ladders, stairs and flooring which are to be designed by the Contractor shall comply with the following requirements:

i. Handrailing shall be capable of withstanding a horizontal loading of 740 N/m. The deflection of handrailing shall not exceed 1 in 200 at mid-span.

ii. Stairs shall be designed for a live loading of 5 kPa.

iii. Flooring shall be designed for a live loading of 5 kPa. The deflection of flooring shall not exceed 1/200 of the span.

2.1.18.3 Fabrication of handrailing, ladders, stairs and flooring

2.1.18.3.1 Fabrication of steelwork

(a) Steelwork for handrailing, ladders, stairs and flooring shall be fabricated in accordance with BS **EN 1090-2:2008+A1:2011**

2.1.18.3.2 Galvanizing to steel

(a) Steel which is to be galvanized shall be hot-dip galvanized in accordance with **BS EN ISO 1461** to a coating thickness of at least 500 g/m^2.

(b) Galvanizing to steel shall be applied after welding, drilling and cutting are complete.

2.1.18.3.3 Welding steel

(a) Welds to steel for handrailing, ladders, stairs and flooring shall be full depth fillet welds. The welded surface shall be clean and flush before application of the protective coating.

(b) Steel shall not be welded after galvanizing unless permitted by the Engineer; if permitted, the welded areas shall be free from scale and slag and shall be treated with appropriate coating system approved by the Engineer which is compatible with the protective system of the parent material.

2.1.18.3.4 Fabrication of handrailing

(a) Handrailing shall be discontinued at movement joints in structures. The spacing between standards shall be regular and shall not exceed 1.6 m. Curved handrailing shall not be made up of a series of straights.

2.1.18.3.5 Fabrication of ladders

(a) Ladders shall comply with **BS 4211**

i. Steel ladders shall be hot-dip galvanized.
ii. Aluminium ladders shall be Grade 6082 aluminium.
iii. Rungs, extended stringers, safety cages and brackets shall be welded to the stringers of ladders.
iv. Rungs on aluminium ladders shall have longitudinal grooves and pressed aluminium alloy caps shall be fixed to open ends.

2.1.18.3.6 Fabrication of stairs

(a) Stairs shall comply with **BS 5395: Part 1**.

2.1.18.3.7 Fabrication of flooring

(a) The shape of each panel of flooring shall be such that the panel can be easily removed. The mass of each panel shall not exceed 40 kg. Where intermediate supports are provided to support flooring they shall be capable of being removed to provide the specified clear opening.

(b) Curbs shall be provided in concrete surfaces for flooring.

(c) Cut-outs in flooring shall be neatly shaped and shall be provided with toe plates. Cut-outs in open mesh flooring shall be trimmed with edge bars welded to the bearing bars. The clearance between the edge of cutouts and the component passing through the cut-out shall not exceed 30mm.

(d) The bearing bars in open mesh flooring shall be welded to the nosing bars. The transverse bars shall be rivetted or welded to the bearing bars. Panels of open mesh flooring shall be secured with adjustable fixing clips.

(e) Chequer plate flooring shall have a non-slip pattern of a type approved by the Engineer and shall be provided with lifting holes. The flooring shall be secured to curbs by countersunk screws.

2.1.18.3.8 Fabrication of toe plates

(a) Toe plates shall be fixed to handrail standards by brackets and shall be bolted or welded to stairs and flooring.

2.1.18.3.9 Fabrication of safety chains

(a) Safety chains shall comply with **BS EN 818** and shall be capable of withstanding a breaking force of 30 kN and a proof force of 15 kN.

(b) Steel safety chains shall be 8 mm nominal size, Grade M4 noncalibrated chain Type 1 and shall be hot-dip galvanized.

(c) The links of stainless steel safety chains shall be welded and shall have an internal length exceeding 45 mm and an internal width of between 12 mm and 18 mm. Fins caused by welding shall be removed.

(d) Hooks on chains shall be fitted with a sprung securing device.

2.1.18.4 Submissions

2.1.18.4.1 Particulars of handraining, stairs, ladders and flooring

(a) The following particulars of the proposed handrailing, ladders, stairs and flooring shall be submitted to the Engineer:

i. details of manufacturer's name and place of manufacture,

ii. a certificate showing that the materials comply with the requirements stated in the Contract,

iii. drawings showing layout and details of handrailing, including

iv. positions of the different type of standards,

v. drawings showing details of ladders, stairs, toe plates and safety chains,

vi. drawing showing layout and details of flooring, including positions and sizes of panels and supports,

vii. details of methods of fixing and of rag, indented, expansion and resin bonded bolts, including manufacturer's literature, and design details.

(b) The particulars shall be submitted to the Engineer at least 14 days before fabrication starts.

2.1.18.4.2 Samples of materials

(a) The following samples of the proposed handrailing, ladders, stairs and flooring shall be submitted to the Engineer at least 14 days before the relevant work starts:

i. handrails,

ii. standards,

iii. ladders, including rungs,

iv. toe plates,

v. flooring and curbs,

vi. safety chains, and

vii. rag, indented, expansion and resin bonded bolts.

(b) The details of samples shall be as instructed by the Engineer.

2.1.18.5 Storage of materials

2.1.18.5.1 Storage of handrailing, ladders, stairs and flooring

(a) Handrailing and flooring shall be stored on level supports in a dry weatherproof store and in a manner which will not result in damage or deformation to the materials or in contamination of the materials.

(b) Handrailing, ladders, stairs and flooring shall be protected from damage and damaged handrailing, ladders, stairs and flooring shall not be used in the permanent work unless permitted by the Engineer.

2.1.18.6 Installation of handrailing, ladders, stairs, and flooring

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2.1.18.6.1 Installion of handrailing, ladders and flooring

(a) Handrailing shall be installed to a smooth alignment.

(b) Handrail standards, flanges, ladders and stairs shall be bolted to metalwork and shall be fixed to concrete using rag, indented, expansion or resin bonded bolts. The bolts shall be fitted into pockets left in the concrete and the pockets shall be filled with cement mortar or resin grout.

2.1.18.6.2 Installation of flooring

(a) Flooring and curbs shall be flush with the adjoining surfaces.

(b) Curbs shall be fitted into rebates left in the concrete and the rebates shall be filled with cement mortar.

(c) Flooring shall be closely butted and the gap between panels and curbs, adjacent panels and other surfaces shall not exceed 10 mm.

2.1.18.7 Tolerances

2.1.18.7.1 Tolerances: handrailing, ladders, stairs and flooring

(a) Handrailing, ladders, stairs and flooring shall comply with the following requirements:

i. The position and height of handrailing shall be within 10 mm of the specified position and height.

ii. The level of the top rung of ladders and the top tread of stairs shall be within 75 mm of the specified level.

iii. The level of flooring and curbs shall be within 3 mm of the specified level.

2.1.18.8 References and Standards

BS END 10255 (2004):Non-alloy steel tubes suitable for welding and threading. Technical delivery conditions

BS 4-1 (2005): Structural steel sections. Specification for hot-rolled sections

BS END 10210-2 (2006): Hot finished structural hollow sections of non-alloy and fine grain steels. Tolerances, dimensions and sectional properties.

BS END 10056-1 (1999): Specification for structural steel equal and unequal angles. Dimensions.

BS END 10025-6 (2004+A1:2009): Hot rolled products of structural steels. Technical delivery conditions for flat products of high yield strength structural steels in the quenched and tempered condition

BS 7668 (2004): Weldable structural steels. Hot finished structural hollow sections in weather resistant steels. Specification

BS END 10029 (2010): Hot-rolled steel plates 3 mm thick or above. Tolerances on dimensions and shape

BS END 10226-1 (2004): Pipe threads where pressure tight joints are made on the threads. Taper external threads and parallel internal threads. Dimensions, tolerances and designation

BS END 10095: (1999) Heat resisting steels and nickel alloys

BS END 10296-1 (2003): Welded circular steel tubes for mechanical and general engineering purposes. Technical delivery conditions. Non-alloy and alloy steel tubes

BS END 485-1 (2008+A1:2009): Aluminium and aluminium alloys. Sheet, strip and plate. Technical conditions for inspection and delivery

BS END 515 (1993): Aluminium and aluminium alloys. Wrought products. Temper designations

BS END 573-3 (2003): Aluminium and aluminium alloys. Chemical composition and form of wrought products. Chemical composition

BS END 573-3 (2009): Aluminium and aluminium alloys. Chemical composition and form of wrought products. Chemical composition and form of products

BS END 12373-1 (2001): Aluminium and aluminium alloys. Anodizing. Method for specifying decorative and protective anodic oxidation coatings on aluminium

BS 4190 (2001) ISO metric black hexagon bolts, screws and nuts. Specification

BS 4320 (1968): Specification for metal washers for general engineering purposes.

BS 4620 (1970): Specification for rivets for general engineering purposes.

BS 1473 (1972): Specification for wrought aluminium and aluminium alloys for general engineering purposes - rivet, bolt and screw stock.

BS END ISO 3506-1 (2009): Mechanical properties of corrosion resistant stainless steel fasteners. Bolts, screws and studs.

BS END ISO 3506-2 (2009): Mechanical properties of corrosion resistant stainless steel fasteners. Nuts.

BS END ISO 1461 (2009): Hot dipped galvanised coatings on fabricated iron and steel articles. Specifications and test methods.

BS 4211(2005+A1:2008): Specification for permanently fixed ladders.

BS 5395-1 (2010): Stairs. Code of practice for the design,of stairs with straight flight and winders.

BS END 818-1(1996+A1:2008): Short link chain for lifting purposes. Safety. General conditions of acceptance

BS END 1090-2 (2008+A1:2011):Execution of steel structures and aluminium structures. Technical requirements for steel structures

BS END 1027 (2000): Windows and doors. Watertightness. Test method

BS 6131 (1982): Glossary of terms relating to household sewing machines

BS END 10250-4 (2000): Open steel die forgings for general engineering purposes. Stainless steels

BS END ISO 7599 (2010): Anodizing of aluminium and its alloys. General specifications for anodic oxidation coatings on aluminium

BS 4933 (2010): Specification for ISO metric black cup and countersunk head bolts and screws with hexagon nuts

2.1.19 METAL COMPOSITE PANEL CLADDING/COVERING

2.1.19.1 Wall cladding

2.1.19.1.1 General performance

(a) Wall cladding to be constructed to achieve a U value of 0.35 w/m²/K and shall comprise a colour coated outer sheet bonded to polyurethane insulation bonded to a metal inner sheet finished in white. Substrate to be ZA255 Galvalloy hot dip zinc-aluminium alloy coated steel to **BS END 10346:2009** Grade Fe E220G with a Z275 coating. Flashings, trims, drips and closers shall provide a completely watertight construction.

(b) Insulated cladding panels with a nominal 200 micron white plastisol coating internally and all joints sealed with a butyl rubber sealant.

(c) External corners shall be constructed from 0.7mm matching HP200 colour coated pressed metal flashings.

(d) Colour and finish of outer face to be leather grain plastisol to standard **BS 4800: 2011** colours.

2.1.19.2 Materials

2.1.19.2.1 Steel sheet

(a) Galvanized-Steel Sheet: ZA255 Galvalloy hot dip zinc-aluminium alloy coated steel to **BS END 10346: 2009** Grade Fe E220G with a Z275 coating.

(b) Corrugated Metal Wall Panels: Provide corrugated metal wall panel cladding system fabricated primarily from a manufacturers standard galvanized steel sheet.panels formed to sizes, shapes and profiles shown and as required to suit performance criteria but not less than 18 gauge. thick. Design system to be complete with all framing members, fasteners, shims, clips, perimeter extrusions, panel extrusions, stiffeners, anchors, gaskets, and wet sealant components.

The corrugated metal cladding system shall be custom fabricated so that the panels are secure yet accommodate expansion and contraction; and that individual panels may be installed using concealed fasteners. All steel cladding members shall be factory finished in corrugated manufacturers standard baked enamel finish in custom colour to match the aluminum window colour.

2.1.19.2.2 Aluminium sheet

(a) Flat Metal Wall Panels: Provide flat metal wall panel cladding system fabricated primarily from aluminum composite panels formed to sizes, shapes and profiles shown and as required to suit performance criteria but not less than 6 mm thick. Design system to be complete with all aluminum framing members, fasteners, shims, clips, perimeter extrusions, panel extrusions, stiffeners, anchors, gaskets, and wet sealant components. The flat metal cladding system shall be custom fabricated so that the composite panels are secure yet accommodate expansion and contraction; and that individual panels may be installed or removed with a minimum amount of disturbance to adjacent components using concealed fasteners. Design support system to avoid penetrating waterproofing systems indicated. All aluminum members shall be finished to match the aluminum windows.

2.1.19.3 Submittals

2.1.19.3.1 Product data

(a) Submit product data for each type of cold-formed metal framing, accessory, and product specified. Include manufacturer's product specifications, standard details, and general recommendations, as applicable to materials and finishes for each component and for total panel assemblies.

2.1.19.3.2 Shop drawings

(a) Submit shop drawings showing layout, spacings, sizes, thicknesses, and types of cold-formed metal framing, fabrication, fastening and anchorage details. Show reinforcing channels, opening framing, supplemental framing, strapping, bracing, accessories, connection details, and attachments to other units of Work. Plans and elevations shall be submitted at not less than 1:50 scale, details of sections and connections shall be shown at not less than 1:5 scale. Show layouts of panels, thickness and dimensions of parts, details of corner conditions, joints, panel profiles, supports, anchorages, trim, flashings, closures, and special details.

2.1.19.3.3 Mill certificate

(a) Submit mill certificates signed by manufacturers of cold-formed metal framing certifying that their products comply with requirements, including uncoated steel thickness, yield strength, elongation, and galvanized-coating thickness.

2.1.19.3.4 Welding

(a) Submit current welder certificates signed by Contractor certifying that welders (both field and shop) comply with requirements specified under **BS END 1011-1 and BS END 1011-2.**

2.1.19.3.5 Samples

(a) Samples: Provide two sample panels 305 mm long by actual panel width, in each profile, style, colour, and texture indicated. Include clips, caps, fasteners, closures, and other exposed panel accessories.

i. **Panel Mock-Up: Provide a 600 mm by 600 mm square mock-up of the flat metal wall panels with a typical joint in the middle to demonstrate the joint appearance and the concealed anchorage system for the panels to the substrate.**

(b) Submit manufacturer's colour charts and chips approximately 100mm x 100mm, showing full range of colours, textures and patterns available for wall panels with factory applied finishes.

2.1.19.4 Fabrication

2.1.19.4.1 Panels

(a) Fabrication and finish metal wall panels and accessories at the factory to greatest extent possible, by manufacturer's standard procedures and processes and as necessary to fulfil indicated performance requirements. Comply with indicated profiles and with dimensional and structural requirements.

(b) Provide panel profile, including major ribs and intermediate stiffening ribs, if any, for full length of panel. Fabricate metal wall panel side laps with factory-installed captive gaskets or separator strips that provide a tight seal and prevent metal-to-metal contact, in a manner that will seal weather tight and minimize noise from movements within panel assembly.

2.1.19.4.2 Sheet metal accessories

(a) Fabricate flashing and trim to comply with recommendations in SMCNA 1793 that apply to the design, dimensions,metal, and other characteristics of item indicated:

i. Form exposed sheet metal accessories that are without excessive oil canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.
ii. End seams: fabricate non-moving and seams with flat-lock systems. Form seals and seal with epoxy seam sealer. Rivet joints for additional strength.
iii. Sealed joints: form non-expansion but movable joints in metal to accommodate elastometric sealant to comply with SMCNA 1793
iv. Concealed fasteners and expansion provisions where possible.Exposed fasteners are not allowed on faces of accessories exposed to view.
v. Fabricate cleats and attachment devices of size and metal thickness recommended by SMCNA 1793 or by the metal wall panel manufacturer for application, but not less than thickness of metal being secured.

2.1.19.4.3 Fasteners

(a) Exposed fasteners

i. Provide corrosion resistant fasteners for wall panels, made of coated steel, aluminum, [300 - series corrosion resisting stainless steel][305 -series corrosion resisting stainless steel], or nylon capped steel compatible with the sheet panel or flashing and of a type and size recommended by the manufacturer to meet the performance requirements and design loads.

ii. Fasteners for accessories must be the manufacturer's standard. Provide an integral metal washer matching the colour of attached material with compressible sealing EPDM gasket.

(b) Hidden fasteners:

i. Provide corrosion resistant fasteners recommended by the manufacturer to meet the performance requirements and design loads.

(c) Screws:

i. Screws to be corrosion resistant coated steel, aluminum and/or [300 - series][305 - series] stainless steel being the type and size recommended by the manufacturer to meet the performance requirements.

(d) Rivets:

i. Rivets to be closed-end type, corrosion resistant coated steel, aluminum or stainless steel where watertight connections are required.

(e) Attachment clips:

i. Fabricate clips from steel hot-dipped galvanized in accordance with BS END ISO 1461 (1999). Size, shape, thickness and capacity as required meeting the insulation thickness and design load criteria specified.

2.1.19.4.4 Accessories

(a) General

i. All accessories must be compatible with the metal wall panels. Sheet metal flashing, trim, metal closure strips, caps and similar metal accessories must not be less than the minimum thickness specified for the wall panels.

ii. Exposed metal accessories/finishes to match the panels furnished, except as otherwise indicated. Molded foam rib, ridge and other closure strips must be non-absorbent closed-cell or solid-cell synthetic rubber or pre-molded neoprene to match configuration of the panels.

(b) Rubber Closure Strips

i. Provide closed-cell, expanded cellular rubber conforming to ASTM D 1056 and ASTM D 1667; extruded or molded to the configuration of the specified wall panel and in lengths supplied by the wall panel manufacturer.

(c) Metal Closure Strips

i. Provide factory fabricated [aluminum][steel] closure strips to be the same[gauge][thickness], colour, finish and profile of the specified wall panel.

(d) Joint Sealants

i. Sealants and Caulking
Provide approved gun type sealants for use in hand- or air-pressure calking guns at temperatures above 4 degrees C (or frost-free application at temperatures above minus 12 degrees C) with minimum solid content of 85 percent of the total volume. Sealants must dry with a tough, durable surface skin which permit remaining soft and pliable underneath, providing a weather-tight joint. No migratory staining is permitted on painted or unpainted metal, stone, glass, vinyl, or wood.
Prime all joints receiving sealants with a compatible one-component or two-component primer as recommended by the wall panel manufacturer.

ii. Shop-Applied
Sealant for shop-applied caulking must be an approved gun grade, non-sag one component polysulfide or silicone conforming to ASTM C 920, Type II, and with a curing time to ensure the sealant's plasticity at the time of field erection.

iii. Field-Applied
Sealant for field-applied caulking must be an approved gun grade, non-sag one component polysulfide or two-component polyurethane with an initial maximum Shore A durometer hardness of 25, and conforming to ASTM C 920,Type II. Colour to match panel colours.

iv. Pressure Sensitive Tape
Provide pressure sensitive tape sealant, 100% solid with a release paper backing; permanently elastic, non-sagging, non-toxic and non-staining as approved by the wall panel manufacturer.

2.1.19.4.5 Sheet metal flashing and trim

(a) Fabrication

i. Shop fabricate sheet metal flashing and trim where practicable to comply with recommendations in SMACNA 1793 that apply to design, dimensions, metal, and other characteristics of item indicated. Obtain field measurements for accurate fit before shop fabrication.

ii. Fabricate sheet metal flashing and trim without excessive oil canning, buckling, and tool marks and true to line and levels indicated, with exposed edges folded back to form hems.

2.1.19.5 Execution

2.1.19.5.1 Examination

(a) Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, metal wall panel supports, and other conditions affecting performance of the Work. Examine primary and secondary wall framing to verify that rafters, purlins, angles, channels, and other structural panel support members and anchorages have been installed within alignment tolerances required by metal wall panel manufacturer and as required for the geographical area where construction will take place.

(b) Examine solid wall sheathing to verify that sheathing joints are supported by framing or blocking and that installation is within flatness tolerances required by metal wall panel manufacturer.

(c) Examine roughing-in for components and systems penetrating metal wall panels to verify actual locations of penetrations relative to seam locations of metal wall panels before metal wall panel installation.

(d) Submit to the Engineer a written report, endorsed by Installer, listing conditions detrimental to performance of the Work. Proceed with installation only after unsatisfactory conditions have been corrected.

2.1.19.5.2 Preparation

(a) Clean substrates of substances harmful to insulation, including removing projections capable of interfering with insulation attachment.

(b) Miscellaneous framing installation, including sub-purlins, girts, angles, furring, and other miscellaneous wall panel support members and anchorage must be according to metal wall panel manufacturer's written instructions.

2.1.19.5.3 Wall panel installation

(a) Provide full length metal wall panels, from sill to eave as indicated, unless otherwise indicated or restricted by shipping limitations. Anchor metal wall panels and other components of the Work securely in place, with provisions for thermal and structural movement.

(b) Erect wall panel system in accordance with the approved erection drawings, the printed instructions and safety precautions of the manufacturer.

(c) Sheets are not to be subjected to overloading, abuse, or undue impact. Bent, chipped, or defective sheets shall not be applied.

(d) Sheets must be erected true and plumb and in exact alignment with the horizontal and vertical edges of the building, securely anchored, and with the indicated eave, and sill.

(e) Work is to allow for thermal movement of the wall panel, movement of the building structure, and to provide permanent freedom from noise due to wind pressure.

(f) Field cutting metal wall panels by torch is not permitted.

(g) Use stainless-steel fasteners for exterior surfaces and galvanized steel fasteners for interior surfaces.

(h) Use aluminum or stainless-steel fasteners for exterior surfaces and aluminum or galvanized steel fasteners for interior surfaces.

(i) Anchor metal wall panels and other components of the Work securely in place, using manufacturer's approved fasteners according to manufacturers' written instructions.

(j) Where dissimilar metals will contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with bituminous coating, by applying rubberized-asphalt underlayment to each contact surface, or by other permanent separation as recommended by metal wall panel manufacturer.

(k) Install gaskets, joint fillers, and sealants where indicated and where required for weatherproof performance of metal wall panel assemblies. Provide types of gaskets, fillers, and sealants indicated or, if not indicated, types recommended by metal wall panel manufacturer.

2.1.19.5.4 Fastener installation

(a) Anchor metal wall panels and other components of the Work securely in place, using manufacturer's approved fasteners according to manufacturers' written instructions.

2.1.19.5.5 Flashing, trim and closure installation

(a) Comply with performance requirements, manufacturer's written installation instructions, and SMACNA 1793. Provide concealed fasteners where possible, and set units true to line and level as indicated.

(b) Install work with laps, joints, and seams to form permanently watertight and weather resistant.

(c) Install sheet metal work is to form weather-tight construction without waves, warps, buckles, fastening stresses or distortion, and allow for expansion and contraction. Cutting, fitting, drilling, and other operations in connection with sheet metal required to accommodate the work of other trades is to be performed by sheet metal mechanics.

(d) Install exposed metal flashing at building corners, sills and eaves, junctions between metal siding and walling. Exposed metal flashing must be the same material, colour, and finish as the specified metal wall panel.

(e) Exposed flashing and flashing subject to rain penetration to be bedded in the specified joint sealant.

(f) Isolate flashing which is in contact with dissimilar metals by means of the specified asphalt mastic material to prevent electrolytic deterioration. Form drips to the profile indicated, with the edge folded back 12mm to form a reinforced drip edge.

(g) Install metal closure strips at open ends of corrugated or ribbed pattern walls, and at intersection of wall and wall unless open ends are concealed with formed eave flashing; and in other required areas.

(h) Install mastic closure strips at intersection of the wall with metal walling; top and bottom of metal siding; heads of wall openings; and in other required locations.

2.1.19.6 Workmanship

(a) Make lines, arises, and angles sharp and true. Free exposed surfaces from visible wave, warp, buckle, and tool marks. Fold back exposed edges neatly to form a 1/2 inch hem on the concealed side. Make sheet metal exposed to the weather watertight with provisions for expansion and contraction.

(b) Make surfaces to receive sheet metal plumb and true, clean, even, smooth, dry, and free of defects and projections which might affect the application. For installation of items not shown in detail or not covered by specifications conform to the applicable requirements of SMACNA 1793.

(c) Provide sheet metal flashing in the angles formed where roof decks abut walls, curbs, ventilators, pipes, or other vertical surfaces and wherever indicated and necessary to make the work watertight.

2.1.19.7 Acceptance provisions

2.1.19.7.1 Erection Tolerances

(a) Erect metal wall panels straight and true with plumb vertical lines correctly lapped and secured in accordance with the manufacturer's written instructions.

2.1.19.7.2 Leakage Tests

(a) Finished application of metal wall panels are to be subject to inspection and test for leakage by request of the Engineer. Conduct inspection and tests at no cost to the Employer.

(b) Inspection and testing is to be made promptly after erection to permit correction of defects and the removal and replacement of defective materials.

2.1.19.7.3 Repais to finish

(a) Scratches, abrasions, and minor surface defects of finish may be repaired with the specified repair materials. Finished repaired surfaces must be uniform and free from variations of colour and surface texture.

(b) Repaired metal surfaces that are not acceptable to the project requirements and/or Enginer are to be immediately removed and replaced with new material.

2.1.19.7.4 Paint-Finish Metal Siding

(a) Paint-finish metal siding will be tested for colour stability by the Engineer during the manufacturer's specified guarantee period.

(b) Panels that indicate colour changes, fading, or surface degradation, determined by visual examination, must be removed and replaced with new panels at no expense to the Employer.

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(c) New panels will be subject to the specified tests for an additional year from the date of their installation.

2.1.19.8 Field quality control

2.1.19.8.1 Construction Monitoring

(a) Make visual inspections as necessary to ensure compliance with specified requirements. Additionally, verify the following:

i. Materials comply with the specified requirements.

ii. All materials are properly stored, handled and protected from damage. Damaged materials are removed from the site.

iii. Framing and substrates are in acceptable condition, in compliance with specification, prior to application of wall panels.
iv. Panels are installed without buckles, ripples, or waves and in uniform alignment and modulus.

v. Side laps are formed, sealed, fastened or seam locked as required.

vi. The proper number, type, and spacing of attachment clips and fasteners are installed.

vii. Installer adheres to specified and detailed application parameters.

viii. Associated flashing and sheet metal are installed in a timely manner in accord with the specified requirements.

(b) Provide five (5) bound copies of Manufacturer's Field Reports to the Engineer two (2) weeks prior to project close-out.

2.1.19.9 Cleanup and disposal

(a) Clean all exposed sheet metal work at completion of installation. Remove metal shavings, filings, nails, bolts, and wires from work area. Remove grease and oil films, excess sealants, handling marks, contamination from steel wool, fittings and drilling debris and scrub the work clean. Exposed metal surfaces must be free of dents, creases, waves, scratch marks, solder or weld marks, and damage to the finish coating.

(b) Collect and place scrap/waste materials in containers. Promptly dispose of demolished materials. Do not allow demolished materials to accumulate on-site; transport demolished materials from government property and legally dispose of them.

2.1.19.10 Roof cladding

Roof cladding system shall be Rigidal Ziplok advanced 'zipup' standing seam system that creates a continuous weathertight roof.

The side laps shall be zipped up in conjunction with a unique halter system that is fixed directly
to the supporting structure without penetrating the external weather sheet.

2.1.19.11 References and Standards

BS END 1011-4 (2000): Welding. Recommendations for welding of metallic materials. Arc welding of aluminium and aluminium alloys.

BS END ISO 1461(2009): Hot dip galvanized coatings on fabricated iron and steel articles. Specifications and test methods

ASTM D1056 (2007): Standard Specification for Flexible Cellular Materials -;Sponge or Expanded Rubber

ASTM D1667 (2011): Standard Specification for Flexible Cellular Materials-Vinyl Chloride Polymers and Copolymers (Closed-Cell Foam)

ASTM C920 (2011): Standard Specification for Elastomeric Joint Sealants.

SMACNA (Sheet Metal And Air Conditioning Contractors' National Association) 1793 - Architectural Sheet Metal Manual, 6th Edition

BS END 10346 (2009): Continuously hot-dip coated steel flat products. Technical delivery conditions

BS END 1011-1 (2009): Welding. Recommendations for welding of metallic materials. General guidance for arc welding

BS END 1011-2 (2001): Welding. Recommendations for welding of metallic materials. Arc welding of ferritic steels

BS 4800 (2011): Schedule of paint colours for building purposes

2.1.20 STRUCTURAL STEEL WORKS

2.1.20.1 Generally

2.1.20.1.1 Generally

(a) The use of structural steelwork shall be to **BS 5950.**

2.1.20.2 Materials

2.1.20.2.1 Transportation and storage

(a) Bundle, pack, handle and transport steelwork in a manner that shall prevent damage to the steelwork and any protective coating.

(b) Take precautions to minimize exposure of steelwork to atmospheric or chemical pollution before and after fabrication.

(c) Store steelwork awaiting erection clear of the ground and keep different members separate. Lay or stack to avoid accumulation of water or dirt on or against any of the surfaces. Provide suitable packings between layers of stacked steelwork. Ventilate covered steelwork sufficiently to preclude condensation.

(d) Store and stack steel members in such a manner that markings are clearly visible.

2.1.20.2.2 Mechanical properties and chemical composition

Structural steelwork shall comprise weldable structural steel to **BS END 10029 (2010)**: grade 43A, grade 43C or 43D(for hollow section only) or grade 50 B.

(a) The use of weldable cold - formed structural hollow sections shall comply with **BS 5950:Part 5**, **BS 5950:Part 7** and **BS END 10219-2:2006**.

2.1.20.2.3 Hot-rolled sections

(a) Dimensions, mass, tolerances and rolling margins shall be :

i. Universal beams, columns, joists, tees and channels to **BS 4: Part. 1**.

ii. Hollow sections to **BS END 10210-2**.

iii. Angles to **BS END 10056-1**

(b) Tolerances and rolling margins for plates, flat bars, wide flats, universal wide flats, round and square bars shall be to **BS 7668**.

2.1.20.2.4 Cold-rolled sections

(a) Dimensions, mass and tolerances of cold rolled sections shall be to **BS END 10162**. Do not use cold rolled sections without approval.

2.1.20.2.5 Rivets

(a) Rivets shall be mild steel rivets for general engineering purposes to **BS 4620**

2.1.20.2.6 Black bolts, screws, nuts and washers

(a) Black hexagon bolts, screws and nuts shall be to **BS END 13602**. Bolts and screws to be strength grade 4.6 and nuts shall be strength grade 4 unless otherwise specified.

(b) Washers for black hexagon bolts, screws and nutsshall shall be single coil square or rectangular section steel spring washers to **BS 4464**, unless otherwise specified. Provide tapered washers to give the bolt heads and nuts a satisfactory bearing where so required.

(c) Length of bolts shall be such that the threaded portion of each bolt projects through the nut by at least one thread after tightening

2.1.20.2.7 Precision hexagonal bolts, screws, nuts and washers

(a) Precision hexagonal bolts, screws and nuts shall be to **BS 3692**. These bolts and screws shall be of strength grade 8.8 and nuts to be of strength grade 8 unless otherwise specified.

(b) Washers and length of bolts shall be as specified in Clause 2.1.20.2.6

2.1.20.2.8 High strength friction grip bolts nuts and washers

(a) High strength friction grip bolts and associated nuts and washersshall be of general grade to **BS 4395** :**Part. 1** unless otherwise specified.

2.1.20.2.9 Turnbuckles and other elements

(a) Obtain approval for specially made elements and components such as turnbuckles

2.1.20.2.10 Non-availability of specified materials

(a) Obtain approval for any variation required when the specified material is not available and bear any additional cost arising therefrom.

2.1.20.2.11 Manufacturer's certificates

(a) Provide the manufacturer's certificates for all steel sections, rivets, bolts, screws, nuts and washers delivered to Site

2.1.20.2.12 Markings

(a) Clearly mark all steelwork in an approved manner.

(b) Bolts, screws, nuts and washers to have either embossed or indented markings identifying the relevant BS.

2.1.20.3 Testing of materials

2.1.20.3.1 Generally

(a) Allow sufficient time for the testing of specimens. Do not incorporate materials until relevant tests have been carried out and approval obtained.

2.1.20.3.2 Testing of sections

(a) Provide one test specimen for every 40 tonnes or part thereof of each section of same thickness from the same cast. For the purpose of this clause "same thickness" means similar sections with a variation in thickness not exceeding + 5 mm. Test specimens shall be taken from sections selected at random on Site by the Engineer.

(b) Prepare the test specimens shall be to **BS END ISO 6892-1:2009** as directed and appropriately mark and deliver them to a laboratory, as directed by the Engineer.

(c) Manufacturer's certificates may be accepted as proof of quality in lieu of sampling on site when all steel sections are prefabricated prior to shipment.

2.1.20.3.3 Security - sampling

(a) Cut test sections under the direction and supervision of the Engineer who shall put his signature on the specimen in indelible ink.

2.1.20.3.4 Security – before delivery for grinding preparation

(a) Keep the specimen with Engineer's signature securely under lock and key in a sample room or in the Engineer's office before delivery to workshop for preparation to the required shape where necessary

2.1.20.3.5 Security – before delivery to laboratory

(a) Take test specimen returned from workshop to the Engineer for verification of signature. Keep section securely under lock and key in a sample room or in the Engineer's office before delivery to the laboratory

2.1.20.3.6 Security – delivery

(a) Deliver samples to the testing laboratory under the escort of the Engineer.

2.1.20.3.7 Security – stock management

(a) Submit for approval by the Engineer at the commencement of the Contract a stock management system to preclude unauthorized use of structural steel sections prior to receipt of test results as well as swapping of sections of different testing s tatus. The followings shall be included:

i. Provide identification marks to different specimens arriving on Site which are uniquely traceable to the record of each batch.

ii. The record of a batch of steel sections shall include date of arrival to Site, quantities delivered of different sections, delivery note, mill certificate and the supplier's certificate.

iii. Establish and maintain a record system, such as colour coding or other approved systems, for identifying and showing clearly specimens that are under different testing status (awaiting test results, approved for use, non-compliant, re-test, omitted for testing etc.).

iv. Keep separately specimens of different testing status at different locations.

2.1.20.3.8 Security – removal of non-compliant steel sections

(a) Remove non-compliant steel sections from Site as soon as possible under the supervision of the Engineer.

2.1.20.3.9 Testing of bolts, nuts and washers

(a) Provide test specimens and carry out testing of bolts and associated nuts and washers in accordance with the relevant BS in an approved testing laboratory when so directed by the Engineer. Rate of sampling shall be as Table 2.1.19.1 unless otherwise specified. Submit test results as soon as they are available.

Table 2.1.19.1

Sampling of bolts

Diameter of bolts	Rate of sample
not exceeding 16 mm	1 in 15000 or part thereof
not exceeding 16 mm but not exceeding 24 mm	1 in 5000 or part thereof
exceeding 24 mm	1 in 2500 or part thereof

2.1.20.3.10 Failure of tests

(a) If any test specimens do not comply with the relevant BS, the Engineer may require further tests. Remove unsatisfactory material off Site when instructed by the Engineer.

2.1.20.4 Workmanship

2.1.20.4.1 Erection

(a) Prepare and submit details of the proposed method of erection for approval. Details submitted shall include type of plant and equipment to be used and, if necessary, drawings and calculations of any temporary work. Approval shall not in any way relieve the Contractor of his responsibility for safe erection of permanent work, or the safe erection and subsequent dismantling of Temporary Works.

(b) Design, construct and dismantle falsework to **BS 5531** when specified.

(c) Do not erect fabricated steelwork until all welded joints and specified protective coatings have been inspected, tested where required, and approved.

(d) Align structural members accurately to the specified tolerances and obtain approval before any permanent welding or tightening of bolts is carried out.

(e) Do not bed stanchion bases or grout anchor bolts until the steelwork has been plumbed, levelled, aligned and approved, and until the method of erection has been approved.

(f) Do not load any part of the structure without prior approval.

2.1.20.4.2 Cutting, sawing and drilling

(a) Cut members to size. Flame cutting shall be by machine. Finish cut edges as follows :

i. Remove burrs, sharp arrises and slag from edges of all cut members.

ii. Dress machine sheared or cropped edges to a neat finish, free from distortion.

(b) Grind stiffeners, plates and the like to fit the profile of the parent member with diagonal cuts to clear the root radius.

(c) Machine stanchion splices and butt joints of compression members true and square.

(d) Form holes for rivets or bolts by drilling, except holes in plate less than 15 mm thick where they may be formed by punching. Punch holes to a size 2 mm less than the required diameter and finish the holes by reaming.

(e) Finished holes shall be 2 mm larger than the nominal size of rivets and bolts up to 24 mm diameter and 3 mm larger where these are over 24 mm diameter. Holes for precision bolts shall be similarly formed except specified as close tolerance holes. Close tolerance holes shall be formed by drilling and to a size of bolt diameter + 0.15 mm - 0 mm.

2.1.20.4.3 High friction grip bolts

(a) Clean the interface of members shall be jointed with high strength friction grip bolts to the specified surface preparation and leave unpainted.

(b) Use high strength friction grip bolts in accordance with **BS END 1993-1-8:2005**
Tighten the bolts and nuts by one of the following methods

i. The torque-control method using a calibrated power-operated or a hand-operated torque wrench to the following proof loads :

TABLE 2.1.19.2

Proof loads

Nominal size and thread diameter	Proof load (minimum shank tension) KN
M12	49.4
M16	92.1
M20	144
M22	177
M24	207
M27	234
M30	286
M36	418

Calibrate the wrench regularly as follows:

- At the commencement of each new working day or shift.
- With each change of bolts diameter.
- With each change of bolts grip length in excess of $^1/_5$th of the length used in the calibration of the wrench in accordance with **BS END 1993-1-8:2005**.

Reapply the wrench to bolts previously tightened in a multi-bolt connection to ensure all bolts have the correct torque.

ii. The direct tension indicator method using approved proprietary load indicators, in the form of specially hardened washers with protrusion on one face, strictly in accordance with the manufacturer's instructions.

Adopt wrenches of adequate capacity. Maintain the wrenches in a proper working condition in accordance with the manufacturer's recommendations

2.1.20.4.4 Joints

(a) Prepare and prime the contact surfaces at riveted, bolted and screwed joints. If the contact surfaces are specified to be coated or otherwise treated, e.g.machined surface finish, the joint shall be approved before assembly.

2.1.20.4.5 Welding

(a) Welding shall be a metal arc process in accordance with **BS END 1011-1** and **BS END 1011-2** together with other clauses contained in the GS, unless otherwise specified.

(b) Welding consumables used shall be chosen to ensure that the mechanical properties of the weld metal are not less than those required for the parent metal.

(c) Execute welding in a flat or horizontal position wherever possible. Do not weld overhead without approval.

2.1.20.4.6 Welders and testing of welders

(a) Provide an experienced and competent operator to supervise welding.

(b) Welders shall be tested to meet the requirements of **BS END 287**:**Part 1** but, in the case of welders engaged on fillet welding only, **BS 4872**:Part 1 is an acceptable alternative.

(c) Test on welders shall be witnessed by a qualified welding inspector and certificates endorsed by an independent inspection authority. The certification shall remain valid providing it complies with the conditions for re-approval of certification specified in **BS END 287**:Part 1 or **BS 4872**:Part 1
where appropriate.

2.1.20.4.7 Welding record

(a) Keep a record on Site when specified to identify welders responsible for major welds.

2.1.20.4.8 Welding procedures

(a) Submit welding procedures which shall be prepared and certified by a qualified welding inspector. Obtain approval of the proposed welding procedures prior to commencing welding including:

i. Welding process or processes when more than one is used in making a complete joint,

ii. Parent metal specification, thickness and other relevant dimensions,

iii. Classification, type and size of electrodes and other consumables,

iv. Welding current, arc voltage and welding speed,

v. Sketch showing edge preparation, fit-up and approximate number and arrangement of runs in multi-run welds,

vi. Whether shop or site welding,

vii. Welding positions,

viii. Welding sequence,

ix. Minimum preheating temperature and interpass temperature range,

x. Post-weld heat treatment if required.

(b) Do not depart from the agreed welding procedure without prior agreement of the Engineer.

2.1.20.4.9 Approval testing of welding

(a) Carry out approval testing of welding procedures to **BS END 15614** when specified, strictly in accordance with the proposed welding procedure using representative samples of the materials.

(b) Strictly follow the procedures of welding established in the successful approval test for the works. Carry out further approval tests if either the material or procedure changes.

2.1.20.4.10 Electrodes

(a) Covered electrodes shall be to **BS END 2560**. If electrodes used in conjunction with fluxes are employed, they shall give a weld deposit having mechanical properties at least equal to the minimum specified for the parent metal. Use electrodes and fluxes strictly in accordance with the manufacturer's recommendations

2.1.20.4.11 Preparation for welding

(a) Prepare fusion surfaces to **BS END 1011-1** and **BS END 1011-2**. Surfaces must be dry. Warm the surfaces if required to remove condensation.

2.1.20.4.12 Slag, tack welds, fillet and butt welds

(b) Remove welding slag by chipping before depositing subsequent runs.

(a) Tack welding may only be used with express approval. Tack welds shall be minimum 50 mm long.

(b) Butt welds shall be full penetration welds between prepared fusion faces, unless otherwise specified. Carry out back chipping, grinding or gouging of the deposited weld as required to obviate imperfections in the root run.

(c) Grind butt welds flush without loss of parent metal.

(d) Deposit fillet welds to the required length, throat thickness and with partial or full penetration as specified.

2.1.20.4.13 Temporary attachments

(a) Do not weld temporary attachments to principle joints. Obtain approval of the position of welds for temporary attachments.

2.1.20.4.14 Stud shear connectors

(a) Weld stud shear connectors by automatic stud welding gun strictly in accordance with the manufacturer's recommendations unless specified otherwise

2.1.20.4.15 Acceptance of welds

(a) Employ an approved independent testing firm to carry out and interpret the inspection and testing of welds, and provide any necessary labour and attendance.

(b) Submit evidence proving that operators carrying out the inspection and testing have been trained and assessed for competence in the inspection and testing of welds. In addition, submit certificates of competence from a recognised authority for operators carrying out ultrasonic examination

(c) Arrange for the independent testing firm to submit a testing programme for the approval of the Engineer. Any welds that shall be rendered inaccessible by subsequent work shall be exa mined prior to the loss of access.

(d) All welds shall be visually inspected in accordance with **BS END ISO 17637:2011** Non-destructive testing shall be carried out after visual inspection in accordance with the table below

Weld Type	**Frequency of Non-destructive Testing**
All types of butt welds	100% ultrasonic examination and magnetic

	particle flaw detection
Fillet welds with leg length exceeding and including 10 mm	20% ultrasonic examination and magnetic particle flaw detection
Fillet welds with leg length not exceeding 10 mm	20% magnetic particle flaw detection
Secondary attachment welds, e.g. for fixing purlins, side rails	5% of attachments by magnetic particle flaw detection and ultrasonic examination if leg length exceeds and includes 10 mm

(e) The standard of acceptance for butt welds shall be in accordance with **BS END 1011-1** and **BS END 1011-2**. The standard of acceptance for fillet welds and secondary attachment welds shall be in accordance with Table 2 in the Appendix of the Practice Note for Authorized Persons and Registered Structural Engineers **PNAP 160**.

(f) Ultrasonic examination shall be carried out in accordance with **BS END ISO 12402-5:2006+A1:2010** Level 2B. Print out results shall be made available during ultrasonic examination on site at 3 specified locations per weld (such as at both ends and in the middle of the weld) and at positions in question. Magnetic particle flaw detection shall be carried out in accordance with **BS END ISO 9934-1:2001**

(g) Examination shall be carried out not less than 16 hours from the time of completion of the weld to be inspected, or not less than 40 hours in the case of butt welds thicker than 40 mm or any welds to Grade 55 steels (except for piling/foundation contracts, where only 2 weld joints are needed to be examined after 40 hours for each contract).

(h) Should test results indicate that welds are below the standard of acceptance, carry out at the Contractor's own expense approved remedial measures and further acceptance tests.

2.1.20.4.16 Painting in general

(a) Painting shall be as Clause 2.1.17.11 in general.

2.1.20.4.17 Preparation and painting of new surfaces

(a) Prepare new surface to receive protective coatings in accordance with one of the followings :-

i. Manually clean metal surface thoroughly to remove all dirt, weld spatter, grease and the like. Chip, scrape and wire-brush to remove mill scale and rust. The surface so prepared shall not be inferior to Swedish Standard SIS 055900 St2. Painting shall be as Table 15.3, Type A.

ii. Degrease metal surface, mechanically re move all millscale, rust and weld spatter with powerdriven tools such as carborundum grinding discs, chipping hammers and needle guns. Cleanoff all loosened particles by wire brushing or vacuum cleaning. The surface so prepared shall not be inferior to Swedish Standard SIS 055900 St3. Apply the protective coating within 2 hours to the cleaned surface. Painting shall be as Table 15.3 Type B.

iii. Blast-clean steel so that the prepared surface is not inferior to Swedish Standard SIS 055900 Sa 2.5. Clean the blasted surface by vacuum and do not touch the surface by hand or contaminate it in any other way. Apply the protective coating within 2 hours to the cleaned surface. Submit a sample of blast cleaned steel not less than 150 x 150 x 6 mm adequately protected in sealed clean polythene wrapping for approval before any work is carried out.

This approved sample shall be retained for comparison with the subsequent prepared steelwork.

2.1.20.4.18 Redecoration of existing painted surfaces

(a) For redecoration of existing painted surfaces of structural steelwork, clean the existing paint coat with an approved detergent, remove loose and flaking portions with wire brush and grind rusted areas back to bare metal as instructed by the Engineer, care being taken to avoid producing a smooth surface by excessive grinding.

(b) Where the existing coating is intact after cleaning, apply the proposed paint coating over a trial panel and examine for adherence after the curing period as recommended by the paint manufacturer. Do not use the paint until the trial is passed.

(c) Where bare metal is exposed, apply primer, undercoat and finishing coat as directed by the Engineer.

2.1.20.4.19 Hot dip galvanizing

(a) Prior to galvanizing, the following requirements have to be satisfied :

i. All welding slags and paints on the steel surface shall be removed.

ii. All cut surfaces shall be ground smooth.

iii. Adequate number of vent holes shall be provided for closed end hollow sections, and

iv. Drainage holes shall be provided at joints where free flow of molten zinc would otherwise be impossible, e.g. joints between stiffeners and I sections.

(b) Apply hot dip galvanized coatings to **BS END ISO 1461**. The thickness of zinc coating shall be minimum 85 µm unless otherwise specified.

(c) Small areas of galvanized coating damaged by welding, cutting or by rough treatment during transit or erection shall be made good by the use of at least two coats of zinc rich paint to **BS 4652**. Thoroughly clean all areas affected by welding with abrasives or mechanical driven tools before applying the zinc rich paint.

2.1.20.4.20 Painting to joints

(a) As soon as possible after joints have been completed and approved, the parent and the joint material, exposed parts of bolts, nuts and washers and weld affected areas shall be brought up to the same standard of preparation and painting as the adjoining surfaces.

2.1.20.5 References and Standards

BS 5950: Structural use of steelwork in buildings.

BS END 1993-1-3 (2006): Eurocode 3. Design of steel structures. General rules. Supplementary rules for cold-formed members and sheeting

.

BS 5950-7 (1992): Structural use of steelwork in building. Specification for materials and workmanship: cold formed sections.

BS END 101037-1 (1996): Plate and wide flats of made of high yield strength structural steels in the quenched and tempererd or precipitation hardened conditions.

BS 7668 (2004): Weldable structural steels. Hot finished structural hollow sections in weather resistant steels. Specification

BS END 10029 (2010): Hot-rolled steel plates 3 mm thick or above. Tolerances on dimensions and shape

BS 4-1 (2005): Structural steel sections. Specification for hot-rolled sections
.
BS END 10210-2 (2006): Hot finished structural hollow sections of non-alloy and fine grain steels. Tolerances, dimensions and sectional properties.

BS 4395-1 (1969): Specification for high strength friction grip bolts and associated nuts and washers for structural engineering. General grade.

BS END 1993-1-8 (2005):Eurocode 3. Design of steel structures. Design of joints

BS END 287-1 (2011): Qualification test of welders. Fusion welding. Steels.

BS END ISO 15614-1(2004+A2:2012): Specification and qualification of welding procedures for metallic materials. Welding procedure test. Arc and gas welding of steels and arc welding of nickel and nickel alloys

BS END 10162 (2003): Cold rolled steel sections. Technical delivery conditions. Dimensional and cross-sectional tolerances.

BS 4464 (1969): Specification for spring washers for general engineering and automobile purposes. Metric series

BS END 10002-1 (1990): Tensile testing of metallic materials. Method of test at ambient temperatures.

BS 5531(1988): Code of practice for safety in erecting structural frames.

BS END 1011-1(2009): Welding. Recommendations for welding of metallic materials. General guidance for arc welding

BS END 1011-2 (2001): Welding. Recommendations for welding of metallic materials. Arc welding of ferritic steels

BS 4872-1 (1982): Specification for approval testing of welders when welding procedure approval is not required. Fusion welding of steel.

BS END ISO 17637 (2011):Non-destructive testing of welds. Visual testing of fusion-welded joints

BS END ISO 2560 (2009): Welding consumables. Covered electrodes for manual metal arc welding of non-alloy and fine grain steels. Classification

BS END ISO 12402-5 (2006+A1:2010):Personal flotation devices. Buoyancy aids (level 50). Safety requirements

BS END ISO 9934-1 (2001):Non-destructive testing. Magnetic particle testing. General principles
.

BS END 10219-2 (2006):Cold formed welded structural hollow sections of non-alloy and fine grain steels. Tolerances, dimensions and sectional properties

BS END 10056-1 (1999): Specification for structural steel equal and unequal angles. Dimensions

BS 4620 (1970): Specification for rivets for general engineering purposes

BS 3692 (2001): ISO metric precision hexagon bolts, screws and nuts. Specification

BS END ISO 6892-1 (2009): Metallic materials. Tensile testing. Method of test at ambient temperature

BS END ISO 2560 (2009): Welding consumables. Covered electrodes for manual metal arc welding of non-alloy and fine grain steels. Classification

BS END ISO 1461 (2009): Hot dip galvanized coatings on fabricated iron and steel articles. Specifications and test methods

BS END 10025-1 (2004): Hot rolled products of structural steelsGeneral technical delivery conditions

BS END ISO 6892-1 (2009): Metallic materials. Tensile testingMethod of test at ambient temperature

2.1.21 BS END 10025-6 (2004+A1:2009): Hot rolled products of structural steelsTechnical delivery conditions for flat products of high yield strength structural steels in the quenched and tempered conditionSPECIALITIES

2.1.21.1 Signage and Graphics

2.1.21.1.1 Materials

1. Material: melamine laminate, non-glare surface, two-colour.
2. Size of Plate: 37mm high x length required for text; 3mm thick.
3. Colours: White letters and numerals on black background.
4. Letters: Helvetica Medium, 14mm high with standard stroke width.

2.1.21.1.2 Workmanship

1. Install all signage, and other Work of this Section level and plumb; secure to substrate in manner as recommended by the Manufacturer for the specific surface where required.
2. Clean all surfaces of Work of this Section.
3. Remove all debris resulting from the Work of this Section from Work area.

2.1.21.1.3 Sign locations

1. Locate interior signs at the locations shown on a schedule to be -furnished by the Contractor for approval of the Engineer.

2. Provide either room name plate or number plate for all rooms in this project. Use the room names and/or numbers shown on the Drawings unless otherwise approved by the Engineer.

2.1.21.1.4 Handicapped signs

1. Fabricate signs to comply with the requirements of **ANSI A 177.1.**

2. Provide handicapped signs of type and with approved text at locations as scheduled or the Drawings interior and exterior.

3. Provide signs at parking areas exterior to the structure.

2.1.21.1.5 Schedule of signage types

The Contractor shall submit a schedule indicating sign type, material, location, text, text letter style, colour, and other pertinent information.

The Contractor is to submit complete details for each of the following sign types.

i. Area Use Sign
ii. Floor Designation with Names and/or numbers
iii. Passenger Information Signs and Graphics
iv. Public Information Signs and Graphics
v. Room Name Plates and Number Plates
vi. Handicapped Use Only
vii. Signs and/or graphics required for building code compliance
viii. Do Not Enter
ix. Restricted Area
x. No Smoking
xi. Up/Down
xii. No Parking

The Contractor is to submit a sample of each type, indicating colours, letter style, size, and other pertinent information.

2.1.21.1.6 Schedule of signage

Contractor shall submit a detailed schedule of all signage required for each space, door, public and passenger area, interior and/or exterior in full compliance with code requirements.

Signage schedule shall include the following information:

a. Sign construction showing materials, size and colours
b. Quantity of each type and/or size
c. Location
d. Unit message
e. Method of attachment

2.1.21.2 Entrance mats and grids

2.1.21.2.1 Materials

(a) Aluminum - **ASTM B 221**, alloys 6063-T5, 6063-T6 for extrusions.

(b) Architectural Bronze **- ASTM B 455**, copper/zinc alloy C38500 for extrusions.

(c) Vinyl/Acrylic - High-impact PVC alloy.

(d) Flexible and prime PVC extrusions.

(e) Tread insert options - refer to Section 2.1.21.2.4.

2.1.21.2.2 Floor mats

(a) Exposed hinge rail connectors shall be extruded 6063-T6 aluminum. (Optional C380 architectural bronze available) complete with perforations for drainage.

(b) Tread rails shall be manufactured from high-impact vinyl/acrylic, complete with coextruded soft-durometer cushions. Supplied in mill (standard) or one of the colours as offered by manufacturer. (Call factory for custom colours.) Choose from anodized of heavyduty powder coat finish.

2.1.21.2.3 Mat frames

(a) SM - Tapered Vinyl Frame shall be 1 1/2"(38.1mm) wide, with tapered lead-in edge for surface mounted applications. Frame colour shall be one of the colours as offered by manufacturer.

(b) AL - Aluminum Block-out Frame shall be a 3/4"(19.1mm) deep recessed frame in 6063-T5 aluminum alloy (optional architectural bronze) with 1/4"(6.4mm) wide exposed surface. Black or brown vinyl fillers shall be furnished as required when standard 2" (50.8mm) tread spacing cannot be maintained. Frame colour shall be supplied in mill (standard) or one of the
optional colours as offered by manufacturer. (Custom colours are available.) Choose from anodized or heavy-duty powder coat finish. Note: Mill finish frames in contact with concrete
to be primer coated. Installer shall use recommended latex screed to ensure level base.

(c) TNG - Tapered Angle Frame (note: the tapered angle frame is for use when additional screed for level base is not necessary.) shall be a 1/2"(12.7mm) deep recessed frame in 6063-T5 aluminum alloy. Frame colour shall be supplied in standard mill or one of the
optional colours as offered by manufacturer. (Custom colours are available.) Choose from anodized or heavy-duty powder coat finish. Note: Mill finish frames in contact with concrete

(d) ANG - Aluminum Angle Frame shall be a 1/2"(12.7mm) deep recessed frame in 6063-T5 aluminum alloy (optional architectural bronze) with 1/8" (3.2mm) wide exposed surface. Black or brown vinyl fillers shall be furnished as required when standard 2" (50.8mm) tread
spacing cannot be maintained. Frame colour shall be supplied in mill (standard) or one of the
optional colours as offered by manufacturer. (Custom colours are available.) Choose from anodized or heavy-duty powder coat finish. Note: Mill finish frames in contact with concrete
to be primer coated. Installer shall use recommended latex screed to ensure level base.

(e) THFR -Threshold Frame shall be supplied in 6063-T6 aluminum alloy. For surface/recess installations to provide a flush transition from the entryway door threshold to the mat surface.
The frame does require a leveling screed.

(f) TA - Tapered Aluminum Frame shall be a 1 1/2"(38.1mm) wide 6063-T5 aluminum alloy and permanently positions mat for surface mounted applications. Frame colour shall be supplied in mill (standard) or one of the optional colours as offered by manufacturer. (Custom
colours are available.) Choose from anodized or heavy-duty powder coat finish. Note: Mill finish frames in contact with concrete to be primer coated.

2.1.21.2.4 Tread insert options

(a) Carpet shall meet the Carpet and Rug Institute's standard for indoor
air quality. Fibers shall include a minimum of 100, 12 mil monofilament fibers per square inch
and colourfast, solution-dyed nylon. Each carpet fiber and monofilament shall be fusion-bonded to a rigid two-ply backing to prevent fraying and supplied in continuous splice-free lengths. Anti-static carpet fiber shall contain antimicrobial additive and be treated with Scotchgard® to reduce soiling.
Carpet weight shall be 33-oz./yd^2.

(b) Exterior Carpet shall be solution dyed polypropylene fibers with 50/50 blend of
600/12-denier multi filament and 595/D1 monofilament, available in one of 4 standard colours
as offered by manufacturer. The texturized fibers have ultraviolet blockers and colour as an
integral part of the filament. Each carpet fiber and monofilament shall be fusion-bonded to a
rigid two-ply backing to prevent fraying and supplied in continuous splice-free lengths.
(Waterproof fibers do not get soggy, rot, fade or stain.) Carpet weight shall be 32-oz./yd^2.

(c) Vinyl shall include a flexible dual durometer vinyl insert in any one of six standard colours as selected.

(d) Logo Option. Each entrance mat specifically detailed shall include a logo or trademark.

2.1.21.2.5 Execution

(a) Verification of conditions: Examine areas and conditions under which work is to be performed
and identify conditions detrimental to proper or timely completion. Do not proceed until unsatisfactory conditions have been corrected.

(b) Preparation: Manufacturer shall offer assistance and guidance to provide a template of irregular shaped mat assemblies to ensure a proper installation.

(c) Installation: Install the work of this section in strict accordance with the manufacturer's recommendations. Set mat at height recommended by manufacturer for most effective cleaning action. Coordinate top of mat surface with bottom of doors that swing across to provide ample clearance between door and mat.

(d) Cleaning:It is important to the life cycle of the entrance mat that a maintenance schedule be developed which includes regular vacuuming and extraction that correctly matches the amount of traffic the mat incurs.

(e) Protection: After completing required frame installation and concrete work, provide temporary filler of plywood or fiberboard in recess, and cover frames with plywood protective flooring. Maintain protection until construction traffic has ended and project is near time of substantial completion.
Defer installation of floor mats until time of substantial completion of project.

2.1.21.2.6 Submittals

(a) Product data for each type of floor mat and frame specified including manufacturer's specifications and installation instructions.

(b) Shop drawings in sufficient detail showing layout of mat and frame specified including details
indicating construction relative to materials, direction of traffic, spline locations, profiles, anchors and accessories.

(c) Samples for verification purposes: Submit an assembled section of floor mat and frame members with selected tread insert showing each type of colour for exposed floor mat, frame
and accessories required.

(d) Maintenance data in the form of manufacturer's printed instructions for cleaning and maintaining floor mats.

2.1.21.2.7 Quality assurance

(a) Flammability in accordance with **ASTM E648**, Class 1, Critical Radiant Flux, minimum 0.45 watts/m^2.

(b) Slip resistance in accordance with **ASTM D-2047-96**, Coefficient of Friction, minimum 0.60 for accessible routes. Approved systems must meet a minimum coefficient of friction of 0.60, when tested in wet conditions.

(c) Standard rolling load performance is 300 lb./wheel with larger loading requirements as specified (load applied to a solid 5" x 2" wide polyurethane wheel, 1000 passes without damage

(d) Single Source Responsibility: Obtain floor mats and frames from one source of a single manufacturer.

(e) Utilize superior structural aluminum alloy 6063-T6 for rail connectors.

2.1.21.2.8 Delivery, storage and handling

(a) Deliver materials to the project site ready for use and fabricated in as large sections and assemblies as practical, in unopened original factory packaging clearly labeled to identify manufacturer.

2.1.21.2.9 Project Conditions

(a) Field measurements: Check actual openings for mats by accurate field measurements before
fabrication. Record actual measurements on final shop drawings. Coordinate fabrication schedule with construction progress to avoid delay of work.

(b) For recess application coordinate frame installation with concrete construction to ensure recess and frame anchorage are accurate and that the base is level and flat. Defer frame

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2.1.21.3 References and Standards

ASTM B221 - 13: Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes

ASTM B455-10 (2010): Standard Specification for Copper-Zinc-Lead Alloy (Leaded-Brass) Extruded Shapes

ASTM E648-10e1 (2010): Standard Test Method for Critical Radiant Flux of Floor-Covering Systems Using a Radiant Heat Energy Source

2.1.22 ASTM D2047-11 (2011): Standard Test Method for Static Coefficient of Friction of Polish-Coated Flooring Surfaces as Measured by the James MachineGENERAL FIXTURES, FURNISHINGS AND EQUIPMENT

2.1.22.1 Metal Lockers

2.1.22.1.1 Materials

(a) Steel Sheet: Commercial quality, stretcher leveled, cold rolled carbon steel sheet, stretcher leveled, free of buckling, scale, and surface imperfections.

(b) Fasteners: Zinc or nickel plated steel; slotless type exposed bolt heads; self locking nuts or lock washers for nuts on moving parts.

(c) Equipment: Manufacturer's standard plated steel hooks or coat rods.

2.1.22.1.2 Wardrobe lockers

(a) Body: Form backs, tops, bottoms, sides, and intermediate partitions of flanged 0.61 mm minimum steel sheet.

(b) Frames: Form channel frames of 1.5 mm minimum steel sheet. Form continuous integral strike on vertical frame members or weld 2.3 mm minimum latch hooks to latch strike frame.

(c) Cross Frames: Form intermediate channel cross frames to double tier lockers of 1.5 mm minimum steel sheet.

(d) Door: One piece steel sheet, flanged at all edges, constructed to prevent springing when opening or closing. Fabricate to swing 180 degrees.

- Thickness: 1.5 mm minimum.

(e) Reinforcing: Brace or reinforce inner face of doors over 381 mm wide.

(f) Reinforcing and Sound Dampening Panels: Brace or reinforce inner face of doors with manufacturer's standard reinforcing angles, channels, or stiffener panels.

(g) Louvered Vents: Stamped, louvered vents in door face, as follows:

(h) Double Tier Lockers: No fewer than 6 louver openings top and bottom.

(i) Hinges: Steel, full loop, 5 knuckle tight pin, 51 mm high minimum. Weld to inside of frame and secure to door with not fewer than 2 factory installed fasteners that are completely concealed and tamperproof when door is closed.

- Provide at least 2 hinges for each door 1067 mm high or less.

(j) Recessed Handle and Latch: Manufacturers' standard housing to form recess for latch lifter and locking devices; nonprotruding latch lifter containing strike and eye for padlock; and automatic, prelocking, pry resistant latch mechanism with latching action as follows:

- Double Tier Lockers: Not less than 2 point latching.

2.1.22.1.3 Locks

(a) Fabricate lockers to receive padlocks.

2.1.22.1.4 Locker accessories

(a) Equipment: Furnish each locker with the following items, unless otherwise shown:

- Double Tier Units: 1 double prong ceiling hook, and not fewer than 2 single prong wall hooks.

(b) Number Plates: Manufacturer's standard etched, embossed, or stamped, nonferrous metal number plates with numerals not less than 9 mm high. Number lockers in sequence indicated. Attach plates to each locker door, near top, centered, with at least 2 fasteners of same finish as number plate. Locker number sequence shall begin with 100, 101, 102, etc. for each separate locker room.

(c) Continuously Sloping Tops: Manufacturer's standard continuously sloped top, not less than 0.91 mm steel sheet. Provide closures at ends and sloped corner fillers.

(d) Recess Trim: Manufacturer's standard 1.2 mm minimum steel sheet trim with concealed fastening clips.

(e) Filler Panels: 1.2 mm minimum steel sheet, factory fabricated.

(f) Locker Benches:

i. Bench Tops: Provide manufacturers standard one piece units fabricated from laminated maple with one coat of clear sealer on all surfaces, and one coat of clear lacquer on top and sides. Provide benches in lengths indicated with a cross sectional size of 241 mm wide x 32 mm thick with rounded corners and edges; benches shall be provided with an overall height of 445 mm.

ii. Pedestals: Provide manufacturers standard 32 mm o.d. steel tube pedestal support assemblies complete with 3.4 mm thick steel flanges welded to each end of tube. Predrill flanges with fastener holes, and provide each pedestal complete with fasteners and anchors. Furnish a minimum of 2 pedestals for each bench, with pedestal spacing not more than 1829 mm o.c.

2.1.22.1.5 Fabrication

(a) Fabricate lockers square, rigid, and without warp, with metal faces flat and free of dents or distortion. Make exposed metal edges free of sharp edges and burrs, and safe to touch. Weld frame members together to form a rigid, 1 piece structure.

- Preassemble lockers by welding all joints, seams, and connections. Grind exposed welds flush.

(b) Locker Unit Size: 305 mm wide x 457 mm deep x 914 mm high, unless otherwise indicated.

2.1.22.1.6 General Finishes

(a) Comply with NAAMM "Metal Finishes Manual" for recommendations relative to applying and designating finishes.

(b) Finish all steel surfaces and accessories, except prefinished stainless steel and chrome plated surfaces.

(c) Protect mechanical finishes on exposed surfaces from damage by applying strippable, temporary protective covering prior to shipment.

(d) Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within 1/2 of the range of approved samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved samples and they are assembled or installed to minimize contrast.

2.1.22.1.7 Steel sheet finishes

(a) Surface Preparation: Solvent clean surfaces complying with SSPC SP 1 to remove dirt, oil, grease, and other contaminants that could impair paint bond. Remove mill scale and rust, if present, from uncoated steel complying with SSPC SP 5 (White Metal Blast Cleaning) or SSPC SP 8 (Pickling), and phosphatize surfaces.

(b) Baked Enamel Finish: Immediately after cleaning and pretreating, apply manufacturer's standard baked enamel finish consisting of a thermosetting topcoat. Comply with paint manufacturer's instructions for application and baking to achieve a minimum dry film thickness of 0.028 mm on doors, and frames, and 0.018 mm elsewhere.

- Colour and Gloss: As selected by Engineer from manufacturer's full range of choices for colour and gloss.

2.1.22.1.8 Workmanship

(a) Install metal lockers complete with accessories according to manufacturer's recommendations. Install plumb, level, rigid, and flush.

(b) Connect together welded locker groups with standard fasteners according to manufacturer's
recommendations, with no exposed fasteners on face frames.

(c) Anchor lockers to floors and walls at intervals recommended by manufacturer but no greater than 910mm. Install anchors through back-up reinforcing plates where necessary to avoid metal distortion, using concealed fasteners.

(d) Install recess trim to recessed lockers using concealed fasteners. Provide hairline joints and concealed splice plates.

(e) Install sloping top units to lockers using concealed fasteners. Provide hairline joints and concealed splice plates.

(f) Securely fasten pedestals, and integral brackets, to bench tops. Anchor pedestals to floor and integral brackets to locker dividers.

2.1.22.1.9 Adjusting, cleaning and protection

(a) Adjust doors and latches to operate easily without binding. Verify that integral locking devices are operating properly.

(b) Clean interior and exposed exterior surfaces and polish stainless-steel and nonferrous metal surfaces.

(c) Protect lockers from damage, abuse, dust, dirt, stain, or paint. Do not permit locker use during construction.

(d) Touch up marred finishes, or replace locker units that cannot be restored to factory-finished appearance. Use only materials and procedures recommended or furnished by locker manufacturer.

2.1.22.1.10 Submittals

(a) Product data: Submit duplicate copies of manufacturer's product data indicating:

i. Performance criteria, compliance with appropriate reference standard(s), characteristics, and limitations.

ii. Product transportation, storage, handling and installation requirements.

(b) Shop drawings: Submit shop drawings indicating type and class of lockers, elevations, sections, dimensions, gauges, tops, bases, hooks, shelves, trim, numbering, doors, handles, anchorage and hardware, and finishes.

(c) Samples: Submit the following samples:
i. Two 50 x 50 Samples of colour and finish on actual base metal.

(d) Closeout submittals: Submit maintenance and cleaning instruction for incorporation into Operations and Maintenance Manuals

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2.1.22.2 Blinds

2.1.22.2.1 Generally

(a) The materials used to manufacture slim-line venetian blinds shall comply with **BS 3415** and shall be free from visible defects e.g. dents, scratches, etc.

(b) Blinds shall be installed in accordance with manufacturer's instructions.

2.1.22.2.2 Materials

(a) Headrail shall be enamel coated galvanized steel section to **BS END 10162** of sufficient strength and thickness to support the completed blind without visible sagging or twisting.

(b) Blinds shall be supplied with galvanized steel fixing brackets able to support the blind and retain it securely.

(c) The blinds shall be constructed with enamel coated flexible aluminium slats of 25 mm wide and 0.18 mm thick (finished thickness) ±5% tolerance in thickness. The material and profile of any slat in the assembled blind shall be such as to provide the strength and flexibility in accordance with **BS 3415**.

(d) Slat widths within a blind shall be consistent to within + 0.2 mm or- 0.5 mm.

(e) Slats shall have radiused ends or corners and shall be free from burrs and sharp edges.
(f) The bottom rail shall be constructed from enamel coated galvanised steel section to **BS END 10162** rigid throughout its length in the mounted blind. The ends of the bottom rail shall be enclosed with ABS plastic end-caps.

(g) Ladder tapes or cords shall be constructed from polyester fibre.

(h) Technical pamphlets and a sample of the venetian blind shall be submitted for the approval of the Engineer.

2.1.22.2.3 Workmanship

(a) The headrail shall not deviate from the horizontal by more than + 5 mm when the blind is mounted beneath a plane surface, and no part of the operating mechanism, within the headrail, shall make contact with that surface.

(b) Unless specifically intended for installation within a recess or box, the ends of the headrail shall be closed off by ABS plastic end caps.

(c) Brackets shall be pre-bored to allow for end or top or face fixing. A minimum of 2 Nos. for blinds with widths not exceeding 1 200 mm and 1 additional bracket for every increment of 600 mm in width. It shall be possible to remove the headrail from the brackets when they are fixed.

(d) Holes and slots cut into each slat shall be positioned symmetrically across the width of the slat and their width shall not exceed the width of the cord passing through them by more than 3 mm to minimize light penetration of the finished blind, consistent with satisfactory operation. The holes and slots in slats of the same blind shall align to within 1 mm, to minimize abrasion of cords and tapes passing through them.

(e) In a finished, assembled blind, the slats shall be capable of tilting through an angle of not less than 70° to the horizontal in each direction and each slat shall overlap the adjoining slat by at least 10% of the slat width in each of the fully closed positions at any point of drop of the blind. The top slat shall be within 5 mm of the headrail in the fully closed position.

(f) Unless specifically designed to clear an obstruction at the point of installation, the length of any slat shall be within ±2 mm of the overall width of the blind, and the alignment of slat ends at any position of the blind, shall not deviate from vertical by more than ±2 mm.

(g) Unless specifically designed to clear an obstruction at the point of installation, the length of the bottom rail including end-caps shall be within ±3 mm of the overall width of the blind.

(h) Tape or cord securing points shall be in alignment to within 3 mm with the holes for these in the slats. Tape or cord anchorage shall withstand a force of 400 N applied directly to the tape or cord.

(i) The rise and fall control mechanism shall ensure quick release and a smooth raising and lowering action at any position, with no fluctuation greater than ±10% in the graduation of the force required to raised or lower the blind completely.

(j) A cord locking control mechanism shall be released by drawing the control cord across the face of the blind and shall be locked when the cord is in a vertical position. The cord locking system shall be so designed that it shall not be possible to drop a blind accidentally.

(k) Lift cords of 2 mm diameter shall have a breaking force of not less than 400 N when tested in accordance with the method given in section three of **BS EN ISO 2307:2010**

(l) Cords shall be secured together so as to prevent horizontal misalignment of the blind by pulling the individual rise and fall cords.

(m) The tilt control shall be able to hold the suspended slats securely in any tilted position.

(n) Control rods ("wand") shall have a breaking force of not less than 400 N when tested in accordance with the method given in section three of **BS EN ISO 2307:2010** and the "wand" shall be of solid core ABS transparent plastic rods.

(o) When tested in accordance with the method given in section three of **BS EN ISO 2307:2010**, vertical sections or supports of the tape or cord shall have a breaking tape/cord strength of not less than 250 N; and the horizontal sections or cross-web of the tape or cord shall have a breaking strength of not less than 50 N. The cross web shall be securely joined to the vertical supports and shall withstand a force of not less than 50 N without separation. The interval between tapes in a finished blind shall be such that the horizontal deflection of the slats between ladders does not exceed 3 mm.

(p) Tapes shall be distributed symmetrically across the blind width, and shall be provided at 225 mm from edge of blind and at 650 mm (maximum) centres.

(q) Vertical blind louvres shall be made of 100 mm wide glass fibre slats or impregnated fabric of a colour and quality approved by the Engineer and shall be installed complete with all necessary accessory materials in accordance with the manufacturer's instructions.

(r) The vertical blinds shall enable operation and rotation of slats in 180° upon a vertical axis to both sides by drawing of an endless cord or a chromium

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2.1.22.3 Cubicle systems

2.1.22.3.1 Generally

(a) Cubicle systems to consist of panels with light weight core material and high performance surface veneer which shall be impervious to water, easily cleaned and with a durable finish.

(b) Panels shall be designed to be bolted or screwed together and may be raised on posts or wall brackets above floor level, floor mounted, or suspended from above.

2.1.22.3.2 Construction

(a) Panels, doors and pilasters of cubicle system shall be either :-

i. Metal construction of baked enamel or vinyl finish constructed with hot-dipped galvanized steel sheets formed and bonded with a cellular honeycomb core, or polyurethane core, or other approved light weight core materials. Edges shall be tack welded around the perimeter and sealed with interlocking molding. Molding

corners shall be welded to each other and to face sheets and ground smooth to form a rigid frame around the component.

ii. Plastic construction fabricated of high pressure laminate on cores of particle board or plywood. Composition core shall be multi-ply to resist warping and assure surface smoothness. Face laminate shall overlap edge laminate to assure water run-off and enhance adhesive bonding.

iii. Solid Laminate for all components minimum. 12mm thick.

(b) Doors and panels supplied under sub paragraphs (i) and (ii) above shall be completely moisture resistant and 20mm thick (minimum) and pilasters shall be 32mm thick (minimum).

2.1.22.3.3 Door fittings

(a) Doors shall be fixed with stainless steel or chromium-plated self-closing hinges which shall be adjustable to allow the door to open to different degrees.

(b) Door latch shall be slide latch indicator bolt or concealed latch knob with indicator, or other proprietary product approved by the Engineer. Locking devices shall have emergency release mechanism.

(c) Buffer hook also serving as clothes hook shall be fixed to each door.

(d) Door stop and door keeper with full height rubber strip shall be fixed to the lock side of the pilaster.

2.1.22.3.4 Fixing of cubicle systems

(a) Cubicle system may be floor supported, wall mounted, overhead braced or ceiling hung. Overhead braced compartments shall be braced with anti-grip headrail.

(b) Panels and headrails shall be screw-fixed to wall and pilaster with stainless steel brackets or aluminium channels .

(c) Edges of pilaster shall be screw-fixed to wall with stainless steel brackets or aluminium channels.

(d) Ceiling mounted pilaster shall be fixed to the overhead structural members by means of stainless steel inverted stirrup brackets and adjustable threaded stud and shall be covered with stainless steel plinth or other approved coverings.

(e) Base of pilaster shall be screw-fixed to the floor by means of stainless steel inverted stirrup brackets with adjusting devices for levelling during installation and permanent height adjustment of the partitions. Connection between base of pilaster and floor shall be covered with stainless steel plinth or other approved coverings.

2.1.22.4 References and Standards

ASTM A366 (1997): Standard Specification for Commercial Steel (CS) Sheet, Carbon (0.15 Maximum Percent) Cold-Rolled

Surface Preparation Commentary for Steel and Concrete Substrates - SSPC SP 1

BS 3415 (1986): Specification for venetian blinds.

BS END 10162 (2003): Cold rolled steel sections. Technical delivery conditions. Dimensional and cross-sectional tolerances.

BS EN ISO 2307 (2010):Fibre ropes. Determination of certain physical and mechanical properties

2.1.23 ASTM A794/A794M – 12 : Standard Specification for Commercial Steel (CS), Sheet, Carbon (0.16 % Maximum to 0.25 % Maximum), Cold-Rolled WATER SUPPLY PIPEWORKS

2.1.23.1 Generally

(a) The works and materials specified in Clauses 2.1.23.1 (a) to 2.1.23.1 (e) shall comply with the sections stated, unless otherwise stated in this Section.

(b) Drainage works shall comply with Section 24.

(c) Earthworks shall comply with Section 2.1.5

(d) Formwork and finishes to concrete shall comply with Section 2.1.7.

(e) Concrete shall comply with Section 2.1.8.

2.1.23.2 Materials

2.1.23.2.1 Materials for water supply pipeworks

(a) Materials for water supply pipeworks for potable water shall be non-toxic, shall not promote microbial growth and shall not impart a taste, odour, cloudiness or discolouration to the water after disinfection and washing out of the pipelines as stated in Clause 2.1.23.12.1

2.1.23.2.2 Steel pipes and fittings

(b) Steel pipes and fittings shall comply with the following:

- Steel pipes, joints and specials for water and sewage : **BS END 10311:2005 and BS END 10224:2002 ,**Dimensions and masses per unit length of welded and seamless steel pipes and tubes for pressure purposes : **BS END 10220**
- Steel pipes and tubes for pressure purposes:carbon steel with specified room temperature properties : **BS END 10216-1** and **BS END 10217-1**.

(c) Steel pipes and fittings shall be manufactured by the electricresistance welded and induction-welded process or by the submerged- arc welded process; the tensile strength of the steel used shall be at least 410 N/mm².

(d) Steel pipes and fittings shall be coated or lined internally and externally as stated in Table 2.1.23.1.

(e) Gusseted steel bends and tees shall be fabricated in accordance with **BS 534, BS 2633** and **BS 4515**.

2.1.23.2.3 Ductile Iron (DI) pipes and fittings

(a) DI pipes and fittings shall comply with **BS EN 545**. Pipes and fittings other than collars, caps and blank flanges shall be lined internally with cement mortar in accordance with **BS EN 545**, Clause 3.2. Linings shall be made with sulphate-resisting Portland cement complying with **BS 4027**.

(b) Pipes shall be externally coated with metallic zinc in accordance with **BS EN 545**, Clause 3.1. Fittings shall be externally coated with zinc rich paint in accordance with **BS EN 545**, Clause 3.1.5(b). After zinc coating pipes and fittings shall be externally coated with a finishing coat of one of the following materials as stated in **BS EN 545**, Clause 3.3:

i. bitumen based hot applied coating material complying with Clause 2.1.23.2.10 and **BS EN 10300**, or
ii. bitumen based cold applied coating material complying with Clause 2.1.23.2.10 and **BS 3416** : Type II.

Table 2.1.23.1: Protection to steel pipes and fittings

Type of pipe or fitting	Internal coating	External coating
Pipes for fresh water	Bitumen lining complying with Clause 2.1.23.2.10 and **BS 534**: Clause 27.2	Reinforced bitumen sheathing complying with **BS 534**: Clause 26.3, or bitumen enamel wrapping (filled bitumen with glass tissue) to **BS 534**: Clause 26.4 or Clause 26.5, with bitumen-based coating materials complying with Clause 2.1.23.2.10 and **BS EN 10300**.
Fittings for fresh water other than slip-on type couplings and flange adapters	Bitumen lining complying with Clause 2.1.23.2.10 and **BS 534**: Clause 27.3	
Pipes exceeding DN 600 for salt water	Sulphate-resisting concrete lining complying with **BS 534**: Clause 29.1	
Fittings exceeding DN 600 for salt water other than slip-on type couplings and flange adapters	Sulphate-resisting concrete lining complying with **BS 534**: Clause 29.2	
Pipes not exceeding DN 600 for salt water	Sulphate-resisting concrete lining complying with **BS 534**: Clause 29.1 or sulphate-resisting cement mortar lining complying with **BS 534**: Clause 29.3	

Fittings not exceeding DN 600 for salt water other than slip-on type couplings and flange adapters	Sulphate-resisting concrete lining complying with **BS 534**: Clause 29.2 or sulphate-resisting cement mortar lining complying with **BS 534**: Clause 29.3	
Slip-on type couplings and flange adapters	Bitumen coating complying with Clause 2.1.23.2.10 and **BS 534** : Clause 25.1	

2.1.23.2.4 UPVC pipes and fittings

(a) UPVC pipes and fittings shall be Class D and shall comply with following:

i. UPVC pipe for cold water services : **BS 3505**

ii. Joints and fittings for use with UPVC pressure pipes
- injection moulded UPVC
- fittings for solvent welding for use with pressure pipes, including potable water supply : **BS 4346: Part 1**
- mechanical joints and fittings principally of UPVC : **BS 4346: Part 2**
- solvent cement : **BS END 14814:2007**

2.1.23.2.5 Galvanise iron (GI) pipes and fittings

(a) GI pipes and fittings shall comply with the following:

i. Steel tubes and tubulars suitable for screwing to **BS 21** pipe threads : **BS 1387**, medium grade

ii. Pipe threads for tubes and fittings where pressure-tight joints are made on the threads : **BS 21**

iii. Wrought steel pipe fittings (screwed BSP thread) : **BS EN 10241**

2.1.23.2.6 Flanges

(a) Steel flanges shall comply with **BS EN 1092-1** and shall be either steel plate for welding type or steel plate blank flange type. The dimensions and drilling of flanges shall comply with **BS EN 1092-1**as appropriate regardless of the nominal pressure rating.

(b) Steel ring flanges shall be machined in the bore to a diameter of 4mm ± 1 mm larger than the outside diameter of the pipe to which the flange is to be welded.

(c) Steel puddle flanges shall be separated into 180° segments.

(d) DI flanges shall be cast-on or welded-on standard flanges complying with **BS EN 545**.

2.1.23.2.7 Bolts and nuts

(a) Bolts and nuts for flanged joints shall comply with **BS EN 1092-1**

(b) Bolts and nuts shall be compatible with the type of joint and, unless otherwise approved by the Engineer, shall be obtained from the same manufacturer as the joint.

(c) Bolts shall be sufficiently long and shall be suitably threaded for jointing the relevant flanges.

2.1.23.2.8 Elastometric joint rings

(a) Elastomeric joint rings shall comply with **BS EN 681-1**.

(b) Elastomeric joint rings for DI pipes and fittings shall comply with **BS EN 545**, Clause 2.3.4.

(c) The dimensions of rings for use with flanged joints shall comply with **BS EN 1514**. The rings shall be compatible with the type of joint and, unless otherwise approved by the Engineer, shall be obtained from the same manufacturer as the joint.

PROPOSED COMPLETION OF THE MAIN ENTRANCE WORKS FOR THE NAIROBI HOSPITAL

2.1.23.2.9 Anti-corrosion tape

(a) Anticorrosion tape shall be a proprietary type approved by the Engineer. The tape shall either be a petrolatum tape with fabric reinforcement or a bituminous tape with PVC backing. Petrolatum tape shall be used for valves, flanged joints, slip-on type couplings and flange adaptors of all sizes. Bituminous tape shall be used in buried or nonexposed condition for welded joints of steel pipe, repair of steel pipe sheathing and other applications as specified on the Drawings.

(b) Anticorrosion tapes shall have a high resistance to cathodic disbondment, acids and alkalis. Colour of bituminous tape shall be black.

(c) Primer and mastic filler for use with anticorrosion tape shall be compatible with the tape and shall be a type recommended by the manufacturer of the tape and approved by the Engineer.

(d) Bituminous tapes shall be stored in a cool dry place away from the sun's rays. No dirt or grits shall be allowed to stick on the edge of the tape before applying the tape for pipe protection.

(e) The following particulars of the proposed anticorrosion tape for water supply pipeworks shall be submitted to the Engineer:

i. manufacturer's literature for anticorrosion tape, and

ii. certificate for anticorrosion tape showing the manufacturer's name, the date and place of manufacture and showing that the material complies with the requirements stated in the Contract and including results of tests in accordance with the Contract.

(f) The particulars, including certificates, shall be submitted to the Engineer at least 14 days before the first delivery of the material to the Site. Certificates shall be submitted for each batch of the material delivered to the Site.

2.1.23.2.10 Bituminous coatings

(a) Bituminous coatings shall comply with the following:

i. Bitumen based hot applied coating material for protecting iron and steel including suitable primers where required : **BS EN 10300**

ii. Black bitumen coating solutions for cold application : **BS 3416**, Type II.

(b) Bituminous coatings used for repairing joints and coatings shall be compatible with the adjacent coating.

(c) Bituminous coatings shall be made from petroleum or asphaltic bitumen.

2.1.23.2.11 Whitewash

(a) Whitewash shall comply with **AWWA C 203**.

2.1.23.2.12 Zinc-based paint

(a) Zinc-based paint shall be a proprietary type approved by the Engineer.

(b) Primers for zinc-based paint shall comply with **BS 4652**.

(c) Rust inhibitor shall be a chemical agent which is capable of converting rust into iron phosphate.

2.1.23.2.13 Joint filler and compressible padding

(d) Joint filler for joints in concrete bed, haunch and surround shall be a proprietary type approved by the Engineer and shall be a firm, compressible, single thickness, non-rotting filler. The thickness of the filler shall be as stated in Table 2.1.23.2.

(e) Compressible padding between pipes and supports shall be bitumen damp-proof sheeting complying with BS 743.

Table 2.1.23.2: Joint filler for concrete bed, haunch and surround

Nominal diameter of pipe	Thickness of joint filler (mm)
less than 450 mm	18
450 mm - 1200 mm	36
exceeding 1200 mm	54

2.1.23.2.14 Polyethylene sheeting

(a) Polyethylene sheeting shall be impermeable and shall have a nominal thickness of 0.125 mm.

2.1.23.2.15 Extension keys

(a) Extension keys and clamps for valves shall be Grade 43A steel complying with BS **7668:2004** and shall be hot-dip galvanised in accordance with **BS EN ISO 1461** after fabrication.

2.1.23.3 Transport, handling and storage of materials

2.1.23.3.1 Transport, handling and storage of pipes, joints and fittings

(a) Pipes, joints and fittings for water supply pipeworks shall be transported, handled and stored in accordance with the manufacturers' recommendations and in a manner which will not result in damage or deformation to the pipes, joints and fittings or in contamination of the pipes, joints and fittings.

(b) Pipes, joints and fittings shall be protected from damage and damaged pipes, joints and fittings shall not be used in the permanent work unless permitted by the Engineer. Pipes, joints and fittings shall be securely packed and supported to prevent movement when being transported.

(c) UPVC pipes, joints and fittings shall be protected from exposure to conditions which may affect the material.

(d) Bolts and nuts shall be packed in sealed metal containers.

(e) Elastomeric joint rings shall be packed in bags and lubricant for joints shall be stored in sealed containers marked to identify the contents.

(f) The rings and lubricant shall be protected from exposure to conditions which may affect the material.

(g) Boxed or crated materials or those in sealed containers shall remain in their original boxes, crates or containers.

2.1.23.3.2 Handling of pipes and fittings

(a) Pipes and fittings other than thin walled pipes shall be handled by manual methods or by using lifting appliances or chains, wire rope or canvas slings of a type recommended by the pipe manufacturer and agreed by the Engineer; hooks shall not be used.

(b) Slings shall be placed around the pipes and fittings and padding shall be provided at points of contact between pipes and fittings and metal lifting appliances or slings. Pipes and fittings shall not be handled by means of metal slings passed through the pipes.

(c) Pipes and fittings shall not be subjected to rough handling, shock loading or dropping and shall not be rolled down ramps unless permitted by the Engineer; if permitted, the ramps shall be padded.

2.1.23.3.3 Storage of pipes

(a) Pipes other than thin walled pipes shall be stored horizontally at least 75 mm above the ground on wedged timber bearers. The bottom layers and the outer pipes in each layer shall be securely wedged to prevent sideways movement.

(b) Socket and spigot pipes shall be stored with the sockets alternating and in such a manner that loads are not applied to the sockets.

(c) The height of stacks of pipes other than thin walled pipes shall not exceed 2 m unless recommended by the manufacturer and permitted by the Engineer.

(d) Pipes shall not be strung out along the route of the pipeline unless permitted by the Engineer.

2.1.23.3.4 Transport and handling of thin walled pipes

(a) When being transported, thin walled pipes shall be supported on three rubber covered saddles shaped such that the pipes are supported over at least one-quarter of the circumference.

(b) The pipes shall be securely fixed in position at each saddle by straps tightened by turnbuckles. One saddle shall be placed at the mid-point of the length of the pipe and the other two saddles shall be placed at distances of one-fifth of the length of the pipe from each end of the pipe.

(c) When being handled and stored, thin walled pipes shall be protected from deformation by means of at least two screw jack cruciform struts with rubber padded ends shaped to fit the circumference of the pipes. The struts shall be fitted inside the pipes; any temporary struts fixed by the manufacturer shall be left in position until the cruciform struts have been fixed.

(d) Thin walled pipes shall be handled by using two reinforced canvas slings at least 300 mm wide. The slings shall be suspended from a lifting beam and shall be placed at a distance of onefifth of the length of the pipe from each end of the pipe.

(e) Thin walled pipes shall not be rolled.

(f) Thin walled pipes shall be stored on timber bearers padded with hessian or straw to provide continuous support over at least one-third of the circumference of the pipe. The pipes shall be securely fixed in position with wedges placed at a distance of one-fifth of the length of the pipe from each end of the pipe.

(g) Thin walled pipes shall not be stacked on top of each other.

2.1.23.3.5 Storage of valves

(a) Valves, including power operated valves and associated electrical and control equipment, shall be stored in accordance with the manufacturer's recommendations in a weatherproof store.

2.1.23.3.6 Access to pipelines

(a) Rubber wheeled trolleys shall be provided to obtain access inside pipelines exceeding DN 500 for water supply pipeworks in order to joint pipes, repair joints, coatings and linings and inspect the pipeline. Persons entering pipelines shall wear clean soft-soled footwear.

(b) Mechanical fans shall be provided to ensure that an adequate air supply is available to those entering pipelines for inspection. Engine driven fans shall be fitted with a flexible exhaust or other methods of keeping exhaust fumes clear of the fresh air intake.

2.1.23.4 Laying and bedding pipes

2.1.23.4.1 Laying pipes

(a) The Engineer shall be allowed to inspect trenches, bedding, pipes, joints, fittings and valves before pipelaying for water supply pipeworks starts. The Contractor shall inform the Engineer 24 hours, or such shorter period agreed by the Engineer, before pipelaying starts in any part of the permanent work.

(b) The permission of the Engineer shall be obtained before pipelaying starts in any part of the permanent work.

(c) The Contractor shall inspect pipes, joints, fittings and valves, including internal and external coatings, immediately before and after pipelaying; valves shall be inspected to ensure that they are in working order and are capable of being fully opened and closed. Deleterious material shall be removed and damage shall be repaired immediately before and after pipelaying; potable water shall be used for washing.

(d) The inside of pipelines shall be kept clean and free from water, dirt, stones, debris and deleterious material. Except when pipes are being jointed, the open ends of pipelines shall be sealed with a wooden plug or stopper or by other methods agreed by the Engineer.

(e) Measures shall be taken to prevent flotation of pipes.

(f) Pipelaying shall follow closely on excavation of the trench. Lengths of trench which in the opinion of the Engineer are excessive shall not be left open.

(g) Unless otherwise permitted by the Engineer, pipelines with a gradient steeper than 1 in 20 shall be laid in an uphill direction with sockets facing uphill.

(h) Pipes shall be laid in such a manner that water will not pond in locations with zero and shallow gradients and such that the line and level of pipes will comply with the specified tolerances.

2.1.23.4.2 Laying steel pipes

(a) Steel pipes with welded joints for water supply pipeworks shall be spot welded to the adjacent pipe to which they will be jointed immediately after laying. Steel pipes manufactured with longitudinal or spiral welds shall be aligned in such a manner that the welds are staggered from pipe to pipe by at least 15° of arc.

2.1.23.4.3 Laying pipes with flexible joints

(a) The degree of the curve of pipes for water supply pipeworks with flexible joints which are to be laid to a curve shall be equally distributed over all joints within the curved section. The deflection at a completed joint shall not exceed 3° or three-quarters of the maximum deflection recommended by the manufacturer whichever is less.

2.1.23.4.4 Installation of valves

(a) Operating gear and associated fittings shall be installed and fixed at the same time as valves for water supply pipeworks are installed. After installation, valves shall be cleaned inside and outside and left in a closed position.

(b) Extension keys and clamps shall be fixed to valves in valve chambers if the vertical distance between the top of the valve spindle and the finished ground level exceeds 600 mm. The length of extension keys shall be such that the top of the extension key is not more than 300 mm below the finished ground level.

2.1.23.4.5 Bedding pipes

(a) Surfaces on which pipes for water supply pipeworks will be laid shall be cleaned and objects which may damage the pipes shall be removed before pipes are laid.

(b) The bottom of trenches on which pipes will be laid directly shall be shaped to support the pipes uniformly along the length of the barrel; holes shall be dug to prevent pipes resting on the sockets and to allow the pipes to be jointed.

2.1.23.5 Cutting and drilling pipes

2.1.23.5.1 Cutting pipes

(a) Pipes for water supply pipeworks shall be cut and the ends shall be prepared in accordance with the manufacturer's recommendations; purpose made equipment recommended by the manufacturer and agreed by the Engineer shall be used for cutting the pipes.

(b) Cut ends of pipes shall be square and even, without damage to the pipe or coating. Cut ends, including cut ends of the piece not immediately required, shall be trimmed and chamfered to suit the type of joint and in such a manner that elastomeric joint rings will not be damaged by the cut end.

(c) Pipes requiring to be cut to form closing lengths shall not be cut until adjacent pipes have been laid and jointed and the length to be cut can be accurately measured.

(d) The permission of the Engineer shall be obtained before pipes provided by the Employer are cut. Only those pipes which in the opinion of the Engineer are suitable for cutting on Site shall be cut. All off-cuts shall be used for the permanent work unless in the opinion of the Engineer this is not practicable.

2.1.23.5.2 Drilling pipes

(a) Pipes for water supply pipeworks shall be drilled for small diameter connections using purpose made drilling and tapping equipment.

(b) The threads of screw joints shall be painted before assembly with two coats of bituminous paint and shall be wrapped with three turns of spun yarn or other material approved by the Engineer.

2.1.23.6 Jointing pipes

2.1.23.6.1 Jointing pipes

(a) Pipes for water supply pipeworks shall be jointed in accordance with the manufacturer's recommendations and using jointing equipment and jointing materials recommended by the manufacturer and agreed by the Engineer.

(b) The Contractor shall inspect pipes, joints, fittings and valves, including internal and external coatings, immediately before and after jointing. Deleterious material shall be removed and damage shall be repaired immediately before and after jointing; potable water shall be used for washing. Surfaces which are to be jointed and jointing materials shall be cleaned immediately before jointing.

(c) All joints in pipelines shall be watertight.

(d) The widths of gaps at joints shall be in accordance with the manufacturer's recommendations and shall be achieved by marking the outside of the pipe, by using metal feelers or by other methods agreed by the Engineer. The position of elastomeric joint rings shall be checked by using metal feelers after jointing.

(e) Gaps at joints in pipes shall be protected after jointing by methods agreed by the Engineer to prevent dirt, stones or other material entering the joint.

(f) Bolts holes in flanged joints and joints incorporating bolted components shall be correctly orientated before the bolts are tightened. The correct size of bolts and nuts shall be used. Bolt threads shall be lubricated and bolts shall be tightened using the correct size of spanner. Bolts shall be tightened in diametrically opposite pairs working around the bolt circle until all bolts are tightened to the torque recommended by the manufacturer.

(g) Bolt holes in flanged joints shall be orientated symmetrically about the vertical diameter with no bolt holes on the vertical diameter.

(h) Elastomeric joint rings shall be the correct size and shall not protrude into the bore of the pipe. The rings may be temporarily fixed to the face of the flange using a minimum amount of adhesive of a type recommended by the manufacturer; jointing compound or paste shall not be used.

2.1.23.6.2 DI pipes with push-in joints

(a) DI pipes with push-in joints for water supply pipeworks shall be jointed by smearing the spigot end of the pipe with lubricant and placing the elastomeric joint ring in position inside the groove of the socket end of the laid pipe. The spigot end of the pipe shall be placed in the socket end of the laid pipe and pushed home.

2.1.23.6.3 DI pipes with mechanical joints

(a) DI pipes with mechanical joints for water supply pipeworks shall be jointed as stated in Clauses 2.1.23.6.3 (b) to (d).

(b) The elastomeric joint ring and the ends of the pipe shall be smeared with lubricant over a distance recommended by the manufacturer.

(c) The gland and the elastomeric joint ring shall be placed in position on the spigot end of the pipe.

(d) The spigot end of the pipe shall be placed in the socket end of the laid pipe before the bolts are tightened.

2.1.23.6.4 Welding joints in steel pipes

(a) Welding of joints in steel pipes for water supply pipeworks shall be carried out by the metal-arc process in accordance with **BS 2633** and **BS 4515**.

(b) Butt welding shall not be used for jointing plain ended pipes other than for gusseted bends unless approved by the Engineer; if approved, the ends of the pipes shall be prepared in accordance with **BS 534** and **BS 2633** and welding shall be carried out in accordance with **BS 4515**.

(c) Records of welding operations shall be kept by the Contractor on the Site and shall be available for inspection by the Engineer at all times.

(d) Records shall contain the following details:
   i. date,
   ii. names of welders,
   iii. location of welding operation, and
   iv. electrodes used in making each weld.

2.1.23.6.5 Steel pipes with spigot and socket joints

(a) Steel pipes with spigot and socket joints for water supply pipeworks shall be jointed as stated in Clause 2.1.23.6.5(b) to (e).

(b) Pipes not exceeding DN 700 shall be welded externally. Pipes exceeding DN 700 shall be welded internally and shall then be welded externally with a sealing weld.

(c) Loose scale, slag, rust, paint and other deleterious material shall be removed from parts of pipes to be welded by wire brushing or by other methods agreed by the Engineer; the parts shall be kept clean and dry before welding.

(d) A double-run convex fillet weld shall be used for pipes not exceeding DN 900 and a triple-run convex fillet weld shall be used for pipes exceeding DN 900. The leg length of the fillet as deposited shall be at least the same as the full thickness of the pipe wall. The actual throat depth shall not be less than seven-tenths, and shall not exceed nine-tenths, of the minimum leg length as deposited.

(e) Deposition of the weld metal shall be carried out in such a manner that all welds have adequate root fusion and are of good, clean metal, free from cracks, gas holes, slag intrusion

and other impurities. The surface of the weld shall have an even contour with a regular finish and shall indicate proper fusion with the parent metal. Slag shall be removed from each weld by light hammering with a chipping hammer and by wire brushing.

(f) Welds which contain cracks or other cavities or defects or in which the weld metal overlaps on to the parent metal without proper fusion shall be cut out and the joints shall be rewelded

2.1.23.6.6 Steel pipes with welded steel collar joints

(a) Steel pipes with welded steel collar joints for water supply pipeworks shall be jointed by leaving a gap not exceeding 75 mm between the ends of the pipes to be jointed. A split steel collar shall be placed centrally around the ends of the pipes; the collar shall be at least the same thickness as the pipe wall and shall be approximately 300 mm long. The end of each pipe shall be fillet welded to the collar as stated in Clause 2.1.23.6.5.

2.1.23.6.7 Steel pipes with couplings and flange adapters

(a) Steel pipes with slip-on type couplings and flange adapters for water supply pipeworks shall be jointed as stated in Clause 2.1.23.6.7 (b) to (d).

(b) Protective wrappings shall be removed from the ends of plain ended pipes to be jointed and shall be replaced by:

i. bitumen coating complying with Clause 2.1.23.2.10 and BS 534 :Clause 25.1, or
ii. epoxy or plastics based coating of a proprietary type approved by the Engineer.

(c) The pipe shall be finished to an even, smooth surface free from distortion to allow the components of the coupling or flange adapter to be correctly positioned and jointed.

(d) The coupling or flange adapter shall be placed in position on the plain end before the bolts are tightened

2.1.23.6.8 UPVC pipes with pushin joints

(a) UPVC pipes with push-in joints for water supply pipeworks shall be jointed as stated in Clause 2.1.23.6.2.

2.1.23.6.9 UPVC pipes with solvent welded joints

- UPVC pipes with solvent welded joints for water supply pipeworks shall be jointed by applying solvent cement to the pipes to be jointed and pushing the pipes home. Excess solvent shall not be applied and surplus solvent shall be removed after jointing. Solvent welded pipes jointed outside the trench shall not be placed in the trench until the solvent setting period recommended by the manufacturer has elapsed.

2.1.23.6.10 GI pipe joints

(a) GI pipes for water supply pipeworks shall be screw jointed using a threaded coupler. The surface of the pipe and coupler shall be cleaned and the threads shall be painted with two coats of bituminous paint. The pipe thread shall be wrapped with three turns of spun yarn or other material approved by the Engineer and the joint tightened using purpose made tools. Coal tar compounds or lead-based paint shall not be used.

(b) Locking nuts to branch connections shall be tightened. Branch connections shall not protrude inside the pipe.

2.1.23.7 Protection to steel flanged joints, slip-on type couplings and flange adapters

2.1.23.7.1 Protection to steel flanged joints, slip-on type couplings and flange adapters

(a) Steel flanged joints, slip-on type couplings and flange adapters in steel pipes for water supply pipeworks shall be protected as stated in Clause 2.1.23.7.1 (a) to (d). Protection shall be carried out after jointing is complete.

(b) The joint, including bolts and nuts, shall be cleaned to remove all moisture, dirt, oil, grease and deleterious material. Bolts and nuts shall be painted with two coats of bituminous paint and the joint shall be coated with primer. Mastic filler shall be applied in such a manner that all depressions, corners and voids between the bolts and nuts are filled and a smooth surface is available on which to apply the anticorrosion tape.

(c) At least two layers of anticorrosion tape shall be applied to all parts of the joint and to the adjacent pipe for at least 200 mm beyond each end of the joint. The tape shall be applied in accordance with the manufacturer's recommendations and shall be wrapped spirally around the joint and pipe with at least 55% overlap per spiral.

(d) The tape shall be moulded manually after application to take up the contours of the parts being protected.

2.1.23.8 Repairs to joints, coatings and linings

2.1.23.8.1 Repairs to joints, coatings and linings

(a) Joints and damage to coatings and linings of pipes, joints and fittings for water supply pipeworks shall be repaired as stated in Clauses 2.1.23.8.1 to 2.1.23.8.7.

(b) Unless otherwise approved by the Engineer, repairs to joints, coatings and linings shall be carried out using materials of the same type and grade as in the pipe, joint or fitting.

(c) External repairs shall be completed before internal repairs are carried out.

(d) Internal repairs and adjacent areas shall be washed with potable water after the repair is complete.

2.1.23.8.2 Internal repairs to steel pipes with bitumen coatings

(a) Internal repairs to joints and coatings of steel pipes with bitumen coatings shall be carried out as stated in Clause 2.1.23.8.2 (a) to (e).

(b) Dirt, mill scale, rust and other deleterious material shall be removed from the areas to be repaired by wire brushing to leave dry, clean, bright metal. All damaged material shall be removed and the area shall be cleaned and dried.

(c) Primer shall be applied to the metal surface by brushing, avoiding bare spots, floods and sags.

(d) The area surrounding the area to be repaired shall be gently heated with a blow lamp or hot iron until the adjacent coating is molten.

(e) Bitumen shall be heated to 200°C and shall be stirred from time to time to prevent overheating. The bitumen shall be worked into the area to be repaired with a heated trowel to the same thickness as the adjacent coating; the bitumen shall be finished to a smooth, uniform surface.

2.1.23.8.3 External repairs to steel pipes with bitumen coatings

(a) External repairs to joints other than flanged joints, slip-on type couplings and flange adapters of steel pipes with bitumen coatings shall be carried out as stated in Clause 2.1.23.8.2 except as stated in Clause 2.1.23.8.3 (b) to (f).

(b) External repairs shall not start until any specified electrical continuity has been provided and any individual test to each joint has been carried out.

(c) A purpose made moulding box shall be cleaned and coated internally with whitewash. After the whitewash has dried, the box shall be fitted centrally around the joint and bolted together. Gaps between the pipe and the box shall be sealed with yarn or other material agreed by the Engineer to prevent leakage.

(d) The heated bitumen shall be poured into the box in one operation. After the bitumen has solidified, the box shall be removed, cleaned and stored for re-use.

(e) The affected area of bitumen coating shall be painted with whitewash after cooling.

(f) External repairs to coatings of steel pipes with bitumen coatings shall be carried out as stated in Clause 2.1.23.8.2 except that the heated bitumen together with woven glass cloth shall be worked into the area to be repaired. The affected area of bitumen coating shall be painted with whitewash after coating.

2.1.23.8.4 Internal repairs to steel pipes with concrete or cement mortar lining

(a) Internal repairs to joints and linings of steel pipes with concrete or cement mortar linings shall be carried out as stated in Clause 2.1.23.8.4 (b) to (e).

(b) The area to be repaired shall be cut back to leave clean, bright metal. The area surrounding the area to be repaired shall be wetted.

(c) The concrete or cement mortar shall be worked into the area to be repaired and compacted to the same thickness as the adjacent lining; the concrete or cement mortar shall be finished to a smooth uniform surface.

(d) The compressive strength and density of the compacted concrete or cement mortar shall be in accordance with **BS 534**, Clause 29.5. The repaired area shall be cured by using curing compound as stated in Clause 2.1.8.2.5.

(e) Samples of the concrete or cement mortar shall be provided and test cubes shall be made and tested.

2.1.23.8.5 Repairs to DI pipes with bitumen coatings

(a) Internal and external repairs to joints and coatings of DI pipes with bitumen coatings shall be carried out using bituminous paint. The area to be repaired shall be cleaned to bare metal and dried. The area to be repaired shall be painted with bituminous paint to the same thickness as the adjacent coating; the paint shall be finished to a smooth uniform surface.

2.1.23.8.6 Internal repairs to DI pipes with cement mortar lining

(a) Internal repairs to joints and linings of DI pipes with cement mortar linings shall be carried out as stated in Clause 2.1.23.8.6 (b) to (d).

(b) The area to be repaired shall be cut back to leave clean, bright metal. The area surrounding the area to be repaired shall be wetted.

(c) The cement mortar shall be worked into the area to be repaired and compacted to the same thickness as the adjacent lining; the cement mortar shall be finished to a smooth uniform surface. The repaired area shall be cured with curing compound as stated in Clause 2.1.8.2.5.

(d) The inside of pipe sockets and the faces of flanges shall be kept free from cement mortar.

2.1.23.8.7 Repairs to GI pipes

(a) Internal and external repairs to joints and coatings of GI pipes shall be carried out using zinc-based paint. The area to be repaired shall be cleaned to bare metal and dried. The area to be repaired shall be painted with a rust inhibitor, primer and two coats of zinc-based paint.

2.1.23.9 Thrust and anchor blocks

2.1.23.9.1 Thrust and anchor blocks

(a) The bearing face, and other faces stated in the Contract, of concrete thrust and anchor blocks for water supply pipeworks shall be cast directly against undisturbed ground; the faces of excavations shall be trimmed to remove loose material before concreting. Excess excavation and working space shall be filled with concrete of the same Grade as the block.

(b) Internal pressure shall not be applied to the pipeline until thrust and anchor blocks have developed the specified grade strength.

2.1.23.10 Bed, haunch and surround

2.1.23.10.1 Concrete bed, haunch and surround

(a) Concrete bed, haunch and surround to pipelines for water supply pipeworks shall be constructed as stated in Clause 2.1.23.10.1 (b) to (e).

(b) Pipes shall be supported at the required level by Grade 20 precast concrete wedges, blocks or cradles or by other methods agreed by the Engineer. One support shall be placed adjacent to each end of each pipe and the spacing between supports shall not exceed 3 m. Compressible sheeting shall be placed between the pipes and supports.

(c) Flexible joints shall be formed in concrete bed, haunch and surround at flexible joints in pipelines. Joint filler shall be placed next to the flexible joint in the pipeline and shall extend for the complete thickness of the bed, haunch and surround.

(d) Polyethylene sheeting shall be placed on the trench bottom before concreting.

(e) Concrete shall be placed evenly over the complete width of the bed and over the complete length of the pipe being concreted up to a level of 25 mm below the underside of the pipe.

Concrete shall then be placed on one side of the pipe only and worked under the pipe until the concrete spreads under the pipe. Concrete shall then be placed equally on both sides of the pipe to the specified level.

2.1.23.11 Tolerances

2.1.23.11.1 Tolerances : pipelines

(a) The line and level of pipelines for water supply pipeworks shall be within 25 mm of the specified line and level.

2.1.23.12 Cleaning and sterilisation of pipelines

2.1.23.12.1 Cleaning and sterilisation of pipelines

(a) Fresh water and potable water pipelines for water supply pipeworks shall be cleaned and flushed through with potable water. Cleaning and flushing shall be carried out after:

i. the complete pipeline, or parts of the pipelines permitted by the Engineer, has been tested,

ii. Temporary Works required for testing have been removed, and

iii. parts of the pipeline removed for testing have been reconnected.

(b) The pipeline shall be completely filled with water that has been dosed with a homogeneous solution of sterilising chemicals such that the final concentration of free chlorine in the water is at least 30 ppm. The water shall be left in the pipeline for at least 24 hours.

(c) After the 24 hour period, the pipeline shall be drained down and the sterilising water shall be flushed out using potable water until the concentration of the remaining chlorine is less than 1 ppm.

(d) Unless otherwise permitted by the Engineer, pipelines shall be cleaned and sterilised not more than 7 days before the pipeline is handed

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2.1.23.13 Testing: joints in steel pipes

2.1.23.13.1 Testing: joints in steel pipes

(a) Spigot and socket joints in steel pipes exceeding DN 700 for water supply pipeworks shall be tested after welding by the nitrogen gas test.

(b) A tapped hole of approximately 6 mm diameter shall be made in the socket end of each pipe to be tested and a non-return valve shall be fixed in the hole. The nitrogen gas test shall be carried out by pumping nitrogen to a pressure of 400 kPa into the annular space between the spigot and socket.

(c) The pump shall be disconnected and the pressure shall be recorded for 30 minutes.

2.1.23.13.2 Compliance criteria: joints in steel pipes

(a) There shall be no drop in pressure in the joint during the 30 minute period of the nitrogen gas test.

2.1.23.13.3 Non-compliance: joints in steel pipes

(a) If the result of any nitrogen gas test does not comply with the specified requirement for the test, the weld at the joint shall be cut out and the joint shall be rewelded and tested.

2.1.23.14 Testing: pressure pipelines for water supply pipeworks

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2.1.23.14.1 Testing: pressure pipelines for water supply pipeworks

(a) Pressure pipelines for water supply pipeworks shall be tested as stated in Clause 2.1.23.14.1 (b) to (g).

(b) The pipeline shall be tested in sections as stated in the Contract unless otherwise permitted by the Engineer; if testing in sections other than those stated in the Contract is permitted, the section to be tested shall be as long as practicable provided that the specified test pressure will not be exceeded. Final tests on complete pipelines which have been tested in sections shall not be carried out unless stated in the Contract.

(c) The test pressure shall be as stated in the Contract. If the test pressure is not stated in the Contract, the test pressure shall be:

i. times the maximum working pressure if the maximum working pressure does not exceed 1.5 MPa, or
ii. 1.3 times the maximum working pressure if the maximum working pressure exceeds 1.5 MPa.

(d) Unless otherwise permitted by the Engineer, pressure tests shall not be carried out until the fill material has been deposited and compacted over the complete length of the pipeline to be tested; if permitted, sufficient fill material shall be deposited to restrain the pipeline in position during the test.

(e) Tests shall not be carried out simultaneously on pipelines in the same trench.

(f) The method of testing shall be in accordance with Clause 2.1.23.16.

(g) Unless otherwise permitted by the Engineer, the pipeline shall be left charged with water at a head of at least 15 m after testing and until the pipeline has been sterilised or handed over to the Employer.

2.1.23.14.2 Compliance criteria: pressure pipelines for water supply pipeworks

(a) The results of tests on pressure pipelines for water supply pipeworks shall comply with the following requirements:

i. The leakage of water from the pipeline determined by the pressure test shall not exceed the permitted leakage calculated in accordance with Clause 2.1.23.16.4 in Clause 2.1.23.16.

ii. There shall be no discernable leakage of water from the pipeline or from any joint during the pressure test.

2.1.23.14.3 Non-compliance: pressure pipelines for water supply pipeworks

(a) If the result of any test on pressure pipelines for water supply pipeworks does not comply with the specified requirements for the test, the Contractor shall investigate the reason. Remedial or replacement work approved by the Engineer shall be carried out and the pipeline shall be retested.

2.1.23.15 Testing: water sterilisation

2.1.23.15.1 Testing: water sterilization

(a) After the pressure test on fresh water and potable water pipelines for water supply pipelines has been completed, samples of the water in the pipeline will be taken by the Engineer. The number of samples and locations of sampling shall be as instructed by the Engineer.

(b) Testing shall be carried out to determine the bacteriological content.

(c) The results of tests for bacteriological content of the water shall demonstrate that in the opinion of the Engineer the structure has been adequately sterilised .

2.1.23.16 Pressure tests on pipelines

2.1.23.16.1 Scope

(a) This method covers the determination of the leakage of water from pipelines for water supply pipeworks by means of a pressure test.

2.1.23.16.2 Equipment

(a) The following equipment is required:

i. Blank flanges or caps.
ii. Struts and wedges.
iii. Temporary concrete blocks or other anchors.
iv. Force pump and pump feed tank.
v. Pressure gauge, readable and accurate to 0.01 m head.
vi. Continuous pressure recorder and purpose made charts.

2.1.23.16.3 Procedure

The procedure shall be as follows:

(a) Pipes and valves shall be checked for cleanliness and the operation of valves shall be checked.

(b) Blank flanges or caps shall be fixed to the ends of the pipeline, or section of the pipeline, to be tested. Tests shall not be made against valve gates.

(c) The blank flanges and caps shall be secured with struts and wedges against temporary concrete blocks or other anchors. The blocks and anchors shall be completed and shall have hardened sufficiently before testing starts.

(d) Thrust and anchor blocks, pipe straps and other devices required to prevent movement of pipes and fittings shall be completed before testing starts.

(e) The pipeline shall be filled with water and all air shall be removed.

(f) Unless otherwise permitted by the Engineer, the pipeline shall remain filled for 3 days before testing starts to allow absorption to take place and to achieve conditions which are as stable as practicable.

(g) The pressure in the pipeline shall be increased slowly to the specified test pressure by pumping water into the pipeline using a force pump.

(h) The pressure in the pipeline shall be maintained within +0% and -5% of the specified test pressure for a test period of at least 2 hours.

(i) At the beginning and end of the test period and at 30 minute 170 intervals during the test period, readings shall be taken from the pressure gauge and the pressures (p) shall be recorded. The pressure shall be adjusted to the specified test pressure each time a reading is taken.

(j) The pressure shall be adjusted to within the specified tolerances for the test pressure at any time during the test period when the pressure falls outside the specified tolerances.

(k) The pressure shall be monitored during the test by means of a continuous pressure recorder with purpose made charts.

(l) The leakage of water from the pipeline shall be measured as the amount of water required to maintain the specified test pressure in the pipeline; the amount of water shall be determined from the fall in level of water in the pump feed tank.

2.1.23.16.4 Calculation

(a) The average test pressure (P) shall be calculated as the average of the pressures (p) recorded during the test.

(b) The permitted leakage of water from the pipeline during the pressure test shall be calculated from the equation:

Permitted leakage = $0.02 \times d \times l \times t/24 \times P/10$ litre where:
- d is the nominal diameter of the pipe (mm)
- l is the length of pipeline tested (km)
- t is the test period (hr)
- P is the average test pressure (m)

2.1.23.16.5 Reporting of results

(a) The following shall be reported:

i. The internal diameter of the pipe to the nearest 1 mm.
ii. The length of pipeline tested to the nearest 1 m.
iii. The test period to the nearest 0.01 hr.
iv. The pressures recorded during the test to the nearest 0.01 m.
v. The average test pressure to the nearest 0.01 m.
vi. The leakage and permitted leakage of water to the nearest 0.1 litre.

vii. Details of any discernable leakage of water from the pipeline during the test.
viii. Charts obtained from the continuous pressure recorder.
ix. That the test method used was in accordance with this Specification.

2.1.23.17 References and Standards

BS END 10311 (2005): Joints for the connection of steel tubes and fittings for the conveyance of water and other aqueous liquids

BS END 10224 (2002): Non-alloy steel tubes and fittings for the conveyance of water and other aqueous liquids. Technical delivery conditions

BS END 10220 (2002): Seamless and welded steel tubes. Dimensions and masses per unit length

BS END 10216-1 (2002): Seamless steel tubes for pressure purposes. Technical delivery conditions

BS END 10217-1 (2002): Welded steel tubes for pressure purposes.Technical delivery conditions. Non-alloy steel tubes with specified room temperature properties

BS 2633 (1987): Specification for Class I arc welding of ferritic steel pipework for carrying fluids.

BS 4515: Specification for welding of steel pipelines on land and offshore.

BS END 545 (2010): Ductile iron pipes, fittings, accessories and their joint for water pipelines. Requirements and test methods.

BS 4027 (1996): Specification for sulphate-resisting Portland cement.

BS END 10300 (2005): Steel tubes and fittings for onshore and offshore pipelines. Bitumen hot applied materials for external coating.

BS 3416 (1991): Specification for bitumen-based coatings for cold application suitable for use in contact with potable water.

BS 3505 (1986): Specification for unplasticized polyvinyl chloride PVC-U pressure pipes for cold potable water.

BS 4346-1 (1969): Joints and fittings for use with unplasticized PVC pressure pipes. Injection moulded unplasticized PVC fittings for solvent welding for use with pressure pipes, including potable water supply.

BS 1387 (1985): Specification for screwed and socketed steel tubes and tubulars and for plain end steel tubes suitable for welding or for screwing to BS 21 pipe threads.

BS END 1092-1(2007+A2:2013): Flanges and their joints. Circular flanges for pipes, valves, fittings and accessories, PN designated. Steel flanges

BS END 681-1(1996): Elastomeric seals. Material requirements for pipe joint seals used in water and drainage applications. Vulcanized rubber

BS END 1514: Flanges and their joints. Dimensions of gaskets for PN designed flanges.

AWWA C203 (2008): Standard for Coal-Tar Protective Coatings and Linings for Steel Water Pipelines—Enamel and Tape—Hot Applied

BS 4652 (1995:2000): Specification for zinc-rich priming paint (organic media).

BS 4346-2 (1970): Joints and fittings for use with unplasticized PVC pressure pipes. Mechanical joints and fittings, principally of unplasticized PVC

BS END 14814 (2007): Adhesives for thermoplastic piping systems for fluids under pressure. Specifications

BS END 10241 (2000): Steel threaded pipe fittings

BS END ISO 1461 (2009): Hot dip galvanized coatings on fabricated iron and steel articles. Specifications and test methods

BS 7668 (2004): Weldable structural steels. Hot finished structural hollow sections in weather resistant steels. Specification
BS END 10255 (2004): Non-alloy steel tubes suitable for welding and threading. Technical delivery conditions

BS END ISO 1452 (2009): Plastics piping systems for water supply and for buried and above-ground drainage and sewerage under pressure.

2.1.24 DRAINAGE WORKS

2.1.24.1 General

(a) The works and materials specified in Clauses 2.1.24.1 (b) to (g) shall comply with the sections stated, unless otherwise stated in this Section.

(b) Metalwork for handrailing, ladders, stairs, metal flooring, toe plates and safety chains shall comply with Section 2.1.18.

(c) Earthworks shall comply with Section 2.1.5.

(d) Formwork and finishes to concrete shall comply with Section 2.1.7.

(e) Concrete shall comply with Section 2.1.8.

(f) Water supply pipeworks shall comply with Section 2.1.23.

(g) Cable duct systems for electrical and mechanical installations shall comply with E&M specifications

2.1.24.2 Materials

2.1.24.2.1 Precast concrete pipes and fittings

(a) Precast concrete pipes and fittings shall comply with **BS 5911-1** and **BS EN 1916**.

(b) Precast concrete pipes and fittings shall have flexible spigot and socket joints.

2.1.24.2.2 Vitrified clay pipes and Fittings

(a) Vitrified clay pipes and fittings shall comply with **BS 65**; the pipes and fittings shall be glazed and shall be the normal chemical resistant type.

(b) Vitrified clay pipes and fittings shall have flexible mechanical joints.

2.1.24.2.3 DI pipes and fittings

(a) DI pipes and fittings shall comply with **BS EN 545**. Pipes and fittings shall be lined internally with cement mortar and shall be coated externally with bituminous coating.

(b) Flexible joints in DI pipes and fittings shall be the push-in type and shall be capable of withstanding a minimum angular deflection of 4°.

(c) Flexible joints shall also be capable of withstanding axial movements and shall allow a minimum withdrawal of 38 mm when there is no deflection of the joint.

(d) Flanged joints in DI pipes and fittings shall be PN 16 rating complying with **BS EN 1092-1**.

(e) Pipes which are to be built in to structures shall have puddle flanges welded on.

2.1.24.2.4 Grey iron pipes and Fittings

(a) Grey iron pipes and fittings shall comply with **BS 4622**.

2.1.24.2.5 UPVC pipes and Fittings

(a) UPVC pipes and fittings shall comply with the relevant British Standard stated in Table 2.1.24.1.

(b) UPVC pipes and fittings above ground shall have solvent welded spigot and socket joints. UPVC pipes and fittings below ground shall have either solvent welded spigot and socket joints or flexible spigot and socket joints with elastomeric joint rings as stated in the Contract.

(c) Joints and fittings for UPVC pressure pipes complying with **BS 3506** shall comply with the following:

i. Injection moulded UPVC fittings for solvent welding for use with pressure pipes, including water supply : **BS 4346: Part 1**

ii. Mechanical joints and fittings principally of UPVC : **BS 4346: Part 2**

(d) Solvent cement for UPVC pressure pipes shall comply with **BS 4346: Part 3**.

(e) The Class of UPVC pressure pipes complying with **BS 3506** shall depend on the pressure rating.

2.1.24.2.6 GI pipes and fittings

(a) GI pipes and fittings shall comply with the following:

i. Steel tubes and tubulars suitable for screwing to **BS 21** pipe threads : **BS EN 10255:2004** medium grade
ii. Pipe threads for tubes and fittings where pressure-tight joints are made on the threads : **BS 21**
iii. Wrought steel pipe fittings (screwed BSP thread) : **BS EN 10241.**

(b) GI pipes and fittings shall be medium class thickness and shall be galvanized in accordance with **BS EN ISO 1461**.

Table 2.1.24.1: UPVC pipes and fittings

Use	Nominal diameter (mm)	British Standard
Gravity sewage pipes and fittings above ground	32 - 50	**BS 5255**
	82 - 160	**BS 4514**
Gravity surface water pipes and fittings above ground	63 - 75	**BS EN 12200-1**
	82 - 160	**BS 4514**
Gravity sewage and storm water pipes and fittings below ground	110 - 160	**BS 4660**
	200 - 630	**BS EN 1401-1**
Pressure pipes and fittings above and below ground	10 - 600	**BS 3506**

2.1.24.2.7 Bolts, nuts and washers

(a) Bolts, nuts and washers for flanged joints, detachable couplings and flange adapters shall comply with the following:
   i. ISO metric black hexagon bolts, screws and nuts : **BS 4190**
   ii. Metal washers for general engineering purposes : **BS 4320**.

(b) The bolts, nuts and washers shall be hot-dip galvanised in accordance with **BS EN ISO 1461** or treated with other suitable coating approved by the Engineer.

(c) Stainless steel bolts and nuts shall comply with **BS EN ISO 3506**, steel Grade A4 and property Class 80. Washers shall be Grade 316 S 31 in the softened condition complying with **BS EN 10029**.

(d) Spheroidal graphite iron bolts shall be Grade 500/7 metal complying with **BS EN 1563**.

(e) Bolts, nuts and washers shall be insulated from electrochemically dissimilar metal by non-metallic washers and sleeves.

(f) Bolts and nuts shall be compatible with the type of joint and, unless otherwise approved by the Engineer, shall be obtained from the same manufacturer as the joint.

2.1.24.2.8 Elastomeric joint rings

(a) Elastomeric joint rings shall comply with **BS EN 681-1**. The rings shall be compatible with the type of joint and, unless otherwise approved by the Engineer, shall be obtained from the same manufacturer as the joint.

(b) Elastomeric joint rings for flanged pipes shall be the inside diameter bolt circle type. The rings shall be natural rubber with a thickness of 3.2 mm and with other dimensions complying with **BS EN 1514**.

2.1.24.2.9 Detachable couplings and flange adapters

(a) Detachable couplings and flange adapters shall be a proprietary type approved by the Engineer.
(b) Detachable couplings and flange adapters shall accommodate the angular deflection and straight draw for the different nominal diameters of pipes connected.

2.1.24.2.10 Anticorrosion tape

(a) Anticorrosion tape shall be a proprietary type approved by the Engineer. The tape shall be a rubber/bitumen compound with fabric reinforcement and shall be backed with PVC film. The tape shall have a high resistance to cathodic disbonding, acids and alkalis.

(b) Anticorrosion tape shall be applied to valves, flanged joints, slip-on couplings and flange adapters. Type 1 shall be used for pipes smaller than 700 mm diameter and Type 2 shall be used for pipes 700 mm diameter and above.

(c) Primer and mastic filler for use with anticorrosion tape shall be compatible with the tape and shall be a type recommended by the manufacturer of the tape and approved by the Engineer.

2.1.24.2.11 Bituminous coatings

(a) Bituminous coatings shall comply with the following:

i. Bitumen based hot applied coating material for protecting iron and steel including suitable primers where required : **BS EN 10300**
ii. Black bitumen coating solutions for cold application: **BS 3416**, Type II.

(b) Bituminous coatings used for repairing joints and coatings shall be compatible with the adjacent coating.

2.1.24.2.12 Aggregates for granular bed and granular fill

(a) Granular bed shall be Type A material and granular fill shall be Type B material.

(b) Type A or Type B material shall consist of hard, clean, crushed slag, gravel, crushed rock, crushed concrete or crushed inert demolition material having a grading within the limits of Table 2.1.24.2. The ten percent fines values shall be at least 50 kN. The material passing the 425 µm BS test sieve shall be non-plastic when tested in accordance with **BS 1377**.

(c) Type A and Type B materials shall be obtained from a source approved by the Engineer.

(d) Aggregates for granular bed shall have the compacting fraction values stated in Clause 2.1.24.22.4.

Table 2.1.24.2: Range of grading of Type A and Type B materials

BS test sieve	**Percentage by mass passing**	
Metric	*Type A*	*Type B*
63 mm	-	100
37.5 mm	100	85-100
20 mm	-	0-20
10 mm	45-100	0-5
3.35 mm	25-80	-
600 µm	8-45	-
75 µm	0-10	-

Table 2.1.24.3: Joint filler for concrete bed, haunch and surround

Nominal diameter of pipe	Thickness of joint filler (mm)
less than 450 mm	18
450 mm - 1200 mm	36
exceeding 1200 mm	54

2.1.24.2.13 Joint filler and compressible padding

(a) Joint filler for joints in concrete bed, haunch and surround shall be a firm, compressible, single thickness, non-rotting filler. The thickness of the filler shall be as stated in Table **2.1.24**.3.

(b) Compressible padding between pipes and supports shall be bitumen damp-proof sheeting complying with **BS 743**.

2.1.24.2.14 Polyethylene sheeting

(a) Polyethylene sheeting shall be impermeable and shall have a nominal thickness of 0.125 mm.

2.1.24.2.15 Precast concrete manholes

(a) Precast concrete manhole units shall comply with **BS 5911-3** and **BS EN 1917**. Cover slabs and reducing slabs shall be reinforced as required to comply with the load test requirements stated in **BS 5911-3**.

2.1.24.2.16 Chambers and gullies

(a) Precast concrete chambers and gullies shall comply with **BS 5911-4:2002+A2:2010**. Cover slabs shall be reinforced as required to comply with the load test requirements stated **in BS 5911-4:2002+A2:2010.** The types of cement for the manufacture of precast concrete chambers and gullies, and cover slabs shall be as stated in **BS 5911-4:2002+A2:2010**, or a combination of PFA and OPC complying with BS 12, or PPFAC. The PFA content shall not exceed 40% by mass of the cementitious content.

(b) Vitrified clay gullies shall comply with **BS 65**.

2.1.24.2.17 Step irons

(a) Step irons shall comply with **BS EN 13101**. Step irons shall be malleable cast iron complying with **BS EN 1562** and shall be hot-dip galvanised in accordance with **BS EN ISO 1461**.

2.1.24.2.18 Manhole covers, gully gratings and kerb overflow weirs

(a) Manhole covers, gully gratings and kerb overflow weirs shall be Grade 150 cast iron complying with **BS EN 1561**; bolts and nuts shall comply with **BS 4190**.

(b) Covers, gratings and weirs shall be cleanly cast, free from air holes, sand holes, cold shuts and chill and shall be neatly dressed and fettled. Castings shall be free from voids whether due to shrinkage, gas inclusions or other causes. Bolts and nuts shall not be over tightened.

(c) The dimensions of the different types of covers, gratings and weirs shall be as stated in the Contract; the test loads which the covers and gratings are required to withstand, and the minimum masses of covers gratings and weirs, shall be as stated in Table 2.1.24.4 and Table 2.1.24.5.

(d) Covers, gratings and weirs shall have the manufacturer's name cast integrally with the unit in a raised form and shall be protected with bituminous coating. Covers shall have a raised design on the top surface as stated in the Contract.

Table 2.1.24.4: Details of manhole covers and frames

Type of manhole cover and frame	Minimum mass(kg)	Grade	Test requirements	
			Diameter of block (mm)	Test load (t)
Double triangular manhole cover and frame	180	Medium duty	100	5
Double triangular manhole cover for sewers	130	Heavy duty	300	30
Double triangular manhole cover for sewers frame	105	Heavy duty	300	30
Double triangular desilting manhole cover for sewers frame	290	Heavy duty	300	30
Double triangular desilting manhole cover for sewers frame	165	Heavy duty	300	30
Double seal terminal manhole cover for sewers	-	Medium duty	300	20
	-	Medium duty	300	20
	-	Heavy duty	100	5
	-	Heavy duty	100	5

Table 2.1.24.5: Details of gully gratings and frames

Type of manhole cover and frame	Minimum mass(kg)	Grade	Test requirements	
			Diameter of block (mm)	Test load (t)
Grating for hinged gully grating	28.0	Heavy duty	300	20
Grating for hinged gully grating frame	24.5	Heavy duty	300	20
Grating for double triangular grating	57.5	Heavy duty	300	20
Shallow frane				
-adjacent to kerb	33.5	Heavy duty	300	20
-away from kerb	36.5	Heavy duty	300	20
Deep frame				
-adjacent to kerb	40.5	Heavy duty	300	20
-away from kerb	44	Heavy duty	300	20
Grating for hinged gully	61.5	Heavy duty	300	20

Grating for hinged gully frame	37	Heavy duty	300	20

2.1.24.2.19 Penstocks

(a) Penstocks shall comply with the following requirements:

i. Frames and gates shall be cast iron complying with **BS 1452**, Grade 220.
ii. Stems shall be stainless steel complying with **BS EN 10095** and **BS END 10250-4**. Operating nuts shall be gunmetal complying with **BS EN 1982**, Grade LG2.
iii. Sealing faces shall be phosphor bronze complying with **BS EN 12167**.
iv. Sealing strips at inverts of flush invert penstocks shall be elastomer complying with ASTM D 2000.
v. Assembly and fixing nuts and bolts shall be stainless steel complying with Clause 2.1.24.2.7 (c).
vi. Adjustable wedges shall be phosphor bronze complying with **BS EN 12167**, Grade PB 102 or stainless steel complying with **BS EN 10095**.

(b) Penstocks shall be designed for on-seating pressure or off-seating pressure or both on-seating and off-seating pressures as stated in the Contract.

(c) Sealing faces shall be of rectangular sections and shall be fixed to the frames and gates using taperhead screws of the same material as the sealing faces.

(d) Adjustable wedges shall have sufficient contact areas with the gates to minimise wear.

(e) Frames shall include guide rails or guide faces for gates.

(f) Clearance within guides shall be as small as practicable such that the gates will not vibrate under flow conditions.

(g) Penstocks shall have rising stems unless otherwise stated in the Contract. Rising stems shall have perspex protection tubes with open/close indicators.

2.1.24.2.20 Gate valves

(a) Gate valves shall comply with **BS END 1171:2002** and with the following requirements:

i. Bodies and wedges shall be cast iron complying with **BS 1452**, Grade 220 and shall have renewable gunmetal seat rings.
ii. Gunmetal for renewable seat rings shall be Grade LG2 complying with BS EN 1982.
iii. Stem nuts shall be gunmetal complying with **BS EN 1982**, Grade LG2.
iv. Stems shall be aluminium bronze complying with **BS EN 12167**.
v. Assembly and fixing nuts and bolts shall be stainless steel complying with Clause 2.1.24.2.7 (c).

(b) Gate valves shall be double flange-ended solid wedge type with nominal pressure designation PN 16. Flanges shall be PN 16 complying with **BS EN 1092-1**.

(c) Gate valves shall have outside screw rising stems unless otherwise stated in the Contract. Rising stems shall have perspex protection tubes with open/close indicators.

(d) Gate valves shall be fitted with a plate showing the operating position of the valve in the closed, quarter closed, half closed, threequarters closed and open positions.

(e) Chains for chain operated gate valves shall be mild steel complying with **BS EN 10095, BS EN 10250-4** and hot-dip galvanized in accordance with **BS EN ISO 1461**; the chains shall be continuous.

2.1.24.2.21 Flap valves

(a) Flap valves shall comply with the following requirements:

i. Frames and flaps shall be cast iron complying with **BS 1452**, Grade 220.
ii. Sealing faces and hinge pins shall be gunmetal complying with **BS EN 1982**, Grade LG2.

(b) The flap shall be hung with double hinges and secured with hinge pins.

(c) Flanges for flange mounting types of flap valves shall be PN 16 complying with **BS EN 1092-1**.

2.1.24.2.22 Sludge valves

(a) Sludge valves shall comply with the following requirements:

i. Bodies and valve sections shall be cast iron complying with **BS 1452**, Grade 220.
ii. Sealing faces and stem nuts shall be gunmetal complying with **BS EN 1982**, Grade LG2.
iii. Stems shall be aluminium bronze complying with **BS EN 12167**.

(b) The stems of sludge valves shall operate through non-rising stem nuts housed in bridges bolted over the body sections.

(c) Outlet flanges of sludge valves shall be PN 16 complying with **BS EN 1092-1**.

2.1.24.2.23 Air valves

(a) Air valves shall be of the elongated body type and shall have a pressure rating of 3 bars unless otherwise stated in the Contract.

(b) Dual orifice air valves shall have:
i. a small orifice valve for releasing air at working pressure, and
ii. a large orifice valve for allowing air to pass at atmospheric pressure during emptying and filling of pipework.

(c) The bodies and covers of small and large orifice valves shall be cast iron complying with **BS 1452**, Grade 220; the trim and float shall be stainless steel complying with **BS EN 10095**.

(d) Small orifice valves shall have an adjustable Vitron orifice button to ensure positive sealing. Large orifice valves shall have a Buna-N seat.

(e) The valve inlet of small orifice valves shall be 75 mm diameter and the valve outlet shall be 25 mm diameter; the venting orifice shall be 5 mm diameter. The valve inlet and the valve outlet of large orifice valves shall be 75 mm diameter.

(f) Air valves shall be provided with isolating gate valves.

2.1.24.2.24 Fittings for penstocks and valves

(a) Handwheels and tee keys for penstocks and valves shall turn in a clockwise direction for closing. Handwheels shall have smooth rims and the direction of opening and closing shall be clearly cast on the handwheel.

(b) The opening effort required at any point on the handwheel rim shall not exceed 250 N when operated against the full unbalanced pressure.

(c) Extension stems for penstocks and valves shall be stainless steel of the same grade as the stems; extension stems shall be connected by muff couplings.

(d) Handwheels, tee keys, headstocks, guide brackets for stems, supporting brackets, surface boxes and other fittings for penstocks and valves shall be cast iron complying with **BS EN 1561**.

(e) Bolts and nuts for fixing penstocks and valves to structures shall be stainless steel complying with 2.1.24.2.7 (c). Bolts shall be indented foundation bolts.

(f) Grout for filling rebates and box-outs shall be a proprietary type approved by the Engineer and shall contain a non-shrink admixture.

2.1.24.2.25 Filling abandoned pipes and manholes

(a) Foam concrete for filling abandoned pipes, culverts, manholes and voids shall be composed of OPC (or PPFAC), fine aggregate, water, admixtures for accelerating or retarding the setting time and foam to reduce the density and to produce a flowing self levelling material.

(b) As an alternative to foam concrete when permitted by the Engineer, a grout of OPC/PFA and water may be used. Sand and admixtures may not be used in the OPC/PFA grout unless approved in writing by the Engineer.

(c) The OPC/PFA grout shall consist of 15 parts of PFA to 1 part of OPC by mass together with the minimum amount of water necessary to achieve a consistency suitable for flowing into the pipes, culverts, manholes and voids.

2.1.24.3 Submissions

2.1.24.3.1 Particulars of pipes, joints and fittings

(a) The following particulars of the proposed pipes, joints and fittings for drainage works shall be submitted to the Engineer:

i. manufacturers' literature, including details of:
- manufacturing process
- pressure and temperature ratings
- permissible values of straight draws and angular deflection of flexible joints
- recommendations for handling, storage, laying, jointing and repair
- drilling and tapping equipment for connections to pipes, and

ii. a certificate for each material showing the manufacturer's name, the date and place of manufacture and showing that the material complies with the requirements stated in the Contract and including results of tests required in accordance with the Contract.

(b) The particulars, including certificates, shall be submitted to the Engineer at least 14 days before the first delivery of the material to the Site. Certificates shall be submitted for each batch of the material delivered to the Site.

2.1.24.3.2 Particulars of anticorrosion tape and joint filler

(a) The following particulars of the proposed anticorrosion tape and joint filler for drainage works shall be submitted to the Engineer:

i. manufacturer's literature for anticorrosion tape, and
ii. certificates for anticorrosion tape and joint filler showing the manufacturers' name, the date and place of manufacture and showing that the material complies with the requirements stated in the Contract and including results of tests in accordance with the Contract.

(b) The particulars, including certificates, shall be submitted to the Engineer at least 14 days before the first delivery of the material to the Site. Certificates shall be submitted for each batch of the material delivered to the Site.

2.1.24.3.3 Particulars of aggregates for granular bed

(a) A certificate for each type of aggregate showing the source of the aggregate and showing that the aggregate complies with the requirements stated in the Contract, and including the results of tests in accordance with the Contract, shall be submitted to the Engineer for the proposed aggregates for granular bed for drainage works.

(b) The particulars, including certificates, shall be submitted to the Engineer at least 14 days before the first delivery of the aggregate to the Site and thereafter each time the source is changed.

2.1.24.3.4 Particulars of manholes, chambers and gullies

(a) The following particulars of the proposed materials for manholes, chambers and gullies for drainage works shall be submitted to the Engineer:

i. a certificate for each type of manhole and chamber unit and for each type of gully showing the manufacturer's name, the date and place of manufacture and showing that the materials comply with the requirements stated in the Contract and including results of tests required in accordance with the Contract,

ii. a certificate for step irons showing the manufacturer's name, the date and place of manufacture and showing that the step irons comply with the requirements stated in the Contract, and including results of tests required in accordance with the Contract, and

iii. a certificate for each type of manhole cover, gully grating and kerb overflow weir showing the manufacturer's name, the date and place of manufacture and showing that the materials comply with the requirements stated in the Contract and including results of tests in accordance with the Contract.

(b) The particulars, including certificates, shall be submitted to the Engineer at least 14 days before the first delivery of the material to the Site. Certificates shall be submitted for each batch of the material delivered to the Site.

2.1.24.3.5 Particulars of penstocks and valves

(a) The following particulars of the proposed penstocks and valves for drainage works shall be submitted to the Engineer:

i. manufacturer's literature, including details of:
- materials;
- pressure ratings;
- recommendations for handling, storage and installation.

ii. drawings showing details of the penstocks and valves, including lengths of stems and details of handwheels, tee keys, extension stems, headstocks, guide brackets

for stems, supporting brackets, surface boxes and other fittings, and positions and sizes of rebates and box-outs.

The particulars shall be submitted to the Engineer at least 28 days before the first delivery of the material to the Site.

2.1.24.3.6 Particulars of foam concrete and OPC/PFA grout

(a) The following particulars of the foam concrete and grouting procedure for filling abandoned pipes, culverts, manholes and voids shall be submitted to the Engineer:

i. proportions of each constituent,
ii. source of supply,
iii. details of mixing,
iv. setting time,
v. strength,
vi. shrinkage expected (for OPC/PFA grout),
vii. details of mixing and grouting equipment, and
viii. method of grouting, including details of trials.

(b) The particulars shall be submitted to the Engineer at least 7 days before grouting starts.

2.1.24.3.7 Particulars of tests

The following particulars of the proposed procedures for tests on pipelines and penstocks for drainage works shall be submitted to the Engineer:

i. test equipment and method of setting up the equipment,
ii. calibration certificates for pressure gauges,
iii. procedure for carrying out the test, and
iv. programme for testing.

The particulars shall be submitted to the Engineer at least 14 days before the test starts.

2.1.24.3.8 Particulars of CCTV inspections

The following particulars of the proposed procedure for CCTV inspections shall be submitted to the Engineer:

i. names and experience of persons carrying out or supervising
ii. the inspections,
iii. details of equipment,
iv. details of the format of report, and
v. examples of video films and photographs obtained from inspections employing the same equipment.

The particulars of the procedure shall be submitted to the Engineer at least 28 days before the inspection starts.

2.1.24.3.9 Particulars of diversions of flow

(a) Unless otherwise permitted by the Engineer particulars of the proposed procedures for diversions of existing flows shall be submitted to the Engineer at least 14 days before the diversion starts.

2.1.24.4 Transport, handling and storage of materials

2.1.24.4.1 Transport, handling and storage of pipes, joints and fittings

(a) Pipes, joints and fittings for drainage works shall be transported, handled and stored in accordance with the manufacturers' recommendations and in a manner which will not result in damage or deformation to the pipes, joints and fittings or in contamination of the pipes, joints and fittings.

(b) Pipes, joints and fittings shall be protected from damage and damaged pipes, joints and fittings shall not be used in the permanent work unless permitted by the Engineer.

(c) UPVC pipes, joints and fittings shall be protected from exposure to conditions which may affect the material.

(d) Bolts and nuts shall be packed in sealed metal containers.

(e) Elastomeric joint rings shall be packed in bags and lubricant for joints shall be stored in sealed containers marked to identify the contents.

(f) The rings and lubricant shall be protected from exposure to conditions which may affect the material.

2.1.24.4.2 Handling of pipes and fittings

(a) Pipes and fittings shall be handled manually or by using lifting appliances or chains, wire rope or canvas slings of a type recommended by the pipe manufacturer and agreed by the Engineer; hooks shall not be used.

(b) Slings shall be placed around the pipes and fittings and padding shall be provided at points of contact between pipes and fittings and metal lifting appliances or slings. Pipes shall not be handled by means of metal slings passed through the pipes.

(c) Pipes and fittings shall not be subjected to rough handling, shock loading or dropping and shall not be rolled down ramps unless permitted by the Engineer; if permitted, the ramps shall be padded.

2.1.24.4.3 Storage of pipes

(a) Pipes shall be stored horizontally at least 75 mm above the ground on wedged timber bearers. The bottom layers and the outer pipes in each layer shall be securely wedged to prevent sideways movement.

(b) Socket and spigot pipes shall be stored with the sockets alternating and in such a manner that loads are not applied to the sockets.

(c) The height of stacks of pipes shall not exceed 2 m unless recommended by the manufacturer and permitted by the Engineer.

(d) Pipes shall not be strung out along the route of the pipeline unless permitted by the Engineer.

2.1.24.4.4 Storage of anticorrosion tape and joint filler

(a) Anticorrosion tape and joint filler shall be stored in accordance with the manufacturer's recommendations in a dry, weatherproof store with a raised floor.

2.1.24.4.5 Handling and storage of aggregates for granular bed

(b) Aggregates for granular bed shall not be handled or stored in a manner which will result in mixing of the different types and sizes or in contamination of the aggregates. Different types and sizes of aggregates shall be stored in separate stockpiles.

2.1.24.4.6 Handling and storage of units for manholes, chambers and gullies

(a) Units for manholes, chambers and gullies shall be lifted only at the lifting points recommended by the manufacturer and shall not be subjected to rough handling, shock loading or dropping.

(b) Units for manholes, chambers and gullies shall be stored off the ground on level supports and in a manner which will not result in damage to the units or in contamination or deformation of the units. The units shall be protected from damage and damaged units shall not be used in the permanent work unless permitted by the Engineer.

2.1.24.4.7 Storage of covers, gratings, weirs penstocks and valves

(c) Manhole covers, gully gratings, kerb overflow weirs, penstocks and valves, including fittings, shall be stored off the ground on level supports and in a manner which will not result in damage to the units or in contamination or deformation of the units. The units shall be protected from damage and damaged units shall not be used in the permanent work unless permitted by the Engineer.

2.1.24.5 Excavation

2.1.24.5.1 Excavation

(a) Excavation for any section of a trench for drainage works shall not commence until the nature, location and size of existing utilities which may be affected by the excavation have been ascertained and the setting out details have been approved by the Engineer.

(b) The effective trench width of trenches for drainage works shall not exceed the relevant effective trench widths stated in Table 2.1.24.6 for the different diameters of pipe. The effective trench width shall be measured as stated in the Contract.

Table 2.1.24.6: Effective trench widths

Nominal diameter of pipe (mm)	Effective trench width (mm)
100	550
150	600
225	750
300	1050
375	1150
450	1200
525	1350
600	1450
750	1500
825	1600
900	1900
975	2000
1050	2050
1125	2200
1200	2300
1350	2450

1500	2600
1650	2800
1800	2950
1950	3150
2100	3350
2250	3400
2400	3500
2550	3650
2700	3800
2850	3950
3000	4150

2.1.24.6 Laying and bedding pipes

2.1.24.6.1 Laying pipes

(a) The Contractor shall allow the Engineer to inspect trenches, bedding, pipes, joints, fittings and valves before pipelaying for drainage works starts. The Contractor shall inform the Engineer 24 hours, or such shorter period agreed by the Engineer, before pipelaying starts in any part of the permanent work.

(b) The permission of the Engineer shall be obtained before pipelaying starts in any part of the permanent work.

(c) The Contractor shall inspect pipes, joints, fittings and valves, including internal and external coatings, immediately before and after pipelaying; valves shall be inspected to ensure that they are in working order and are capable of being fully opened and closed. Deleterious material shall be removed and damage shall be repaired immediately before and after pipelaying.

(d) The inside of pipelines shall be kept clean and free from water, dirt, stones, debris and deleterious material. Except when pipes are being jointed, the open ends of pipelines shall be sealed with a wooden plug or stopper or by other methods agreed by the Engineer.

(e) Measures shall be taken to prevent flotation of pipes.

(f) Pipelaying, testing and backfilling shall follow as closely as practicable on excavation of the trench.

(g) Unless otherwise permitted by the Engineer, pipelines shall be laid in an uphill direction with sockets facing uphill.

(h) Pipes shall be laid in such a manner that water will not pond in locations with zero or shallow gradients and such that the pipes will comply with the specified tolerances.

2.1.24.6.2 Bedding pipes

(a) Surfaces on which pipes for drainage works will be laid shall be cleaned and objects which may damage the pipes shall be removed before pipes are laid.

(b) The bottom of trenches on which pipes will be laid directly shall be shaped to support the pipes uniformly along the length of the barrel; holes shall be dug to prevent pipes resting on the sockets and to allow the pipes to be jointed.

2.1.24.7 Cutting pipes

2.1.24.7.1 Cutting pipes

(a) Pipes for drainage works shall be cut and the ends shall be prepared in accordance with the manufacturers' recommendations; purpose-made equipment recommended by the manufacturer or approved by the Engineer shall be used for cutting the pipes.

(b) Cut ends of pipes shall be square or cut to the correct angle and without damage to the pipe or coating. Cut ends shall be trimmed and chamfered to suit the type of joint and in such a manner that elastomeric joint rings will not be damaged by the cut end.

(c) Pipes requiring to be cut to form closing lengths shall not be cut until adjacent pipes have been laid and jointed and the length to be cut can be accurately measured.

(d) Reinforcement in precast concrete pipes which are cut shall be cut back flush with the concrete and protected with epoxy resin or by other methods agreed by the Engineer.

(e) Pipes which terminate at the inside face of structures shall be cut such that the end of the pipe is flush with the face.

2.1.24.8 Jointing pipes

2.1.24.8.1 Jointing pipes

(a) Pipes for drainage works shall be jointed in accordance with the manufacturers' recommendations and using jointing equipment and jointing materials recommended by the manufacturer or approved by the Engineer.

(b) The Contractor shall inspect pipes, joints, fittings and valves, including internal and external coatings, immediately before and after jointing. Deleterious material shall be removed and damage shall be repaired immediately before and after jointing. Surfaces which are to be jointed and jointing materials shall be cleaned immediately before jointing. Pipes shall be cleaned out with clean water.

(c) All joints in pipelines shall be watertight.

(d) The widths of gaps at joints shall be in accordance with the manufacturers' recommendations and shall be achieved by marking the outside of the pipe, by using metal feelers or by other methods agreed by the Engineer. The position of elastomeric joint rings shall be checked by using metal feelers after jointing.

(e) Gaps at joints in pipes shall be protected after jointing, by methods agreed by the Engineer, to prevent dirt, stones or other material entering the joint.

2.1.24.8.2 Flanged joints

(a) Flanged joints in pipes for drainage works shall be made as stated in Clause 2.1.24.8.2(b) and (c).

(b) Bolts holes in flanged joints and joints incorporating bolted components shall be correctly orientated before the bolts are tightened. The correct size of bolts and nuts shall be used. Bolt threads shall be lubricated and bolts shall be tightened using the correct size of

spanner. Bolts shall be tightened in diametrically opposite pairs working around the bolt circle until all bolts are tightened to the torque recommended by the manufacturer.

(c) Bolt holes in flanged joints shall be orientated symmetrically about the vertical diameter with no bolt holes on the vertical diameter. Elastomeric joint rings shall be the correct size and shall not protrude into the bore of the pipe. The rings may be temporarily fixed to the face of the flange using a minimum amount of adhesive of a type recommended by the manufacturer; jointing compound or paste shall not be used for this purpose.

2.1.24.8.3 Flexible collar joints

(a) Flexible collar joints in pipes for drainage works shall be made as stated in Clause 2.1.24.8.3(2) to (4).

(b) The elastomeric joint rings shall be placed in position inside the grooves of the sleeve. The ends of the pipes shall be well smeared with lubricant over a distance of at least 100 mm from the end of the pipe.

(c) The sleeve shall be placed on the end of the laid pipe and pushed home to the location mark on the pipe; the location mark shall be at a distance of half the length of the sleeve minus 3 mm from the end of the pipe unless otherwise recommended by the manufacturer.

(d) The pipe which is to be jointed to the laid pipe shall be placed in the sleeve and pushed home to the location mark on the pipe.

2.1.24.8.4 Push-in joints

(a) Push-in joints in pipes for drainage works shall be made by smearing the elastomeric joint ring with lubricant and placing the ring in position on the spigot end of the pipe. The spigot shall be placed in the socket of the laid pipe and pushed home.

2.1.24.8.5 Detachable joints

(a) Detachable joints in pipes for drainage works shall be jointed as stated in Clause 2.1.24.8.5 (b) and (c).

(b) Both CI flanges, the elastomeric joint rings and the central collar shall be placed over the ends of the pipes before the pipes are placed to the required line and level; a gap of between 5 mm and 6 mm shall be left between the ends of the pipes.

(c) The flanges, elastomeric joint rings and central collar shall be moved into position at the ends of the pipes; the central collar shall be positioned centrally over the gap between the ends of the pipe before the bolts are tightened.

2.1.24.8.6 Flange adapters

(a) Joints with flange adapters in pipes for drainage works shall be made by placing the flange adaptor on the plain end before the bolts are tightened.

2.1.24.8.7 Solvent welded joints

(a) Solvent welded joints in pipes for drainage works shall be made by applying solvent cement to the pipes to be jointed and pushing the pipes home. Excess solvent shall not be applied and surplus solvent shall be removed after jointing. Solvent welded pipes jointed outside the trench shall not be placed in the trench until the solvent setting period recommended by the manufacturer has elapsed. In addition, any material or thing contaminated by the solvent shall not be left in the pipe or trench.

2.1.24.8.8 Screw joints

(a) Screw joints in pipes for drainage works shall be made using a threaded coupler. The threaded surfaces of the pipes and coupler shall be cleaned and the threads shall be painted with two coats of bituminous paint. The pipe thread shall be wrapped with three turns of spun yarn or other material approved by the Engineer and the joint tightened using purpose made tools. Coal tar compounds or white lead paint shall not be used.

Locking nuts to branch connections shall be tightened. Branch connections shall not protrude inside the pipe.

2.1.24.9 Protection of joints

2.1.24.9.1 Protection of joints

(a) Flanged joints, detachable couplings and flange adapters on buried pipes for drainage works shall be protected as stated in Clause 2.1.24.9.1 (b) to (d).

(b) The joint, including bolts and nuts, shall be cleaned to remove all moisture, dust, oil, grease and deleterious material. Bolts and nuts shall be painted with two coats of bituminous point and the joint shall be coated with primer. Mastic filler shall be applied in such a manner that all depressions, corners and voids between the bolts and nuts are filled and a smooth surface is available on which to apply the anticorrosion tape.

(c) At least two layers anticorrosion tape shall be applied to all parts of the joint and to the adjacent pipe for at least 200 mm beyond each end of the joint. The tape shall be applied in accordance with the manufacturer's recommendations and shall be wrapped spirally around the joint and pipe with at least 55% overlap per spiral.

(d) The tape shall be moulded manually after application to take up the contours of the parts being protected.

2.1.24.10 Repairs to coatings and linings

2.1.24.10.1 Repairs to coatings and linings

(a) Damage to coatings and linings of pipes for drainage works shall not be repaired unless permitted by the Engineer. If permitted, repairs shall be carried out using materials recommended by the manufacturer and approved by the Engineer.

2.1.24.11 Thrust and anchor blocks

2.1.24.11.1 Thrust and anchor Blocks

(b) Thrust or anchor blocks shall be used to resist forces at bends, branches and stopends in pressure pipelines for drainage works except where self anchoring joints are used. Concrete for thrust and anchor blocks shall be Grade 20.

(c) The bearing face, and other faces stated in the Contract, of concrete anchor and thrust blocks shall be cast directly against undisturbed ground; the faces of excavations shall be trimmed to remove loose material before concreting. Excavation required for the block beyond the trench width shall be carried out after the pipe or fitting has been jointed. Excess excavation beyond the face at the block shall be filled with concrete of the same Grade as the block.

(d) Internal pressure shall not be applied to the pipeline until thrust and anchor blocks have developed the specified grade strength.

2.1.24.12 Bed, haunch and surround

2.1.24.12.1 Granular bed

(a) Granular bed to pipelines for drainage works shall be constructed as stated in Clause 2.1.24.12.1 (b) to (d).

(b) Aggregates for granular bed shall be deposited in the trench in layers not exceeding 150 mm thick and for the complete width of the trench. Each layer shall be compacted using a plate vibrator or by other methods agreed by the Engineer.

(c) Holes shall be dug in the granular bed to prevent pipes resting on the sockets and to allow the pipes to be jointed. The pipes shall be laid directly on the granular bed; temporary supports shall not be used.

(d) After the pipes have been jointed, aggregate shall be deposited in layers not exceeding 150 mm thick equally on both sides of the pipe to the specified level for the complete width of the trench. Each layer shall be compacted using a plate vibrator or by other methods agreed by the Engineer.

2.1.24.12.2 Concrete bed, haunch and surround

(a) Concrete bed, haunch and surround to pipelines for drainage works shall be constructed as stated in Clause 2.1.24.12.2 (b) to (g).

(b) Concrete for concrete bed, haunch and surround shall be Grade 20.

(c) Polyethylene sheeting or a blinding layer shall be placed on the trench bottom before concreting.

(d) Pipes shall be supported at the required level by Grade 20 precast concrete wedges, blocks or cradles or by other methods agreed by the Engineer. One support shall be placed adjacent to each end of each pipe and the spacing between supports shall not exceed 3 m. Compressible sheeting shall be placed between the pipes and supports.

(e) Flexible joints shall be formed in concrete bed, haunch and surround at flexible joints in pipelines. Joint filler shall be placed next to the flexible joint in the pipeline and shall extend for the complete thickness of the bed, haunch and surround.

(f) Concrete shall be placed evenly over the complete width of the bed and over the complete length of the pipe being concreted up to a level of 25 mm below the underside of the pipe. Concrete shall then be placed on one side of the pipe only and worked under the pipe until the concrete spreads under the pipe. Concrete shall then be placed equally on both sides of the pipe to the specified level.

(g) Pipes for drainage works which are 1 m or less below the surface of a carriageway shall be protected with Grade 20 concrete surround.

(h) The aggregate for Grade 20 concrete stated in Clause 2.1.24.12.2 (a) to (g) shall be natural stone, crushed rock or crushed concrete.
Such Grade 20 concrete shall have the following minimum cementitious content:

Exposure condition*	Minimum cementitious content (kg/m3)
Moderate	280
Severe	330

[* Exposure condition shall be as stated in the Contract]

2.1.24.12.3 Fill material surround

(a) Fill material surround to pipelines for drainage works shall comply as stated in Clause 2.1.24.12.3 (b) to (e).

(b) Except as stated in Clause 2.1.24.12.3(d), fill material deposited within 0.5m of a structure or utility shall be fine fill material unless otherwise stated in the Contract. In addition, the material may contain up to 5% by weight of fresh, slightly decomposed or moderately decomposed rock fragments of up to 200 mm provided that these do not cause any damage to structures, nor do they interfere with the compaction requirements.

(c) Fill material shall not be deposited adjacent to or above structures or utilities until the construction of the structure or utility is sufficiently advanced to accept the imposed forces without disturbance or damage.

(d) Fill material shall be deposited evenly on all sides of structures and utilities and in such a manner that the structure or utility is not disturbed or damaged.

(e) Unless otherwise stated in the Contract, fill material around water, sewage and drainage pipes which are constructed as part of the permanent work shall be special fill material. They shall be deposited in layers not exceeding 100 mm thick to a level of 300 mm above the top of the pipe. The fill material shall be deposited in such a manner that the layer on one side of the pipe is not more than 100 mm higher than the layer on the other side.

2.1.24.13 Tolerances

2.1.24.13.1 Tolerances: pipelines for drainage works

(a) Except as stated in Clause 2.1.24.13.1 (b), pipelines for drainage works shall comply with the following requirements:

i. The line of gravity pipelines shall be within 20 mm of the specified line.
ii. The invert level of gravity pipelines shall be within 6 mm of the specified invert level and shall be such that there is no backfall at any point.
iii. The line of pressure pipelines shall be within 50 mm of the specified line.
iv. The invert level of pressure pipelines shall be within 20 mm of the specified invert level.

(b) Termination pipes in pipelines for drainage works which are designed to connect to pipes or fittings laid by others shall comply with the following requirements:

i. The position of the centre of the termination face of the pipe in the longitudinal direction shall be within 10 mm of the specified position.
ii. The position of the centre of the termination face of the pipe in the lateral direction shall be within 3 mm of the specified position.
iii. The gradient of the termination pipe shall be within 0.5° of the specified gradient.
iv. The invert level at the termination face of the pipe shall be within 3 mm of the specified invert level.

2.1.24.14 Connections

2.1.24.14.1 Connections to Structures

(a) The joints between pipes for drainage works and structures into which the pipes are built shall be watertight; protective coatings shall be removed over the length to be built in before the pipe is built in. Pipe collars and sockets shall not be built in to structures.

(b) Two flexible joints shall be provided in pipelines adjacent to the outside faces of structures into which pipes will be built. The distances from the outside face of the structure to the first joint and from the first joint to the second joint shall be as stated in Table 2.1.24.7.

(c) The ends of pipes which are built in to structures shall be temporarily sealed with a blank flange, brickwork or timber boarding as instructed by the Engineer. The temporary seals shall be left in position until the Engineer instructs their removal.

Table 2.1.24.7: Flexible joints at structures

Diameter of pipe from structure	**Position of first flexible joint from structure**		**Distance of second flexible joint from first flexible joint**
	Minimum	**Maximum**	
not exceeding 450 mm	150 mm	500 mm or diameter of pipe, whichever is less	450 mm - 800 mm
exceeding 450mm but not exceeding 1050 mm			900 mm – 1200 mm
exceeding 1050 mm			1500 mm – 1800 mm

2.1.24.14.2 Connections to pipes

(a) Pipe saddles shall be connected to concrete or vitrified clay pipes by bedding the saddle on a cement mortar bed and forming a cement mortar fillet to provide at least 50 mm cover to the base of the saddle. Cement mortar shall consist of cement and sand in the proportions 1:3 by mass.

(b) UPVC pipe saddles shall be fixed to UPVC pipes using a purposemade mechanical clip or solvent cement of a type recommended by the manufacturer and approved by the Engineer.

(c) Unless otherwise agreed by the Engineer, branch pipelines shall be connected to main pipelines using Y-junctions of the same type and strength as the stronger of the pipes being jointed; the angle of the Y-junction shall be between 30° and 45°.

(d) Pipes which are to be connected to concrete or clay pipes without a Y-junction or purpose made pipe saddle shall be cut on a splay to form a junction such that the incoming pipe is at an angle of between 30° and 60° to the main pipe upstream of the joint. The hole which is cut in the main pipe to which a connection is to be made shall be of a suitable elliptical shape to suit the cut end of the branch pipe. The length of the branch pipe shall be such that:

i. the cut end of the pipe rests on the outside barrel of the main pipe, and

ii. the cut pipe does not project inside the main pipe.

(e) The joint between the cut pipe and the main pipe shall be sealed externally and, unless otherwise permitted by the Engineer, sealed internally flush with the main pipe with cement mortar. Cement mortar shall consist of cement and sand in the proportions 1:3 by mass.

(f) The positions of the pipe junctions relative to the manhole or structure immediately downstream shall be measured and recorded before backfilling.

(g) The ends of connecting pipes which are not required for immediate use shall be sealed with a blank flange, brickwork or other methods instructed by the Engineer and the position measured and recorded before backfilling.

2.1.24.15 Manholes, chambers, gullies and channels

2.1.24.15.1 Manholes, chambers and gullies

(a) Bases, inverts and benching for precast concrete manholes shall be constructed in-situ using Grade 20 concrete, unless otherwise stated in the Contract.

(b) Precast concrete units for manholes and chambers shall be set vertically with step irons staggered and vertically aligned above each other. Joints between precast units shall be the rebated type and shall be sealed with cement mortar; lifting holes shall be filled with cement mortar.Surplus cement mortar shall be removed and joints shall be pointed.

(c) Concrete surround to manholes, chambers and gullies shall be Grade 20 concrete. Joints in concrete surround shall be staggered by at least 150 mm from joints in the precast units. Concrete surround to gullies shall be placed up to the sides of the excavation.

(d) The frames for manhole covers and gully gratings shall be set to the same levels as the surrounding surface, allowing for falls and cambers, using brickwork and/or concrete as specified in the Contract. The number of courses of brickwork used below frames shall not exceed three and the minimum grade for concrete shall be Grade 20.

(e) Cement mortar for fixing manhole covers and gully gratings in position and bonding brickwork shall consist of cement and sand in the proportions 1:3 by mass.

(f) Excavations around manholes and chambers in carriageways shall be filled using Grade 10 concrete up to the carriageway formation level.

(g) Fill material for excavations around other manholes and chambers shall be fine fill material.

2.1.24.15.2 Concrete open channels

(a) The top surfaces of side walls of concrete open channels shall be constructed to the same levels as the adjoining permanent works. Excess excavation beyond the channel walls shall be filled with Grade 10 concrete.

2.1.24.16 Marker blocks

2.1.24.16.1 Marker blocks

(a) The ends of pipes which do not terminate at a manhole, chamber, gully or structure shall be marked with marker blocks. The blocks shall be 150 mm x 150 mm x 150 mm and shall be constructed using Grade 20 concrete.

(b) A wire shall be connected from a hook on the underside of the block to the plug on the end of pipes.

(c) Marker blocks shall be set flush with level of the adjacent permanent works and shall have the letters `CD' marked on the upper surface.

2.1.24.17 Installation of penstocks and valves

2.1.24.17.1 Installation of penstocks and valves

(a) Penstocks and valves shall be installed in accordance with the manufacturer's recommendations and in the closed position.

(b) Frames for penstocks shall be fixed in position leaving a 20 mm gap between the frame and the concrete surface. Contact between the penstock door and frame shall be checked using a feeler gauge 0.1 mm thick or other size recommended by the manufacturer.

(c) Box-outs and rebates for penstock and valve frames and gaps between frames and concrete surfaces shall be filled with cement mortar.

(d) After installation, penstocks and valves shall be cleaned and moving parts shall be lightly greased and checked for ease of operation. Penstocks and valves shall be left in a closed position.

2.1.24.18 Pipes and manholes to be abandoned

2.1.24.18.1 Pipes and manholes to be abandoned

(a) If the top of a pipe or culvert, or the bottom of a manhole, chamber or gully, which is to be abandoned is 1 m or less below the finished ground level, the pipe, manhole, chamber or gully shall be removed and disposed of unless otherwise permitted by the Engineer. The void shall be filled with foam concrete, granular fill material or special fill material as directed by the Engineer.

(b) If the top of a pipe or culvert, or the bottom of a manhole, chamber or gully, is more than 1 m below the finished ground level, the pipe, culvert, manhole, chamber or gully shall be filled with foam concrete or grout as stated in Clause 2.1.24.2.25.

(c) Manholes, chambers and gullies which are to be abandoned shall be demolished to 1 m below finished ground level unless otherwise stated in the Contract. Abandoned pipes, culverts, manholes, chambers and gullies shall be filled with foam concrete or grout, by pumping or by gravity. The lowest point of abandoned pipelines shall be sealed with concrete, bricks or by other methods approved by the Engineer. Filling shall start from the lowest point and shall continue until all voids are completely filled.

2.1.24.19 Cleaning of pipelines

2.1.24.19.1 Cleaning of pipelines

(a) Pipelines for drainage works shall be cleaned by pigging, by high pressure water jetting or by other methods agreed by the Engineer; manholes and chambers shall be cleaned and washed. Cleaning shall be carried out after:

i. the pipeline has been tested,
ii. Temporary Works required for testing have been removed, and
iii. parts of the pipeline removed for testing have been reconnected.

(b) Unless otherwise permitted by the Engineer, pipelines shall be cleaned not more than 7 days before the pipeline is handed over.

2.1.24.20 Inspection of pipelines

2.1.24.20.1 Inspection of pipelines

(a) Unless otherwise permitted by the Engineer, the cleanliness, bore, linearity and joints of pipelines of 450 mm diameter or less shall be checked by pulling a mandrel through the completed pipeline, or parts of the pipeline if permitted by the Engineer, after cleaning. The mandrel shall be 750 mm long and 12 mm less in diameter than the nominal diameter of the pipe.

2.1.24.20.2 Inspection of pipelines by CCTV

(a) The procedure for internal inspection of pipelines by CCTV shall be as stated in Clause 2.1.24.20.1.

2.1.24.21 Testing: pipes for drainage works

2.1.24.21.1 Batch: pipes for drainage works

(a) A batch of pipes or fittings for drainage works is any quantity of pipes or fittings of the same type and nominal diameter, manufactured by the same manufacturer, covered by the same certificates and delivered to the Site at any one time.

2.1.24.21.2 Samples: pipes for drainage works

(a) Unless otherwise required by the Engineer, one sample of pipe for drainage works and each type of fitting shall be provided from each 50 pipes or fittings or part thereof in a batch.

2.1.24.21.3 Testing: pipes for drainage works

(a) Unless otherwise permitted by the Engineer, each sample of pipes and fittings for drainage works shall be tested in accordance with the relevant British Standard.

(b) The method of testing shall be in accordance with the following:

Concrete pipes and fittings :	**BS 5911: Part 100**
Vitrified clay pipes, fittings and joints :	**BS 65**
Ductile iron pipes and fittings :	**BS EN 545**
Grey iron pipes and fittings :	**BS 4622**
UPVC pipes for industrial purposes :	**BS 3506**
UPVC soil and ventilating pipes, fittings and accessories :	**BS 4514**
UPVC rainwater goods :	**BS EN 12200-1**
UPVC underground drain pipes and fittings :	**BS 4660**
Plastic waste pipes and fittings :	**BS 5255**
UPVC pipes and fittings for gravity sewers :	**BS EN 1401-1**.

2.1.24.21.4 Non-compliance: pipes for drainage works

(a) If the result of any test required in accordance with the relevant British Standard for pipes and fittings for drainage works does not comply with the specified requirements for the test, one additional sample shall be provided from the same batch and additional tests for the property shall be carried out.

(b) The batch shall be considered as not complying with the specified requirements for the property if the result of any additional test does not comply with the specified requirements for the property.

2.1.24.22 Testing: aggregates for granular bed

2.1.24.22.1 Batch: aggregates for granular bed

(a) A batch of aggregates for granular bed is any quantity of aggregates for granular bed of the same type, produced at the same time in the same place, covered by the same certificates and delivered to the Site at any one time.

2.1.24.22.2 Samples: aggregates for granular bed

(a) Unless otherwise permitted by the Engineer, one sample of aggregates for granular bed shall be provided from each batch of aggregates for granular bed delivered to the Site.

(b) The size of each sample shall be 40 kg.

(c) The method of sampling shall be in accordance with **BS 812: Part 102.**

(d) The moisture content of the sample shall be representative of the moisture content of the material in the batch.

2.1.24.22.3 Testing: aggregates for granular bed

(a) Each sample of aggregates for granular bed shall be tested to determine the particle size distribution and the ten percent fines value in accordance with BS 812:Part 103 and BS 812:Part 111, and the compaction fraction value.

2.1.24.22.4 Compliance criteria: compaction fraction value

(a) The results of tests for compaction fraction value of aggregates for granular bed shall comply with the following requirements:

i. The compaction fraction value for bed for pipes not exceeding 300 mm nominal diameter shall not exceed 0.3.
ii. The compaction fraction value for bed for pipes exceeding 300 mm nominal diameter shall not exceed 0.15.

2.1.24.23 Testing: precast concrete units for manholes, chambers and gullies

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2.1.24.23.1 Batch: manholes, chambers and gullies

(a) A batch of precast concrete units for manholes, chambers or gullies is any quantity of precast concrete units for manholes, chambers or gullies of the same type and size, manufactured by the same manufacturer, covered by the same certificates and delivered to the Site at any one time.

2.1.24.23.2 Samples: manholes, chambers and gullies

(a) Unless otherwise permitted by the Engineer, one sample of precast units for manholes, chambers or gullies shall be provided from each 50 precast concrete units for manholes, chambers or gullies or part thereof in a batch.

2.1.24.23.3 Testing: manholes, chambers and gullies

(a) Unless otherwise permitted by the Engineer, each sample of precast concrete units for manholes, chambers or gullies shall be tested in accordance with the relevant British Standard.

(b) The method of testing shall be in accordance with the following:

i. Precast concrete units for manholes : **BS 5911: Part 200**
ii. Inspection chambers and gullies : **BS 5911: Part 2**.

2.1.24.23.4 Non-compliance: manholes, chambers and gullies

(a) If the result of any test required in accordance with the relevant British Standard for precast concrete units for manholes, chambers or gullies does not comply with the specified requirements for the test, one additional sample shall be provided from the same batch and additional tests for the property shall be carried out.

(b) The batch shall be considered as not complying with the specified requirements for the property if the result of any additional test does not comply with the specified requirements for the property.

2.1.24.24 Testing: manhole covers, gully gratings and kerb overflow weirs

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2.1.24.24.1 Batch: covers, gratings and weirs

(a) A batch of manhole covers, gully gratings or kerb overflow weirs is any quantity of covers, gratings or weirs of the same type, manufactured by the same manufacturer, covered by the same certificates and delivered to the Site at any one time.

2.1.24.24.2 Samples: covers, gratings and weirs

(a) One sample of manhole covers, gully gratings or kerb overflow weirs shall be provided from each 20 covers, gratings or weirs or part thereof in a batch.

2.1.24.24.3 Testing: covers, gratings and weirs

(a) Each sample of manhole covers, gully gratings or kerb overflow weirs shall be weighed and subjected to a load test.

(b) The method of testing shall be as stated in Clause 2.1.24.29. The test loads shall be as stated in Table 2.1.24 .4 and Table 2.1.24.5.

2.1.24.24.4 Compliance criterion: resistance to fracture of covers and gratings

(a) Manhole covers and gully gratings shall withstand the test load without fracture or cracking.

2.1.24.24.5 Non-compliance: mass of covers, gratings and weirs

(a) If any manhole cover, gully grating or kerb overflow weir does not comply with the specified requirements for mass, every cover, grating and frame in the batch shall be weighed to determine its mass.

(b) If any cover, grating or weir does not comply with the specified requirements for mass, it shall not be used in the permanent work.

2.1.24.24.6 Non-compliance: resistance to fracture of covers and gratings

(a) If any manhole cover or gully grating does not comply with the specified requirements for resistance to fracture, two additional samples shall be provided from the same batch and tested to determine their resistance to fracture.

(b) The batch shall be considered as not complying with the specified requirements for resistance to fracture if the result of any additional test does not comply with the specified requirements for resistance to fracture.

PROPOSED COMPLETION OF THE MAIN ENTRANCE WORKS FOR THE NAIROBI HOSPITAL

2.1.24.25 Testing: watertightness of penstocks

2.1.24.25.1 Testing: watertightness of penstocks

(a) Penstocks which are to be tested shall be tested for watertightness after installation by applying pressure using a head of water applied to one face of the penstock and no head of water on the other face. The test pressure and the face on which the pressure is to be applied shall be as stated in the Contract.

(b) The method of testing shall be as agreed by the Engineer.

(c) The test pressure shall be maintained for 24 hours.

2.1.24.25.2 Compliance criteria: watertightness of penstocks

(a) The results of tests for watertightness of penstocks shall comply with the following requirements:

i. There shall be no leaks through the penstock during the test.
ii. There shall be no leaks or damp patches visible at the joint between the penstock and the structure during the test.

2.1.24.25.3 Non-compliance: watertightness of penstocks

(a) If the result of any test for watertightness of penstocks does not comply with the specified requirements, the Contractor shall investigate the reason.

(b) Remedial or replacement work approved by the Engineer shall be carried out and the penstock shall be re-tested.

2.1.24.26 Testing: gravity pipelines for drainage works

2.1.24.26.1 Testing: gravity pipelines for drainage works

(a) Gravity pipelines for drainage works shall be tested as stated in Clause 2.1.24.26.1 (b) to (e).

(b) Gravity pipelines for sewage shall be tested by the methods stated in Table 2.1.24.8 at the following times:

i. after the pipes have been jointed and the bedding has been placed and immediately before haunch or surround is placed or fill material is deposited, and

ii. after haunch and surround has been placed and fill material has been deposited and compacted, and

iii. not more than 7 days before the pipeline is handed over.

(c) Gravity pipelines for surface water shall be tested by the methods stated in Table 2.1.24.8 at the following times:

i. after the pipes have been jointed and the bedding has been placed and immediately before haunch or surround is placed or fill material is deposited, or

ii. after haunch and surround has been placed and fill material has been deposited and compacted.

(d) Water tests and air tests on pipelines shall be carried out on the complete pipeline between manholes, chambers and structures; pipelines shall not be tested in parts unless permitted by the Engineer or unless the specified test pressure would otherwise be exceeded. Short branch pipelines shall be tested with the main pipeline and long branch pipelines shall be tested separately.

(e) Infiltration tests shall be carried out on the complete pipeline between manholes, chambers and structures, including manholes, chambers and branches within the pipeline system.

(f) The method of testing shall be in accordance with Clause 2.1.24.30.

Table 2.1.24.8: Testing gravity pipelines

Type of pipeline	Diameter of pipeline	Time of test	Method of testing
Sewage	not exceeding 900mm	as Clause 2.1.24.26.1 (b)(i)	Water test or air test
		as Clause 2.1.24.26.1 (b)(ii)	Water test or air test
		as Clause 2.1.24.26.1 (b)(iii)	Infiltration test
Sewage	exceeding 900mm	as Clause 2.1.24.26.1 (b)(i)	Visual inspection
		as Clause 2.1.24.26.1 (b)(ii)	Water test or air test
		as Clause 2.1.24.26.1 (b)(iii)	Infiltration test
Surface	exceeding 900mm	as Clause 2.1.24.26.1 (b)(i)	Water test or air test
		as Clause 2.1.24.26.1 (b)(ii)	
Surface	not exceeding 900mm	as Clause 2.1.24.26.1 (b)(i)	Visual inspection
		as Clause 2.1.24.26.1 (b)(ii)	Water test or air test

2.1.24.26.2 Compliance criteria: gravity pipelines for drainage works

(a) The results of tests on gravity pipelines for drainage works shall comply with the following requirements:

i. The leakage of water from the pipeline determined by the water test shall not exceed the permitted leakage calculated in accordance with Clause 5.4.8 of Appendix 5.4.

ii. There shall be no discernable leakage from the pipe or from any joint during the water test.

iii. The air pressure shall remain above 75 mm head of water at the end of the air test.

iv. There shall be no infiltration or damage to pipes or joints as determined by the visual inspection.

2.1.24.26.3 Non-compliance: gravity pipelines for drainage works

(a) If the result of any test on gravity pipelines does not comply with the specified requirements for the test, the Contractor shall investigate the reason. Remedial or replacement work approved by the Engineer shall be carried out and the pipeline shall be re-tested.

2.1.24.27 Testing: pressure pipelines for drainage works

2.1.24.27.1 Testing pressure pipelines for drainage works

(a) Pressure pipelines for drainage works shall be tested as stated in Clause 2.1.24.27.1 (b) to (g).

(b) The pipeline shall be tested at the following times:

i. after the pipes have been jointed and the bedding has been placed and immediately before haunch or surround is placed or fill material is deposited, and

ii. after haunch and surround has been placed and fill material has been deposited and compacted.

(c) The test stated in Clause 2.1.24.27.1(b)(i) shall not be carried out on parts of a pipeline unless permitted by the Engineer or unless the specified test pressure would otherwise be exceeded. The test stated in Clause 2.1.24.27.1(b)(ii) shall be carried out on the complete pipeline.

(d) The test pressure shall be as stated in the Contract. If the test pressure is not stated in the Contract, the test pressure shall be 1.5 times the maximum working pressure in the part of the pipeline tested.

(e) Tests shall not be carried out simultaneously on more than one pipeline in the same trench.

(f) The method of testing shall be in accordance with Clause 2.1.24.27.

(g) Testing of pressure pipelines by means of tests on individual joints shall not be carried out instead of tests stated in Clause 2.1.24.27.1(b) to (g).

(h) unless permitted by the Engineer; if permitted, the method of testing and the compliance criteria shall be as approved by the Engineer.

2.1.24.27.2 Compliance criteria: pressure pipelines for drainage works

(a) The results of tests on pressure pipelines for drainage works shall comply with the following requirements:

i. The leakage of water from the pipeline determined by the pressure test shall not exceed the permitted leakage calculated in accordance with Clause 2.1.24.31.4 of Clause 2.1.24.312.1.24.31.

ii. There shall be no discernable leakage of water from the pipeline or from any joint during the pressure test.

2.1.24.27.3 Non-compliance: pressure pipelines for drainage works

(a) If the result of any test on pressure pipelines for drainage works does not comply with the specified requirements for the test, the Contractor shall investigate the reason. Remedial or replacement work approved by the Engineer shall be carried out and the pipeline shall be re-tested.

2.1.24.28 CCTV inspection of pipelines

2.1.24.28.1 Scope

(a) This method covers the internal inspection of pipelines by means of closed circuit television.

2.1.24.28.2 Equipment

(a) The following equipment is required:

i. A CCTV colour camera with integral lighting unit. The camera shall be a type designed and constructed for the specified purpose and shall be capable of operating in 100% relative humidity. The camera shall be fitted with a rotating mirror for complete circumferential viewing. The system shall be capable of producing a clear and high quality picture of the entire periphery of the pipe on the monitor screen and recording tape. The camera and lighting unit shall be mounted on a self-propelled crawler or on skids linked to a manual or power operated winch.

ii. A monitor screen which displays the camera view during the inspection. The monitor screen shall be housed in covered accommodation with facilities for inspection by the Engineer and others.

iii. A screen writer which displays on the monitor screen details of the inspection including date, location, pipe material, diameter of pipe, direction of view and comments on the condition of the pipe.

iv. A measuring device which displays the camera location automatically on the monitor screen. The device shall be capable of measuring the location to within an accuracy of 0.1% of the length of the pipeline or ±0.3 m whichever is the greater.

v. A control unit which controls camera movement, lighting intensity, focusing and recording.

vi. A DVD video recording system to record the inspection and information displayed on the monitor screen.

vii. A 35 mm single lens reflex (SLR) camera capable of producing photographs with the date.

2.1.24.28.3 Procedure

(a) The procedure shall be as follows:

i. The camera shall be moved through the pipeline in the direction instructed by the Engineer at a speed not exceeding 0.15 m/s. If the camera cannot pass through the complete pipeline in one operation, the inspection may be carried out from both ends of the pipeline.

ii. The camera shall be stopped whenever instructed by the Engineer to allow inspection by the Engineer.

iii. The video system shall be operated during the complete inspection to provide a continuous record of the inspection and information on the monitor screen.

iv. Photographs of the monitor screen shall be taken whenever instructed by the Engineer.

2.1.24.28.4 Recording of results

(a) Records of the inspections shall be kept by the Contractor on the Site and a report shall be submitted to the Engineer within 14 days of completion of the inspection. The report shall contain the following details:

i. key map showing pipelines inspected and associated manholes, chambers and structures,

ii. tables listing details of inspection, including date, location, pipe material, diameter of pipe, chainage, manholes, junctions and other features and the condition of pipes and joints; the condition of pipes and joints shall be illustrated by a coding systems in accordance with the `Manual of Sewer Condition Classification' (2004) published by the U.K. National Water Council, and

iii. a summary showing the number and type of defects in each pipeline inspected.

(b) The following items shall be submitted at the same time as the report:

i. video film providing a continuous record of the inspection and information on the monitor screen, and photographs of the monitor screen including date and chainage;

ii. the photographs shall be 3R size and shall be mounted in photograph albums.

2.1.24.29 Determination of the resistance to fracture of manhole covers and gully gratings

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2.1.24.29.1 Scope

(a) This method covers the determination of the resistance to fracture of manhole covers and gully gratings by means of a load test.

2.1.24.29.2 Equipment

(a) The following equipment is required:

i. The manufacturer's recommended frame for the manhole cover or gully grating or a fabricated test frame of a type agreed by the Engineer which will simulate the normal conditions of use of the cover or grating.

ii. A circular hardwood bearing block faced with hard rubber or other resilient material. The diameter of the block shall be as stated in Table 2.1.24.4 or Table 2.1.24.5 for the relevant cover or grating. The block shall be sufficiently rigid to ensure that the load is equally distributed over the whole area of the block.

iii. Test loads. Equipment for measuring the loads applied, readable and accurate to 0.05 t or 2% of the specified test load, whichever is greater.

2.1.24.29.3 Procedure

(a) The procedure shall be as follows:

i. The full bearing area of the frame shall be rigidly supported.
ii. The cover or grating shall be placed in the frame. The bearing block shall be placed centrally on the cover or grating.
iii. The specified test load as stated in Table 5.6 and 5.7 shall be applied without shock.
iv. The specified test load shall be maintained for at least 30 seconds and removed.

2.1.24.29.4 Reporting of results

(a) The following shall be reported:

Identification of sample.
The load applied, to the nearest 0.05 t or 2% of the specified test load, whichever is greater.
Details of any fracture or cracks.
That the test method used was in accordance with this Specification.

2.1.24.30 Tests on gravity pipelines for drainage works

2.1.24.30.1 Scope

(b) This method covers water tests, air tests, visual inspections and infiltration tests on gravity pipelines for drainage works.

(c) The following equipment is required:

i. Expanding disc stoppers, air bags or other methods of sealing pipes agreed by the Engineer.
ii. Struts and wedges.
iii. Force pump for water test.
iv. Standpipe for water test.
v. Measuring vessel for water test, readable and accurate to 0.01 litre.
vi. U-tube for air test.
vii. Trolleys to obtain access inside pipelines for visual inspections.
Mechanical fans shall be provided to ensure that an adequate air supply is available; engine driven fans shall be fitted with a flexible exhaust or other methods of keeping exhaust fumes clear of the fresh air intake.

2.1.24.30.2 Procedure: before tests and inspections

(a) The procedure before tests and inspections shall be as follows:

i. Debris and water shall be removed from the pipeline.
ii. Openings to the pipeline shall be sealed using expanding disc stoppers, air bags or other methods agreed by the Engineer and the seals secured against movement.

2.1.24.30.3 Procedure: water test

(a) The procedure for the water test shall be as follows:

i. The pipeline shall be filled with water and shall be kept filled for two hours before testing starts to allow absorption to take place.

ii. A test pressure of 1.2 m head of water above the soffit of the pipe at the high end shall be applied at the standpipe and maintained for 30 minutes; the test pressure applied shall not exceed 6 m head of water at the invert of the low end of the pipe.

iii. The head of water at the standpipe shall be topped up at 5 minute intervals during the test, and shall be filled to the specified head at the end of the test period; the amounts of water added to the standpipe shall be measured using the measuring vessel.

iv. The leakage of water from the pipeline shall be measured as the amount of water added to maintain the specified head of water.

2.1.24.30.4 Procedure: air test

(a) The procedure for the air test shall be as follows:

i. Air shall be pumped into the pipeline until a test pressure of slightly more than 100 mm of water is registered on a U-tube manometer connected to the pipeline. Five minutes shall be allowed for stabilisation of the air temperature, and the air pressure shall then be adjusted to 100 mm of water.

ii. The pressure shall be read from the U-tube at the end of a five-minute period without further pumping.

2.1.24.30.5 Procedure: visual inspection

(a) The inside of the pipeline shall be inspected visually, and infiltration or damage to pipes or joints shall be recorded.

2.1.24.30.6 Procedure: infiltration test

(a) The procedure for the infiltration test shall be in accordance with **BS 8005: Part 1** Clause 13.6.

2.1.24.30.7 Calculation

(a) The permitted leakage of water from the pipeline during the water test shall be calculated from the equation:

Permitted leakage = $d \times l \times t/_{60}$ litre
where:
- d is the internal diameter of the pipe (m),
- l is the length of pipeline tested (m),
- t is the test period (min).

2.1.24.30.8 Reporting of results

(a) The following shall be reported:

i. The nominal internal diameter of the pipe.
ii. The location and length of pipeline tested to the nearest 0.3 m.
iii. The test pressure applied during the water test to the nearest 0.01 m, and during the air test to the nearest 1 mm head of water.
iv. The test period to the nearest 1 min.

v. The leakage and permitted leakage for the water test to the nearest 0.1 litre.
vi. The amount of infiltration for the infiltration test to the nearest 0.1 litre.
vii. Details of any discernable leakage of water from the pipe or from any joint during the water test.
viii. That the test method used was in accordance with this Specification.

2.1.24.31 Tests on pressure pipelines for drainage works

2.1.24.31.1 Scope

(a) This method covers the determination of the leakage of water from pressure pipelines for drainage works by means of a pressure test.

2.1.24.31.2 Equipment

(a) The following equipment is required:

i. Blank flanges or caps.
ii. Struts and wedges.
iii. Temporary concrete blocks or other anchors.
iv. Force pump.
v. Pressure gauge, readable and accurate to 0.01 m head of water. The gauge shall be either a conventional circular type of at least 300 mm diameter or shall be a digital indicator type.
vi. Measuring vessel, readable and accurate to 0.01 litre.

2.1.24.31.3 Procedure

(a) The procedure shall be as follows:

i. Pipes and valves shall be cleaned and the operation of valves shall be checked. Air valves shall be isolated.

ii. Blank flanges or caps shall be fixed to the ends of the pipeline, or part of the pipeline, to be tested. Tests shall not be made against closed valves unless permitted by the Engineer.

iii. The blank flanges and caps and closed valves against which tests are made shall be secured with struts and wedges against temporary concrete blocks or other anchors. The blocks shall be completed

iv. and shall have hardened sufficiently before testing starts. Thrust and anchor blocks, pipe straps and other devices required to prevent movement of pipes and fittings shall be completed before testing starts.

v. The pipeline shall be filled with water and all air shall be removed; measures shall be taken during filling to provide free outlets for air and to prevent water hammer.

vi. The pressure in the pipeline shall be increased to working pressure and the pipeline shall remain filled at this pressure for 2 hours to allow absorption to take place and to achieve conditions which are as stable as practicable.

vii. The pressure in the pipeline shall be increased slowly by pumping water into the pipeline using a force pump until the specified test pressure is reached at the lowest part of the pipeline being tested.

viii. The pressure in the pipeline shall be maintained at the specified test pressure, using the force pump if necessary, for a period of at least 1 hour.

ix. At the end of the 1 hour period the pressure shall be increased, if necessary, to the specified test pressure and pumps and water supply points shall be disconnected.

x. The pipeline shall be left in this condition for a test period of 1 hour; no water shall be allowed to enter the pipeline during the test period.

xi. At the end of the test period the pressure in the pipeline shall be recorded.

xii. The pumps and water supply points shall be reconnected and the pressure shall be increased to the specified test pressure.

xiii. Water shall be drawn off from the pipeline until the pressure in the pipeline is the same as at the end of the test period. The leakage of water from the pipeline shall be measured as the amount of water drawn off.

2.1.24.31.4 Calculation

(a) The average test pressure (P) shall be calculated as the average of the specified test pressure and the pressure at the end of the test period.

(b) The permitted leakage of water from the pipeline during the pressure test shall be calculated from the equation:

Permitted leakage = $d \times l \times t/_{12} \times P$ litre
where:
- d is the nominal internal diameter of the pipe (m),
- l is the length of pipeline tested (km),
- t is the test period (hr),
- P is the average test pressure (m).

2.1.24.31.5 Reporting of results

The following shall be reported:

i. The nominal internal diameter of the pipe.
ii. The location and length of pipeline tested to the nearest 0.3 m.
iii. The test period to the nearest one minute.
iv. The specified test pressure to the nearest 0.01 m head of water.
v. The pressure at the end of the test period to the nearest 0.01 m head of water.
vi. The average test pressure to the nearest 0.01 m head of water.
vii. The leakage and permitted leakage to the nearest 0.1 litre.
viii. Details of any discernable leakage of water from the pipeline during the test.
ix. That the test method used was in accordance with this Specification.

2.1.24.32 References and Standards

BS 5911-1(2002+A2:2010): Concrete pipes and ancillary concrete products. Specification for unreinforced and reinforced concrete pipes (including jacking pipes) and fittings with flexible joints. (Complementary to BS END 1916:2002)

BS END 1916 (2002): Concrete pipes and fittings, unreinforced, steel fibre and reinforced.

BS 5911-3 (2010): Concrete pipes and ancillary concrete products. Specification for unreinforced and reinforced concrete manholes and soakaways. (Complementary to BS END 1917:2002)

BS END 1917(2002): Concrete manholes and inspection chambers, unreinforced, steel fibre and reinforced

BS 65 (1991): Specification for vitrified clay pipes, fittings and ducts, also flexible mechanical joints for use solely with surface water pipes and fittings.

BS END 545 (2010): Ductile iron pipes, fittings, accessories and their joint for water pipelines. Requirements and test methods.

BS END 1092-1(2007+A1:2013): Flanges and their joints. Circular flanges for pipes, valves, fittings and accessories, PN designated. Steel flanges

BS 4662 (2006+A1:2009): Boxes for flush mounting of electrical accessories. Requirements, test methods and dimensions

BS 3506 (1969): Specification for unplasticized PVC pipe for industrial uses.

BS 4320 (1968): Specification for metal washers for general engineering purposes. Metric series

BS END ISO 3506 (1998): Mechanical properties of corrosion resistant stainless steel fasteners.

BS END 10029 (2010): Hot-rolled steel plates 3 mm thick or above. Tolerances on dimensions and shape

BS END 1563 (2011): Founding. Spheroidal graphite cast iron.

BS END 10300 (2005): Steel tubes and fittings for onshore and offshore pipelines. Bitumen hot applied materials for external coating.

BS 3416 (1991:2000): Specification for bitumen-based coatings for cold application suitable for use in contact with potable water.

BS 4346-1 (1969:1998): Injection moulded unplasticized PVC fittings for solvent welding for use with pressure pipes including potable water supply.

BS 21(1985): Specification for pipe threads for tubes and fittings where pressure-tight joints are made on the threads (metric dimensions).

BS END 10241 (2000): Steel threaded pipe fittings.

BS END ISO 1461 (2009): Hot dipped galvanised coatings on fabricated iron and steel articles. Specifications and test methods.

BS 4514 (2001): Unplasticized PVC soil and ventilating pipes of 82.4 mm minimum mean outside diameter, and fittings and accessories of 82.4 mm and of other sizes. Specification.

BS 1377(1990): Methods of test for soils for civil engineering purposes.

BS END 13101(2002): Steps for underground man entry chambers. Requirements, marking, testing and evaluation of conformity.

BS END 1562 (2012): Founding. Malleable cast irons.

BS END 1982 (2008): Copper and copper alloys. Ingots and castings.

BS END 12167 (2011): Copper and copper alloys. Profiles and bars for general purposes

BS END 12200-1(2000): Plastics rainwater piping systems for above ground external use. Unplasticized poly (vinyl chloride) (PVC-U). Specifications for pipes, fittings and the system

BS 4660 (2000): Thermoplastics ancillary fittings of nominal sizes 110 and 160 for below ground gravity drainage and sewerage.

BS END 1401-1(2009): Plastic piping systems for non-pressure underground drainage and sewerage. Unplasticized poly(vinyl chloride) (PVC-U). Specifications for pipes, fittings and the system

BS 4190 (2001) ISO metric black hexagon bolts, screws and nuts. Specification

BS END 13602 (2013): Copper and copper alloys. Drawn, round copper wire for the manufacture of electrical conductors

BS END 1561(2011): Founding. Grey cast irons.

BS END 13602 (2002): Copper and copper alloys. Drawn, round copper wire for the manufacture of electrical conductors

BS END 10095(1999): Heat resisting steels and nickel alloys

BS END 10250-4 (2000): Open steel die forgings for general engineering purposes. Stainless steels

BS END 1171(2002): Industrial valves. Cast iron gate valves.

BS END 10255 (2004):Non-alloy steel tubes suitable for welding and threading. Technical delivery conditions

BS 5255 (1989): Specification for thermoplastics waste pipe and fittings

BS END 681-1 (1996): Elastomeric seals. Material requirements for pipe joint seals used in water and drainage applications. Vulcanized rubber

BS 743 (1970): Specification for materials for damp-proof courses

BS 5911-4 (2002+A2:2010): Concrete pipes and ancillary concrete products. Specification for unreinforced and reinforced concrete inspection chambers (complementary to BS END 1917:2002)

BS END ISO 1452-3 (2010): Plastics piping systems for water supply and for buried and above-ground drainage and sewerage under pressure. Unplasticized poly(vinyl chloride) (PVC-U). Fittings

BS 812-124 (2009): Testing aggregates. Method for determination of frost heave

2.1.25 FENCING

2.1.25.1 Materials

2.1.25.1.1 Wire

(a) Wire for fencing, including plastic coated wire, shall be galvanized mild steel complying with **BS 4102**.

(b) Barbed wire shall consist of two line wires and point wire formed in accordance with **BS 4102**, Clause 4.1.

(c) Galvanized coatings to steel wire shall comply with **BS EN 10244**.

(d) Plastic coatings to steel wire shall be green and shall comply with **BS 4102**, Section 6.

2.1.25.1.2 Chain link fence

(a) Chain link fence shall comply with **BS 1722: Part 1** unless otherwise stated in this Section.

2.1.25.1.3 Plywood

(a) Plywood for hoardings shall comply with **BS EN 636** and shall have a Grade 2 veneer. The bonding adhesive between veneers shall be phenol formaldehyde resin adhesive classified as weather-proof and boil-proof in accordance with **BS 1203**.

2.1.25.1.4 Timber

(a) Timber for fencing shall be of mature growth and shall be seasoned and free from large, loose or dead knots, wood wasp holes, infestation, splits and other defects which will reduce the strength or produce blemishes. The moisture content in timber at the time of fabrication shall not exceed 20%.

(b) Hardwood shall be camphor and shall have a density of at least 720 kg/m^3 at 15% moisture content.

(c) Softwood shall be cedar or cypress.

(d) Timber which is not to be painted shall be preserved with coal tar creosote. The creosote shall comply with BS 144 and shall be applied by pressure impregnation in accordance with **BS 144**.

2.1.25.1.5 Steel

(a) Steel for fencing shall comply with the following:

Hot rolled sections :	**BS 4: Part 1**
Hot rolled structural steel sections	
- equal and unequal angles :	**BS EN 10056-1**
- hollow sections :	**BS EN 10210-2**
Weldable structural steels :	**BS 7668**.

2.1.25.1.6 Bolts, nuts, washers and fittings

(a) Bolts, nuts and washers for fencing shall comply with the following:

ISO metric black hexagon bolts, screws and nuts :	**BS 4190**
ISO metric black cup and countersunk head, bolts andscrews with hexagon nuts :	**BS 4933**
Metal washers for general engineering purposes :	**BS 4320**

(b) The length of bolts shall be such that the threaded portion of each bolt projects through the nut by at least one thread and by not more than four threads.

(c) Fittings, including eye bolt strainers, cleats, winding brackets, stretcher bars, extension arms, hook bolts and base plates, shall be galvanized mild steel.

(d) Bolts, nuts, washers and fittings for fixing to concrete and timber shall be galvanized. Bolts, nuts, washers and fittings for fixing to steel shall have the same protective treatment as the steel.

(e) Staples shall be D-section galvanized wire.

2.1.25.2 Fabrication of fencing

2.1.25.2.1 Fabrication of steelwork

(a) Steelwork for fencing shall be fabricated in accordance with **BS END 1090-2:2008+A1:2011**

2.1.25.2.2 Galvanizing to steel

(a) Steel which is to be galvanized shall be hot-dip galvanized in accordance with **BS EN ISO 1461** to a coating thickness of at least 500 g/m^2.

(b) Galvanizing to steel shall be applied as far as possible after welding, drilling and cutting are complete.

2.1.25.2.3 Welding steel

(a) Welds to steel for fencing shall be full depth fillet welds. Weld surfaces shall be clean and flush before application of the protective coating.

(b) Steel shall not be welded after galvanizing unless permitted by the Engineer; if permitted, the welded areas shall be free from scale and slag and shall be treated with an alternative galvanizing or zinc coating system approved by the Engineer.

2.1.25.3 Posts and gates for fencing

2.1.25.3.1 Concrete posts

(a) Concrete posts and struts for fencing shall be precast using Grade 30/10 concrete. The finish to formed surfaces shall be Class F4 and the finish to unformed surfaces shall be Class U5. The tops of posts and all arrises shall be rounded or chamfered.

(b) Reinforcement for concrete posts and struts shall be Grade 250 plain round steel bars.

2.1.25.3.2 Gates

(a) Steel gates shall be of welded construction. The frame shall be square with the corners mitred or saddled.

(b) Chain link infilling in gates shall be of the same type and size as in the adjoining fence and shall be attached to the framework by stretcher bars.

2.1.25.4 Submissions

2.1.25.4.1 Particulars of fencing

(a) The following particulars of the proposed fencing shall be submitted to the Engineer:

i. drawings showing the fabrication details of gates, and

ii. details of the source, type and properties of timber.

(b) The particulars of the proposed fencing shall be submitted to the Engineer at least 14 days before the fencing is erected.

2.1.25.4.2 Samples of materials

(a) The following samples of the proposed materials shall be submitted to the Engineer at the same time as particulars of the proposed fencing are submitted:

i. each type of wire and fitting,

ii. chain link,

iii. plywood, and

iv. precast concrete, steel and timber posts.

2.1.25.5 Storage of materials

2.1.25.5.1 Storage of fencing

(a) Plywood and timber posts, rails and struts for fencing shall be stored on level supports in a dry weatherproof store.

(b) Gates and concrete and steel posts and struts for fencing shall be stored off the ground on level supports and in a manner which will not result in damage or deformation to the materials or in contamination of the materials.

(c) Fencing shall be protected from damage and damaged fencing shall not be used in the permanent work unless permitted by the Engineer.

2.1.25.6 Erecting fencing

2.1.25.6.1 Alignment of fencing

(a) Fencing shall be erected to a smooth alignment with no abrupt irregularities. The ground shall be trimmed or filled in such a manner that the bottom of the fence will approximately follow the level of the ground. The distance between the bottom of chain link mesh and hoardings and the ground shall not exceed 100 mm.

2.1.25.6.2 Posts for fencing

(a) Straining posts for fencing shall be provided at all ends and corners, at changes in direction, at abrupt changes in level, at gate posts and at intervals not exceeding 30 m along straight lengths of fencing. Struts shall be fitted to straining posts in the direction of each wire secured to the post.

(b) Intermediate posts shall be provided at intervals not exceeding 3.5 m.

2.1.25.6.3 Erecting posts for fencing

(a) Posts and struts for fencing shall be set in excavations for foundations and the excavations shall be filled with Grade 30/20 concrete up to 50 mm below ground level.

(b) Struts shall be fitted into slots in timber posts and concrete posts; struts shall be bolted to steel posts.

(c) The ground surface around posts shall be made good with the same material as in the adjoining area.

2.1.25.6.4 Fixing wire for fencing

(a) Line wire, chain link mesh and barbed wire for fencing shall be strained tightly between straining posts. Winding brackets shall be used for straining between steel posts and winding brackets or eye bolt strainers shall be used for straining between concrete and timber posts. The tension in the wire on each side of straining posts shall be equal. Wire shall not be strained until at least 14 days after concrete has been placed in the foundation.

(b) Chain link mesh shall be secured at each straining post by a stretcher bar and shall be tied to the line wire by tying wire at 150 mm intervals.

(c) Each line wire and each line of barbed wire shall be secured to each intermediate post by one of the following methods as stated in Table 20.1.

i. A hairpin staple shall be passed through a hole in the post and secured to the wire by three complete turns on each side of the post.

ii. A stirrup shall be passed through a hole in the post and the ends bent over twice.

iii. The wire shall be threaded through a hole in the post.

iv. The wire shall be stapled to the post.

v. A hook bolt shall be passed through a hole in the post and secured with a nut and washer.

Table 20.1: Method of securing wire to intermediate posts

Type of fence	Type of wire	Type of post	Method of securing wire
Strained wire	Line wire	Concrete	(i), (ii) or (iii)
		Steel	(i), (ii) or (iii)
		Timber	(i), (ii) or (iv)
	Barbed wire	Concrete	(i), (ii)
		Steel	(i)
		Timber	(ii), (iii) or (iv)
Chain link	Line wire Mesh wire	Concrete	(i), (ii) or (v)
		Steel	(i) or (iii)
		Timber	(iv)
	Barbed wire	Concrete	(i), (ii) or (v)
		Steel	(i)
		Timber	(iv)

2.1.25.6.5 Fixing gates

(a) Gates shall be hung plumb and shall not be installed until the wire has been strained.

2.1.25.6.6 Fixing timber for fencing

(a) The ends of timber rails for fencing shall be closely butted together and the rails shall be securely nailed to each post. The ends of plywood sheets in hoardings shall be closely butted together and the sheets shall be securely nailed to each post and to the horizontal rails.

2.1.25.7 Tolerances

2.1.25.7.1 Tolerances: fencing

(a) Fencing shall comply with the following requirements:

i. The position of posts shall be within 75 mm of the specified position.

ii. The level of the top of posts shall be within 25 mm of the specified level.

iii. Posts shall be vertical to within 5 mm in the height of the post.

2.1.25.8 References and Standards

BS END 10223-1 (2012): Steel wire and wire products for fencing and netting. Zinc and zinc alloy coated steel barbed wire

BS 1722-1 (2006): Fences. Specification for chain link fences.

BS END 636 (2012): Plywood specifications.

BS 1203 (2001): Hot-setting phenolic and aminoplastic wood adhesives. Classification and test method

BS 144 (1997): Specification for coal tar creosote for wood preservation.

BS 4-1 (2005): Structural Steel sections. Specification for hot rolled sections
.
BS END 10210-2 (2006): Hot finished structural hollow sections of non-alloy and fine grain steels. Tolerances, dimensions and sectional properties.

BS 7668 (2004): Weldable structural steels. Hot finished structural hollow sections in weather resistant steels. Specification

BS END 13602 (2013): Copper and copper alloys. Drawn, round copper wire for the manufacture of electrical conductors

BS 4933 (2010): Specification for ISO metric black cup and countersunk head bolts and screws with hexagon nuts.

BS 4320 (1968): Specification for metal washers for general engineering purposes.Metric series

BS END 1090-2 (2008+A1:2011): Execution of steel structures and aluminium structures. Technical requirements for steel structures

BS END ISO 1461 (2009): Hot dipped galvanised coatings on fabricated iron and steel articles. Specifications and test methods.

BS 4102 (1998):Specification for steel wire for general fencing purposes

BS END 10244-1 (2009):Steel wire and wire products. Non-ferrous metallic coatings on steel wire. General principles

BS END 10056-1 (1999): Specification for structural steel equal and unequal angles. Dimensions

BS 4190 (2001): ISO metric black hexagon bolts, screws and nuts. Specification

2.1.26 PAVEMENTS

This Section covers the construction of sub base, base course, shoulders and wearing course from natural gravel or partially crushed gravel and bituminous materials.

2.1.26.1 Pavement; Graded Crushed Stones Base

2.1.26.1.1 Scope

This Section covers the procuring, furnishing and placing of approved crushed aggregate base course layers in accordance with the requirements of these Specifications.
This Section covers the requirements for the following types of material:

- **GCS1** crushed, fresh, quarried rock compacted to a percentage of the maximum dry density of the material at BS-Vibrating hammer compaction, with enhanced requirements for workmanship during construction
- **GCS2** crushed stone or quarried rock compacted to a percentage of the maximum dry density of the material at BS-Vibrating hammer compaction, with normal requirements for workmanship during construction

2.1.26.1.2 Materials

(a) Source of material, crushing and screening

(i) General

The aggregate used for crushed aggregate course shall contain no contamination or deleterious material such as decomposed rock, clay or shale. The Contractor shall take all necessary measures to prevent segregation of the material, including watering during crushing and screening and any other measures required in the opinion of the Engineer.

(ii) GCS1 class of crushed aggregate

Crushed aggregate class GCS1 shall be made of clean, hard, durable and fresh rock fragments from the crushing of quarried rock or boulders of minimum 0.3 m diameter. Single stage crushing shall not be allowed and all particles shall be crushed; no soil fines are allowed. If the multi-stage crushing does not directly and continuously provide materials complying with the grading requirements specified in Table 26.1 the crushed material shall be screened into a sufficient number of fractions GCS2 class of crushed aggregate and reconstituted and mixed thoroughly in a pug mill or by other suitable means to ensure compliance with the grading requirements.

(iii) GCS2 class of crushed aggregate

Crushed aggregate class GCS2 shall be made of hard, durable and un-weathered fragments made by the crushing of stones, boulders, oversize from borrow pits or quarried rock. Minimum 50% by mass of particles larger than 5 mm shall have at least one crushed face. Maximum 30% by mass of material passing 5 mm can be approved soil fines.

(b) Soluble salts

The Contractor shall discard the material or fulfil all requirements for appropriate construction techniques and timing of operations to the satisfaction of the Engineer if assessments of soluble salt contents in base course materials show deleterious values. Such assessments are only required where the pavement is going to receive a bituminous seal as the only surfacing. No additional payment will be made for any measures taken, or for any alterations of the material utilisation, due to presence of soluble salts in materials or construction water.

(c) Material requirements – class GCS1

Materials for base course layers of material class GCS1 crushed aggregate as specified on the Drawings shall meet the requirements for grading given in Table 26.1.

(d) Material requirements – class GCS2

Materials for base course layers of material class GCS2 crushed aggregate as specified on the Drawings shall meet the requirements for grading given in Table 26.1.

2.1.26.1.3 Construction

(a) Preparation of the sub base

No base course shall be placed until approval is obtained from the Engineer and the sub base is placed, compacted and finished in accordance with the Specifications and is tested and found acceptable to the full satisfaction of the Engineer. Before placing the base course, the sub base shall be inspected and proof rolled as required by the Engineer in order to establish whether there is any damage, wet spots or other defects. Any such defect shall be rectified to the satisfaction of the Engineer before the next layer is placed. Pre-tipping of material prior to sub base processing shall be over a maximum distance of 300m.

(b) Shoulders

Bitumen surfaced shoulders made with the same base course material as the carriageway shall be the preferred method for construction of shoulders. Where the shoulders are nevertheless to be constructed with a different material than the carriageway, or where any other obstruction such as kerbstones could impair drainage of the base course, all work shall be so constructed that the base course will be adequately drained at all times during and after construction by means of sufficient drainage pipes through the obstructions or by the use of freely draining materials passing through shoulders. The Contractor shall not start constructing the base course of any part of the road before he/she has ensured sufficient drainage through the shoulders to the satisfaction of the Engineer.

(c) Spreading and mixing

Crushed aggregate complying with the requirements specified above shall be placed in quantities sufficient to ensure that the completed layer will comply with all the requirements in regard to layer thickness, level, cross-section and density. Segregation of the aggregate during spreading shall be prevented by appropriate choice of working method to the satisfaction of the Engineer. Allowance shall be made for sufficient extra material to enable the layer to be properly trimmed.
The maximum compacted thickness of any layer of crushed aggregate base course compacted in one process shall be 200 mm, unless otherwise specified or permitted by the Engineer.
The dumps of material shall be spread out to a flat-surfaced layer with a thickness that will be suitable for mixing. The required quantity of water shall then be added and the material mixed until a homogeneous mixture is obtained.

Table 0.1 Requirements For Class GCS1 Crushed Aggregate Base Course

Material properties	Material class: GCS1		
Atterberg limits: 1)			
Max Plasticity Index KS 999: Part 2	Non plastic		
Max Linear Shrinkage KS 999: Part 2			
Grading: KS 999: Part 2			
Sieve size (mm)	Grading limits – GCS1 (% passing sieve) 2)		
	0/20	0/30	0/40
50	-	-	100
37.5	-	100	90-100
28	100	90-100	75-95
20	90-100	65-95	60-90
10	60-75	40-70	40-75
5	40-60	30-55	30-63
2	30-45	20-40	20-45
1.18	15-30	15-32	15-35
0.425	13-27	10-24	10-26
0.075	4-10	4-10	4-12
Particle strength and shape:			
Minimum TFVdry KS 1238-12	110 kN		
Ratio dry to soaked value of KS 1238-12	TFVsoaked shall be minimum 60% of the corresponding TFVdry value		
Maximum flakiness index KS 1238-6	30		
It is emphasised that the Atterberg limits shall be measured according to KS 999: Part 2. Other laboratory test procedures and equipment may not give comparable results and shall not be used unless proper correlation to BS has been carried out to the satisfaction of the Engineer. The base course material on the road after final compaction shall comply with above grading limits.			

(d) Compaction

(i) General

After mixing, the crushed aggregate material shall be placed to the correct thickness and level and thoroughly compacted by suitable equipment so that the specified density is obtained throughout the entire layer.

The finally compacted layer shall be free from surface laminations, portions exhibiting segregation of the fine and coarse aggregate, corrugations, or other defects that may adversely affect the performance of the layer.

(ii) Compaction requirements

The minimum required compacted density for pavement layers made of crushed aggregate shall be as given in Table 26.2. The Contractor's attention is drawn to the high density requirements for class GCS1 materials and the required high standards of workmanship necessary to achieve these on site.

Table 0.2Compaction Requirements For Base Course Of Crushed Aggregate

Material class specified	Minimum dry density, lower specification limit, KS 999: Part 4, Vibrating Hammer
GCS1	98%
GCS2	96%

GCS1 crushed aggregate base material shall, unless otherwise specified in the Special Specifications, be laid by an approved type of self-propelled mechanical spreader and finisher capable of laying to the required widths, thicknesses, profile, camber or cross-fall, without causing segregation, dragging or other defects.
The Engineer may, if so specified in the Special Specifications, allow that nuclear method to be used for control of density and moisture content.
Compaction method specifications shall not be used for compaction control of crushed aggregate base course.

(e) Processing of class GCS1 materials

Class GCS1 shall be slushed as described herein to achieve the required field density. After completion of the compaction described above, short sections of the surface shall be thoroughly watered, rolled and slushed by means of steel-wheeled rollers with a mass of not less than 12 tonnes each, or with pneumatic-tyre rollers. The process shall continue until all excess fines are brought to the surface. The grout thus formed shall be uniformly broomed over the surface with stiff brooms to correct any areas still deficient in fines.
Thereupon the excess fines shall be broomed from the surface of the layer. This process shall continue until all excess fines in the mixture have been brought to the surface of the layer and its specified density has been reached. Excess fines and loose aggregate shall then be swept from the surface while the surface is still damp. The layer shall then receive final rolling with pneumatic-tyre rollers and the layer shall then be allowed to dry out. During slushing operations, care shall be taken not to roll the surface out of shape.
The slushing process shall be carried out on each section in one continuous process, and each section shall be completed before the next is proceeded on.
The completed layer shall be firm and stable with a closely-knit surface of aggregate exposed in mosaic and free from nests of segregated material, laminations or corrugations.

Table 0.3 Requirements For Class GCS2 Crushed Aggregate Sub-Base Course

Material properties	Material class: GCS2	
Atterberg limits: *1)*		
Max Plasticity Index KS 999: Part 2	6	
Max Linear Shrinkage KS 999: Part 2	3	
Grading: KS 999: Part 2		
Sieve size (mm)	Grading limits - GCS1 (% passing sieve) 2)	
	0/40	0/60
75	-	100
63	-	95-100
50	100	85-100
37.5	90-100	75-95
28	75-95	60-87
20	60-90	50-80
10	35-75	30-67
5	25-63	23-58
2	15-45	13-40
1.18	8-35	7-32
0.425	4-23	4-20
0.075	0-12	0-10
Particle strength and shape		

Minimum TFV_{dry} KS1238-12	90 kN
Ratio dry to soaked value of KS1238-12	TFV_{soaked} shall be minimum 75% of the corresponding TFV_{dry} value
Maximum flakiness index KS1238-6	35%
It is emphasised that the Atterberg limits shall be measured according to KS 999: Part 2. Other laboratory test procedures and equipment may not give comparable results and shall not be used unless proper correlation to BS has been carried out to the satisfaction of the Engineer. The base course material on the road after final compaction shall comply with above grading limits.	

2.1.26.1.4 Protection and maintenance

The Contractor shall protect and maintain the completed layer at his/her own expense until the surfacing is applied. Maintenance shall include the immediate repair of any damage to or defects in the layer and shall be repeated as often as is necessary. Repairs shall be so made as to ensure an even and uniform surface to be restored after completion of the repair work. Traffic shall not be allowed directly on any un-primed crushed aggregate layer unless so authorised or directed by the Engineer.

2.1.26.1.5 Construction tolerances and testing

The completed crushed aggregate layer shall comply with construction tolerances and testing requirements specified in Section 3.4.

2.1.26.2 Pavement; Natural material for subbase

2.1.26.2.1 Scope

This Section covers the construction of subbase from natural gravel or partially crushed gravel.

This Section covers the requirements for the following types of material:

- G30 natural gravel with minimum soaked CBR value of 30%

2.1.26.2.2 Materials

(a) General

Gravel material shall be obtained from approved sources. Any test results provided in design documents such as the Materials Report, read in conjunction with these Specifications, may give a preliminary indication as to the purpose for which cut or borrow material may be used as well as the treatment, if any, which the roadbed shall receive. Any test results or recommendations of method of work in the Materials Report are solely for information. The Contractor shall undertake his/her own assessment and any tests required and submit his/her proposed methods of work and test results of all material he/she intends to use for the approval of the Engineer.

The material type given in the Drawings denotes the minimum quality for a particular use in the Works, either specified in the Drawings or as instructed by the Engineer. In the cases where a minimum quality of earthworks material is not specified, the following guidelines shall apply and the Engineer's instruction shall be the applied standard to which materials quality control is applied:

Irrespective of the minimum required quality specified or the above guidelines, the highest quality of approved gravel for pavement layers available at economical haul distances,

complying with the requirements of the Specifications and Drawings, shall be selected for fill, improved subgrade and the individual pavement layers.

Materials for subbase layers of G30 materials as specified on the Drawings shall meet the requirements given in TABLE 26.4 below.

Table 0.4 Requirements for subbase layers of G30 materials

Material properties	Material class G30	
	General requirements	Coral gravel
CBR: KS 999: Part 4		
CBR (%)	Minimum 30 after 4 days soaking ***1)***	
CBR-swell (%)	Maximum 1.0 measured at BS-Heavy compaction	
Atterberg limits: 2)		
Max Liquid limit KS 999: Part 2	45	45
Max Plasticity Index KS 999: Part 2	16	18
Grading: KS 999: Part 2		
Requirements:	Grading modulus, GM shall be minimum 1.2	

1) CBR values shall be measured at the specified field density for the layer.
2) It is emphasised that the Atterberg limits shall be measured according to KS 999: Part 2. Other laboratory test procedures and equipment may not give comparable results and shall not be used unless proper correlation to BS has been carried out to the satisfaction of the Engineer. Limits specified are for 'wet' areas: for 'dry' areas, some relaxation is permitted: see Kenya Design Manual Part III.

2.1.26.2.3 Construction

(a) Requirements applying prior to placing of the layer

No pavement layer shall be placed until approval is obtained from the Engineer and the underlying layer is placed, compacted and finished in accordance with the Specifications and is tested and found acceptable to the full satisfaction of the Engineer. Before placing any pavement layer the underlying layer shall be inspected and proof rolled as required by the Engineer in order to establish whether there is any damage, wet spots or other defects. Any such defect shall be rectified to the satisfaction of the Engineer before the next layer is placed.

(b) Processing to improve quality

The Contractor may elect to crush, screen or mix materials from different sources or undertake other processing of materials to meet the specified material requirements. No additional payment will be made for any such processing unless stated in the Special Specifications and the Bill of Quantities.

(c) Shoulders

Where the shoulders and the base course are to be constructed from the same material, they shall be constructed simultaneously.

Where the base course is to be constructed from a different material than the shoulders, the shoulders shall first be constructed and then neatly cut to the required line to provide lateral support for the base course. Care shall be taken not to contaminate the base course material with the shoulder material. Where the base course is made of a bituminous mix, the base course may however be constructed before the shoulders. Work shall be so constructed that the road will be adequately drained at all times by means of sufficient drainage pipes passing through the shoulders. The Contractor shall not start constructing the final bituminous surfacing of any part of the road before he/she has completed the shoulders of such section to the satisfaction of the Engineer.

Shoulder material shall be spread, broken down as required, watered, mixed and compacted in accordance with the Specifications, and shall be compacted to a density of not less than 95% of BS-Heavy or as directed by the Engineer.

(d) Subbase and base course materials

Subbase or base course materials respectively shall be spread, broken down as required, watered, mixed and compacted in accordance with the Specifications, and shall be compacted to a density of not less than 95% of BS-Heavy

2.1.26.2.4 Protection and maintenance

The compacted layers shall be adequately drained and shaped to prevent water from standing on or along or causing damage to the completed work. Windrows shall be removed to facilitate the drainage of water from the surface.

No material for a subsequent layer shall be placed if the underlying layer has been softened by excessive moisture and requires repair in the opinion of the Engineer.

2.1.26.3 Pavement; Concrete Pavement

2.1.26.3.1 Scope

The work covered in this chapter consists of furnishing of all plant, labour, equipment and material and in performing all operations in connection with the construction of concrete slabs on a previously constructed sub grade, complete, in place and accepted, subject to the terms and conditions of the contract.

2.1.26.3.2 General

(a) Formwork and finishes

Formwork and finishes to concrete for concrete carriageways shall comply with the general specification for concrete works under buildings.

(b) Reinforcement

Steel reinforcement for concrete carriageways shall comply with the general specification for concrete works under buildings..

(c) Concrete

Concrete for concrete carriageways shall comply with the general specification for concrete works under buildings.

(d) Curing compound

Curing compound for concrete carriageways shall comply with the general specification for concrete works under buildings.

(e) Earthworks

Earthworks for concrete carriageways shall comply with the general specification for Earthworks works under buildings.

2.1.26.3.3 Materials

(a) Reinforcement

1. Fabric reinforcement shall be steel fabric complying with BS 4483. The fabric shall be manufactured from steel wire which complies with BS 4482 and which has a type 2 bond classification.
2. Dowel bars, tie bars, cradles and tie bars for cradles shall be Grade 250 plain round steel bars complying with CS 2. Dowel bars and tie bars shall be straight. Both ends of dowel bars and one end of tie bars shall be sawn square with all burrs removed.

(b) Cement mortar for cradles

Cement mortar for supporting cradles shall consist of 1 part of cement to 3 parts of fine aggregate together with the minimum amount of water necessary to achieve a consistency suitable for the required work. Fine aggregates shall be sand or crushed rock to BS 1200 and shall pass a 5 mm BS test sieve.

(c) Fine aggregate

Fine aggregate for concrete shall be natural river-deposited sand consisting of at least 95% by mass of quartz grains or clean, hard and durable crushed rock in accordance with Section 16.

(d) Polyethylene sheeting

Polyethylene sheeting shall be impermeable and shall have a nominal thickness of 0.125 mm.

(e) Joint filler

Joint filler shall be of a proprietary type approved by the Engineer and shall be a firm, compressible, single thickness, non-rotting filler.

(f) Joint sealant

(1). Joint sealant shall be of a grade suited to the climatic conditions of Nairobi and shall perform effectively over a temperature range of 0°C to 60°C.
(2). Joint sealant shall be a cold poured two-part polymer-based sealant complying with BS 5212, Type N.
(3). Primers and caulking material for use with joint sealant shall be of proprietary types recommended by the joint sealant manufacturer and approved by the Engineer.

(g) Bond breaker tape

Bond breaker tape shall be of a proprietary type recommended by the joint sealant manufacturer and approved by the Engineer. The tape shall be a polyethylene film with adhesive applied on one side and shall be the full width of the groove.

(h) **Groove forming strip**

(1). Groove forming strip shall be of a proprietary type approved by the Engineer. The strip shall be a firm compressible strip of either ethylene vinyl acetate foam with a density of at least 90 kg/m3 or synthetic rubber.
The strip shall be 25 mm deep and 5 mm thick and shall be sufficiently rigid to remain in position during concreting without deforming or stretching.
(2). Adhesive for groove forming strip shall be of a proprietary type recommended by the groove forming strip manufacturer and approved by the Engineer.

(i) Sleeves for dowel bars and tie bars

Sleeves for dowel bars and tie bars shall be uPVC and shall have a nominal wall thickness not exceeding 1.5 mm. The sleeves shall fit tightly to the bars.

(j) Epoxy resin grout

Epoxy resin grout shall be of a proprietary type approved by the Engineer.

2.1.26.3.4 Concrete

(a) Concrete mix

Concrete for concrete carriageways shall comply with the following requirements:

a) Concrete shall be Grade 40/20 and shall be a designed mix.
b) The concrete mix shall contain either PFAC or a minimum of 265 kg of PC plus a minimum of 85 kg of PFA per m3 of compacted concrete.
c) The percentage by mass of fine aggregate to total aggregate shall be at least 30%.
d) The workability in terms of designed slump value shall not exceed 30 mm.

(b) Cementitious content of concrete

The minimum cementitious content of concrete for concrete carriageways shall be 350 kg/m3.

2.1.26.3.5 Submissions

(a) Particulars of materials for joints

(1). The following particulars of the proposed materials for joints in concrete carriageways shall be submitted to the Engineer:

a) (a) Manufacturer's literature and a certificate for joint filler showing the manufacturer's name, the date and place of manufacture and showing that the joint filler complies with the requirements stated in the Contract and including results of tests for:
   - Disintegration and shrinkage
   - Recovery value and reduction in mass
   - Extrusion,
b) (b) Manufacturer's literature for joint sealant, including details of the method and time required for mixing the different components, and a certificate showing the manufacturer's name, the date and place of manufacture and showing that the sealant complies with the requirements stated in the Contract and including results of tests for:
   - Application life
   - Tack-free time
   - Resistance to flow
   - Recovery
   - Adhesion and cohesion in tension and compression
   - Resistance to heat ageing,
c) Manufacturer's literature and a certificate for groove-forming strip showing the manufacturer's name, the date and place of manufacture and showing that the groove forming strip complies with the requirements stated in the Contract and including results of tests for density, and
d) Particulars of primers and caulking material for joint sealant, adhesive for groove forming strip, bond breaker tape and sleeves for dowel bars and tie bars.

(2). The particulars, including certificates, shall be submitted to the Engineer at least 14 days before the first delivery of the material to the Site. Certificates shall be submitted for each batch of the material delivered to the Site.

(b) Particulars of methods of construction

Particulars of proposed methods of construction for concrete carriageways shall be submitted to the Engineer at least 7 days before the trial length is constructed.

(c) Samples of materials

Samples of the following proposed materials shall be submitted to the Engineer at the same time as particulars of the material are submitted:
(a) Polyethylene sheeting,
(b) Joint filler,
(c) Bond-breaker tape,
(d) Groove-forming strip, and
(e) Sleeves for dowel bars, including compressible filler, and for tie bars.

2.1.26.3.6 Trials

(a) Compliance criteria: trial-mix concrete

The results of the tests on trial-mix concrete for concrete carriageways shall comply with the following requirements:

- Each of the six slump values shall not exceed 40 mm, and the average of the six slump values shall not exceed 35 mm.

(b) Trial length

(1). A trial length of concrete carriageway shall be constructed to demonstrate that the proposed materials, mix design, methods of production and methods of construction will produce a concrete carriageway which complies with the specified requirements.
(2). The trial length shall be constructed using the materials, mix design, methods of production and methods of construction submitted to the Engineer.
(3). If it is not stated in the Contract that the trial length is to be constructed in a location separate from the permanent carriageway, the trial length shall be the first 30 m of the permanent carriageway, or such other length agreed by the Engineer. The trial length shall be constructed over a width of two bays and shall include at least one expansion joint, one contraction joint and the longitudinal joint between the bays.
(4). The Contractor shall inform the Engineer at least 48 hours, or within a shorter period agreed by the Engineer, before constructing the trial length.
(5). The trial length shall be completed in sufficient time before the permanent carriageway is constructed to allow the Engineer a period of at least 7 days to determine if the specified requirements have been complied with in the trial length.
(6). The trial length shall be protected from damage and shall be left in position unless the Engineer instructs its removal. A trial length which forms part of the permanent carriageway and which complies with the specified requirements shall not be removed.

(c) Testing: trial length

(1). The trial length shall be tested to determine the accuracy of the alignment and level, the surface regularity and the texture depth.
(2). Concrete cores shall be cut from the trial length to determine the thickness of the slab, the positions of the reinforcement and joint components, the amount of segregation of the constituents and the presence of voids.

(d) Non-compliance: trial length

(1). If the result of any test on the trial length does not comply with the specified requirements for the trial length, particulars of proposed changes to the materials, mix design, methods of production or methods of construction shall be submitted to the Engineer. Further trial lengths shall be constructed until the result of every test on the trial length complies with the specified requirements for the trial length. Further trial mixes shall be made unless in the opinion of the Engineer non-compliance of the trial length was not due to the concrete mix.
(2). Unless otherwise permitted by the Engineer, trial lengths, or parts of trial lengths, which do not comply with the specified requirements for the trial length shall be removed.

(e) Commencement of concreting

(1). Concrete shall not be placed in the permanent carriageway other than in a trial length until the result of every test on the trial length complies with the specified requirements for the trial length.
(2). Concrete may be placed in the permanent carriageway before the results of tests for compressive strength of the trial mix are available provided that the result of every other test on the trial mix and trial length complies with the specified requirements for trial mix concrete and for the trial length.

(f) Changes in materials and methods of construction

Unless permitted by the Engineer, the materials mix design, methods of production and methods of construction used to produce a trial length which complies with the specified requirements shall not be changed.

2.1.26.3.7 Storage of materials

(a) Storage of materials for joints and polyethylene sheeting

(1). Joint sealant, primer for joint sealant and adhesive for groove forming strip shall be stored in sealed containers marked to identify the contents and protected from exposure to conditions that may adversely affect the material. The materials shall be stored in accordance with the manufacturers' recommendations and shall not be used after the recommended shelf life has been exceeded.
(2). Polyethylene sheeting, joint filler, bond breaker tape, groove forming strip and sleeves for dowel bars and tie bars shall be stored in accordance with the manufacturers' recommendations in a dry, weatherproof store with a raised floor. Joint filler shall be stored in sealed plastic bags and shall not be exposed to moisture or air.

2.1.26.3.8 Preliminary work

(b) Installation of utilities

(1) Pipes, cables, manholes, chambers, gullies and other utilities below concrete carriageways shall be completed and fill material shall be deposited and compacted in trenches before the carriageway is constructed. Openings to manholes, chambers and gullies shall be protected by temporary covers or by other methods agreed by the Engineer.
(2) Box-outs shall be formed in concrete carriageways for covers, frames and other hardware. The covers, frames and other hardware shall be fixed in position after the main slab has been concreted and before the infill slab is concreted.

(c) Preparation of formation and sub-base

Construction of concrete carriageways shall start as soon as practicable after the formation or sub-base has been completed. The formation and the sub-base shall be protected until construction of the carriageway starts.

(d) Laying polyethylene sheeting

Polyethylene sheeting below concrete carriageways shall be laid flat without creases. Laps shall be at least 300 mm and there shall be no gaps at the edges of bays.

2.1.26.3.9 Formwork

(a) Formwork

(1). Unless otherwise approved by the Engineer, formwork for concrete carriageways shall be steel. The finish to concrete surfaces for transverse and longitudinal joints shall be Class F3. The finish to concrete surfaces for other edges of the carriageway shall be Class F2.
(2). Concrete shall not be placed against excavated surfaces or against kerbs unless permitted by the Engineer.
(3). Formwork shall not be loosened or removed until at least 7 hours after concreting has been completed.

2.1.26.3.10 Forming joints

(a) Forming joints

(1). Materials for joints in concrete carriageways shall be used in accordance with the manufacturers' recommendations or as otherwise stated in the Contract.
(2). Dowel bars, tie bars and their sleeves shall be securely fixed in position through holes in the formwork before concreting. The bars shall be parallel to the top surface of the slab and to each other. Bars at transverse joints shall be parallel to the adjacent longitudinal joint or to the longitudinal axis of the carriageway if there is no longitudinal joint or to other lines instructed by the Engineer.
(3). Joint filler shall be cut to size before fixing and shall be securely fixed in position to the existing concrete surface before concreting. There shall be no gaps between the joint filler and the formation. Holes in joint filler for dowel bars shall be cut to form a sliding fit to the sleeved bar.
(4). Joints shall be formed perpendicular to the top surface of the slab.

(b) Transverse joints

(1). Unless otherwise permitted by the Engineer, transverse joints in concrete carriageways shall be straight and perpendicular to the longitudinal axis of the carriageway.
(2). Transverse expansion joints and transverse contraction joints shall be formed only at the specified positions. The joints shall be continued across longitudinal joints and shall be in line and of the same type on both sides of the longitudinal joint. The joints shall be continued through kerbs, edgings and quadrants and their foundation and backing. The joint dimensions and materials shall be the same as the transverse joints with the omission of dowel bars. The location of additional contraction joints shall be as instructed by the Engineer. (3) The joint filler and groove for joint sealant at transverse expansion joints shall provide complete separation of adjacent slabs.

(c) Longitudinal joints

Longitudinal joints in concrete carriageways shall be formed only at the specified positions.

(d) Isolation joints

Isolation joints shall be formed in concrete carriageways at manholes and chambers.

(e) Forming grooves

(1). Grooves in concrete carriageways for joint sealant shall be straight, shall have parallel sides and shall be perpendicular to the top surface of the slab. The bottom of the groove shall be flat and shall be parallel to the top surface of the slab.
(2). Grooves at transverse expansion joints and at isolation joints at manholes and chambers shall be formed by sawing the groove to the specified width and depth not less than 7 days after concreting. The grooves shall be located over the joint filler such that the upper surface of the joint filler is entirely contained in the groove.
(3). Grooves at transverse contraction joints shall be formed using one of the following methods:

(i) Method 1:

An initial groove shall be sawn as soon as practicable after concreting without causing spalling of the edges.
The width of the initial groove shall be less than the specified width of the final groove and the depth of the initial groove shall be between 1/4 and 1/3 of the thickness of the slab. The final groove shall be sawn to the specified width and depth not less than 7 days after concreting. The center-lines of the initial and final grooves shall coincide.

(ii) Method 2:

The final groove shall be sawn to the specified width and depth as soon as practicable after concreting without causing spalling of the edges.

(1). Grooves at transverse construction joints shall be formed by fixing groove-forming strip with adhesive to the concrete already placed before concreting the adjacent slab.

(f) Protection of grooves

Before permanent sealing, grooves in concrete carriageways for joint sealant shall be protected from contamination by a temporary sealing strip or by other methods agreed by the Engineer.

(g) Sealing joints

(1) The permanent sealing of joints in concrete carriageways shall be carried out at least 7 days after concreting unless otherwise permitted by the Engineer.
(2) Immediately before permanent sealing, groove forming strips, temporary seals, dirt and loose material shall be removed from the groove and the sides of the groove shall be cleaned and roughened by water jetting, sand blasting or by other methods agreed by the Engineer.
(3) Caulking material shall be firmly packed in the bottom of the groove if the joint sealant is not required to extend to the bottom of the groove.
(4) Bond breaker tape shall be fixed continuously and evenly along the bottom of the groove for the full width and length of the groove.
(5) Primer for the joint sealant shall be applied to the sides of the groove in accordance with the manufacturer's recommendations.
(6) Joint sealant shall be applied between the minimum and maximum drying times of the primer recommended by the manufacturer. The components of the sealant shall be thoroughly mixed in accordance with the manufacturer's recommendations using a power operated paddle mixer for sufficient time to produce a homogeneous mass without entrapped air.
The sealant shall be dispensed into the groove as soon as practicable after mixing and within the time recommended by the manufacturer.
(7) The groove shall be clean and dry at the time of applying the primer and joint sealant.
(8) Excess joint sealant shall be removed by using a purpose made finishing tool such that the finished surface of the sealant is between 4 mm and 6 mm below the surface of the slab.

2.1.26.3.11 Placing and compacting concrete

(a) Placing and compacting concrete

(1). Concrete shall be placed continuously between the joints in concrete carriageways unless otherwise permitted by the Engineer.
(2). Concrete in unreinforced slabs shall be placed and compacted to the full thickness of the slab in one operation.
(3). Unless otherwise permitted by the Engineer, concrete in reinforced slabs shall be placed and compacted to the specified level of the fabric reinforcement. The fabric reinforcement shall be placed in position and concrete shall be placed and compacted to the remaining thickness of the slab. The time between compaction of the first layer and placing of the remaining layer shall not exceed 30 minutes unless in the opinion of the Engineer the

concrete already placed is sufficiently workable and the permission of the Engineer has been obtained. If permission is not obtained, a construction joint shall be formed. Concrete shall not be placed against the concrete already placed for at least 24 hours unless permitted by the Engineer.

(4). Concrete in infill slabs at covers, frames and other hardware shall be placed and compacted after the covers, frames and hardware have been fixed in position and shall not be placed at the same time as the concrete in the main slab.

2.1.26.3.12 Construction joints

(a) Construction joints

(1). Construction joints shall be formed in concrete carriageways only where approved by the Engineer or in cases of emergency if concreting is interrupted by adverse weather, plant breakdown or similar circumstances. Construction joints shall not be formed within 2.5 m of an existing or planned expansion or contraction joint.

(2). Transverse construction joints shall be formed by either:
   (a) Using formwork and cast-in tie bars, or
   (b) Breaking back from an unformed edge and fixing the tie bars and sleeves with epoxy resin grout in drilled holes.

2.1.26.3.13 Surface finish

(a) Surface regulation

(1). Unless combined double beam compactor-levellers are being used, then after compaction, the concrete in concrete carriageways shall be struck off to slightly above the levels of the formwork and the surface shall be regulated by a regulating machine or a vibrating beam.

(2). Regulating machines shall be purpose made and shall span the full width of the slab either transversely or obliquely. The machine shall be equipped with at least two oscillating-type transverse screeds and shall be supported on a carriage.

(3). Vibrating beams shall have a steel or aluminium surface and shall be mounted on a separate carriage. The beam shall be driven by a motor to provide a vibration frequency of at least 3500 cycles per minute.

(4). After regulation by the regulating machine or vibrating beam, the surface of the carriageway shall be regulated by at least two passes of a scraping straight edge with a blade length of at least 1.8 m. Scraping straight edges that operate in conjunction with regulating machines shall pass across the surface at right angles to the longitudinal axis of the carriageway. If the surface is torn by the straight edge, the surface shall be regulated again by the regulating machine or vibrating beam and by the scraping straight-edge.

(5). Wooden floats may be used to tamp and regulate small areas of the carriageway as agreed by the Engineer. Steel floats or trowels shall not be used.

(b) Surface texturing

(1). After the surface of the concrete carriageway has been regulated and before the curing compound is applied, the surface, other than the surface of channels and edges of slabs that do not require to be textured, shall be textured by brushing with a wire broom.

(2). The wire broom shall be at least 450 mm wide and shall have two rows of tufts. The rows shall be 20 mm apart and the tufts in each row shall be at 10 mm centres and in line with the centre of the gaps between the tufts in the other row. The tufts shall contain an average of 14 wires, each of 32 gauge and initially 100 mm long. The broom shall be replaced if any tuft wears down to a length of 90 mm.

(3). The surface texture shall be produced by brushing evenly across the slab in one direction at right angles to the longitudinal axis of the carriageway. Brushing shall be carried out after the moisture film has disappeared from the concrete surface and before the initial set is complete.

2.1.26.3.14 Curing concrete

(a) Curing concrete

The surface and edges of concrete carriageways shall be protected by one of the methods approved by the Engineer except that covering with hessian, sacking, canvas or other absorbent material as stated in Method 2 shall not be used. If Method 1 is used, the curing compound shall be applied to the surface immediately after the surface has been textured and shall be applied to the edges immediately after the formwork has been removed.

2.1.26.3.15 Protection of concrete carriageway

(a) Protection of concrete carriageway

(1). Immediately after the curing system has been applied, the concrete carriageway shall be fenced off from pedestrian traffic and covered with protective sheeting for at least 24 hours. The sheeting shall be lapped and securely held in position in such a manner that the surface of the carriageway will not be damaged.
(2). Loads from materials not forming part of the permanent work or from construction plant or other vehicles shall not be applied to the concrete carriageway until at least 14 days after concreting has been completed and until all grooves at joints have been temporarily or permanently sealed or protected.

2.1.26.3.16 Tolerances

(a) Tolerances: sub-base

The level of the sub-base below concrete carriageways shall not be more than 10 mm higher, and shall not be more than 20 mm lower, than the specified level.

(b) Tolerances: formwork

(1). The line of formwork for concrete carriageways shall be within 10 mm of the specified line of the concrete carriageway.
(2). The level of the top of the formwork shall be within 3 mm of the specified level of the concrete carriageway.
(3). Abrupt irregularities in the line of the formwork and in the level of the top of formwork shall not exceed 3 mm.

(c) Tolerances: reinforcement

The cover to fabric reinforcement in concrete carriageways shall be within 10 mm of the specified cover.

(d) Tolerances: dowel bars and tie bars

(1). Dowel bars at joints in concrete carriageways shall be within 20 mm of the mid-depth of the slab.
(2). Dowel bars shall be parallel to within 3 mm in half the length of the bar to:
   a) The longitudinal joint, or the longitudinal axis of the concrete carriageway if there is no longitudinal joint,
   b) The top surface of the slab, and
   c) Adjacent dowel bars.

(e) Tolerances: grooves

Unless otherwise recommended by the manufacturer of the joint sealant the depth of grooves for joint sealant in concrete carriageways shall be within 3 mm of the specified depth.

(f) Tolerances: covers, frames and other hardware

The level of covers, frames and other hardware shall not be higher than, and shall not be more than 3 mm lower than, the surface of the adjacent carriageway.

(g) Tolerances: alignment of concrete carriageway

(1) The best-fit straight line of straight joints and of straight edges of concrete carriageways shall be within 25 mm of the specified line. The line of straight joints and of straight edges of concrete carriageways shall be within 10 mm of the best-fit straight line.
(2) The best fit curved line of curved joints and of curved edges of concrete carriageways shall be as agreed by the Engineer and shall be within 25 mm of the specified line. The line of curved joints and of curved edges of concrete carriageways shall be within 10 mm of the best-fit curved line.

(3) Joints in concrete carriageways shall be continuous across intersections of joints to within 5 mm of the best fit straight lines or best fit curved lines of each joint.

(h) Tolerances: level of concrete carriageway

(1). The levels of the surface of concrete carriageways shall be determined 200 mm from the edges of each bay at 10 m centres in the longitudinal direction and at 2 m centres in the transverse direction.
(2). The level of the surface of concrete carriageways shall be within 6 mm of the specified level. In low lying and flat areas the Contractor shall pay special attention to level control to ensure that falls on the surface of the carriageway are in the specified direction.
(3). The difference in level of the surface of concrete carriageways across joints shall not exceed 3 mm.
(4). The thickness of concrete carriageway slabs shall not be less than the specified thickness minus 10 mm.

2.1.26.4 Pavement; Reflective Marking

2.1.26.4.1 Glossary of terms

(i) Road Markings

Road markings are white or yellow continuous or intermittent lines, letters, characters, figures, arrows or symbols marked on the carriageway to guide road users and pedestrians.

2.1.26.4.2 Materials

(a) Hot-applied thermoplastic material

(1). Hot-applied thermoplastic material shall comply with BS EN 1871:2000. In particular,
  (a) The luminance factor when tested in accordance with Annex E of BS EN 1871: 2000 shall be Class LF4 for white material and Class LF2 for yellow material.
  (b) The softening point when tested in accordance with Annex F of BS EN 1871: 2000 shall be Class SP2.
(3). Solid glass beads shall be included in the supplied mixture of hot applied thermoplastic material.
(4). Thermoplastic material shall be of a solvent-free marking substance supplied in block, granular or powder forms, which can be heated to a molten state and then applied with an appropriate hand or mechanical applicator, and form a cohesive film by cooling.
(5). Thermoplastic material shall belong to either of the following types:
  - Type 'A'-Standard hot applied thermoplastic material.
  - Type 'B'-Alkyd resin hot applied thermoplastic material.

(b) Cold-applied preformed material

(1). Cold-applied preformed material for road markings shall be of a proprietary type approved by the Engineer

(2). Solid glass beads shall be applied to cold-applied preformed material at the place of manufacture.

(c) Cold plastic road marking

Cold plastics road marking material shall comply with BS EN 1871: 2000. In particular, when applied at the manufacturer's stated thickness and tested in accordance with Annex A of BS EN 1871: 2000, the luminance factor shall be Class LF4 for white material and Class LF2 for yellow material.

(d) Paint for road markings

Road-marking paint material, including water-based road-marking paint, shall comply with BS EN 1871: 2000. In particular,

(a) The luminance factor when tested in accordance with annex A of BS EN 1871: 2000 shall be Class LF6 for white material and Class LF2 for yellow material.
(b) The difference in luminance factor after UV ageing shall be Class UV1.
(c) The difference in luminance factor after bleed resistance test shall be Class BR1.

(e) Solid glass beads

(1). Drop-on glass beads shall comply with BS EN 1423: 1998. In particular, the refractive index of the glass beads shall conform to Class A when determined in accordance with Annex A of BS EN 1423: 1998.
(2). Premix glass beads shall comply with BS EN 1423: 1998. In particular, the refractive index of the glass beads shall conform to Class A when determined in accordance with Annex A of BS EN 1423: 1998.

(f) Functional life of the material

The functional life of the road-marking material as defined in BS EN 1436: 1998 shall be not less than 1 year after laying is carried out.

2.1.26.4.3 Submissions

(a) Test certificate and routine testing

(1). When required by the Engineer, the Contractor shall submit the test certificate prepared and signed by a local or overseas independent laboratory to the Engineer before commencing the Works in order to certify that the samples taken from the materials to be used in the Contract comply with BS EN 1871: 2000.
(2). The Contractor shall supply all samples of materials for testing. He shall render such assistance as may from time to time be required by the Engineer in taking and packing them in bags, which are to be provided by the Contractor, and dispatching them to Public Works Central Laboratory for testing.

2.1.26.4.4 Delivery and storage of materials

(a) Delivery and storage of thermoplastic material

Each container for keeping thermoplastic road marking material shall be clearly and indelibly marked with the following information:

(a) The name, trade mark or other means of identification of the manufacturer;
(b) Batch number;
(c) Date of manufacture;
(d) The number and date of the Standard, i.e. BS EN 1871: 2000;
(e) Whether reflectorized;
(f) Color (white, yellow, or black);
(g) Chemical description and type of resin;

(h) Maximum application temperature and maximum safe heating temperature;
(i) Relative density;
(j) If applicable, the class of its contents
(k) If applicable, a warning about the use of lead pigment.

(b) Storage of road marking paint material

Road-marking paint material shall be discarded after expiry of the shelf life.

(c) Storage of preformed material

Cold-applied preformed material shall be stored in accordance with the manufacturer's recommendations.

2.1.26.4.5 Laying road markings

(a) Preparation of surfaces

(1). Road markings shall not be laid over loose detritus, mud or similar extraneous matter. Oil and grease shall be removed from the surface of carriageways on which road markings will be laid.
(2). Curing compound shall be removed from the surface of new concrete carriageways on which road markings will be laid, by wire brushing or by other methods agreed by the Engineer.
(3). Existing road markings that are to be replaced by a different type of material shall be removed by high pressure water jetting, shot blasting, rotary grinding or by other methods agreed by the Engineer. The existing markings shall not be masked using black paint or similar methods.
(4). Existing road markings that are to be renewed using a similar type of material shall be roughened by a method agreed by the Engineer until the thickness of the existing material is reduced by approximately 50%.
(5). A tack coat shall be applied to the surface of concrete carriageways before hot thermoplastic material is laid. The tack coat shall be compatible with the road marking material and shall be applied in accordance with the manufacturer's recommendations
(6). Rotary grinding machines shall not be used to remove or roughen existing road markings within 100 mm of longitudinal or transverse joints on concrete carriageways.

(b) Laying hot-applied thermoplastic material

(1). Hot-applied thermoplastic material shall be prepared and laid in accordance with BS 3262: Part 3, Clauses 4 and 5. The material shall not be laid when the surface of the carriageway is wet, or the air ambient temperature in the shade is less than 10°C.
(2). Hot-applied thermoplastic material shall be laid by machine or by screeding methods. The machine or apparatus shall be capable of producing a marking to a uniform thickness and width. The marking shall have clean edges and shall be free of streaks and blisters.
(3). The thickness of road markings, not including surface applied solid glass beads, shall comply with the following:
   (a) Screed markings : 4 mm
   (b) Sprayed lines other than yellow edge lines : ≥ 1.5 mm
   (c) Sprayed yellow edge lines : ≥ 0.8 mm
   The thickness shall be measured in accordance with BS 3262: Part 3, Appendix B.

(c) Laying cold-applied preformed material

(1). Cold-applied preformed material shall be laid in accordance with the manufacturer's recommendations. The material shall not be laid when the surface of the carriageway is wet.
(2). The thickness of road markings shall be at least 1.5 mm

(d) Use of road- marking paint

(1) Road-marking paint may only be used on roads or areas where the use of other road marking materials, such as thermoplastic, will affect the functional performance of the road markings and the use shall be subject to written approval of the Engineer.
(2) Road-marking paint shall be applied in accordance with the manufacturer's recommendations.
(3) Road-marking paint shall not be used for temporary road markings and shall not be used to temporarily cover up existing road markings.

(e) Road marking performance for road users

Performance of the road marking during its functional life shall comply with BS EN 1436:1998. In particular,
(a) The minimum luminance coefficient under diffuse illumination measured in accordance with Annex A of BS EN 1436: 1998 shall be Class Q2 and Q3 on asphaltic surface and concrete surface respectively for white markings, and shall be Class Q1 for yellow markings.
(b) The minimum coefficient of retro reflected luminance for dry road markings measured in accordance with Annex B of BS EN 1436: 1998 shall be Class R2 and R1 for permanent white and yellow markings respectively, and shall be Class R3 for temporary markings.
(c) The minimum luminance factor for dry road markings measured in accordance with Annex C of BS EN 1436: 1998 shall be Class B3 for white markings and B2 for yellow markings.

(f) Temporary road markings

(1). Cold-applied preformed material shall be used for temporary road markings. Where existing road markings have to be masked temporarily to facilitate roadwork, the proprietary black tape approved by the Engineer shall be used.
(2). Temporary road markings shall be disposed of by the Contractor after removal. All traces of tape shall be removed from the surface of the carriageway and existing permanent road markings shall be made good such that in the opinion of the Engineer it is safe to allow traffic to use the road.

(g) Skid resistance level

The minimum skid resistance of the road marking measured in accordance with Annex D of BS EN 1436: 1998 shall be Class S1.

2.1.26.4.6 Tolerances

(a) Tolerances

The lengths, thicknesses and widths of road markings shall comply with the following requirements:
(a) The thickness of screed markings shall be within 1 mm of the specified thickness.
(b) The length and width of screed markings and sprayed lines shall be within +10%, -5% of the specified dimension.

2.1.26.4.7 Removing road markings

(a) Shot-Blasting Machine

Where existing road marking is directed by the Engineer to be removed by steel shot-blasting, the removal of road marking materials shall be carried out by a shot-blasting machine approved by the Engineer. The machine
shall be self-propelled, and shall have a minimum cleaning path of 350 mm.

2.1.26.5 Pavement; Interlocking Concrete Blocks

2.1.26.5.1 Definition

Block paving is the term applied to flexible surfacing consisting of precast concrete paving blocks laid on a laying course.
Laying course is the layer of material on which paving blocks are bedded.
Surface course is the layer of interlocked paving blocks.
Edge restraint is that part of the construction such as raised or flush kerb or channel, which prevents sideways movement of the blocks and prevents loss of material from the laying course.

2.1.26.5.2 Materials

(a) Precast Concrete Blocks

Precast concrete blocks shall be heavy duty type complying with BS EN: 2003.
Compressive crushing strength: 45N/mm2
Colour: Silver Grey.

(b) Jointing Material

Moisture Content: < 0.5%
Jointing Material: Sand to BSEN 13242:2002 or BS EN 12620
Grading: See table 26.5 below

Nominal Sieve Size (mm)	Percentage by Mass Passing (%)
2.36	100
1.18	90-100
600µm	60-90
300µm	30-60
150µm	15-30
75µm	5-10

Table 0.5 Jointing Material-Sieve size Specification

(c) Laying Course

Bedding: Sand. See table 26.6 for sieve size specifications
Nominal thickness after compaction: 50mm
Moisture content: 4-8% at the time of laying

Nominal Sieve Size (mm)	Percentage by Mass Passing (%)
10mm	100
5mm	85-100
2.36	65-100
1.18	40-98
600µm	25-72
300µm	10-35
150µm	0-15
75µm	0-10

Table 0.6

(d) Hand Packed Stones

All open-graded granular sub-base material shall comprise crushed gravel rock possessing well defined edges. Rounded gravels shall not be used. The sub-base material shall be sound, clean, non-friable and free from clay.

2.1.26.5.3 Method of Construction

(a) Laying Course

After completion of the specified sub base and approval by the Engineer, the Contractor shall spread the laying course material in a loose uncompacted layer to approximately required final depth below the surface profile. The loose thickness must be such that after compaction it forms a layer approximately 20mm thick below the paving blocks. In no case shall the material be less than 20mm thick at any point.
The moisture content of the laying course material shall be between 80 and 105% of the optimum moisture content for that material. Any material which gets saturated following rain or for any reason shall be removed and dried out to bring the moisture content to acceptable limits.
After evenly spreading the material, the layer shall be compacted using a vibrating plate compactor until the surface achieves uniform density and compaction. Upon completion of the compaction and inspection and approval by the Engineer, the Contractor shall spread a further layer of material about 15mm thick and screed it to create a loose surface on which the paving blocks can be placed.

(b) Surface Course

Paving blocks shall be laid such that the surface layers are within the tolerances specified below. Prior to commencing, the Contractor shall obtain the Engineer's written approval of the bond pattern adopted. The bond pattern shall be either Herringbone, Stretcher type as shown on the Drawings, or as directed by the Engineer.
The order of laying shall be such that an open working face is maintained. The first row of blocks shall be aligned against the edge restraint or by using a string line. Alignment of the blocks shall be checked by the Contractor as the work proceeds and adjustment made where necessary.
The bond pattern shall be maintained at all times. Joint width for sand filling shall be in the range of 2mm to 5mm. The area to be laid shall be completed as far as possible with whole blocks. Formation of boundaries and changes in direction shall be carried out using blocks trimmed to shape and size for the purpose. In no case shall pieces less than one third the size of a full block be inserted.

To work round any obstruction, the latter shall be surrounded with concrete using maximum aggregate size of 10mm and a compression strength of 40 N/mm^2 to form a regular shape and paving blocks trimmed to abut the obstructions shall be completed as the laying proceeds and before compaction commences.

(c) Compaction

After laying of the blocks is possible is complete, the surface course shall be compacted using a vibrating plate compactor with a plate area of not less than $0.25mm^2$ transmitting an effective force of not less than 75 kN/m^2 of plate at a frequency of vibration in the range of 75 Hz to 100 Hz. Alternative compaction equipment to achieve the same degree of compaction shall be to the approval of the Engineer.
Compaction shall be carried out as soon as possible after laying but not within 1 metre of any laying surface. No area of paving shall be left uncompacted at the completion of the day's work. No paving shall be laid in inclement weather conditions as instructed by the Engineer.

(d) Joint Filling

After compaction of the surface course, dry sand or crushed rock fines complying with the grading specified above shall be spread over the surface and brushed into the joints. The surface shall be vibrated using the vibratory plate compactor to ensure complete filling of the block-to block joint by the sand or fines. Where necessary, further sand or fines shall be added and surface re-vibrated.

(e) Tolerance

Tolerance on surface course shall be as follows:

Overall	±6mm

Flatness	10mm under a 3m straightedge 2mm between adjacent blocks
Adjacent gullies, Surface drainage Channels & outlets	6m, 0mm

2.1.26.5.4 Measurement and Payment

Concrete block paving shall be measured in square metres as the net plan area instructed by the Engineer to be laud.

The rate shall include for all works necessary to comply with the requirements of subclause 2301, 2302 and 2303 above.

2.1.26.6 Sidewalks and Other Paved Areas

2.1.26.6.1 Reinforced Concrete Sidewalk

Construction methods for embankment, subbase and base course, and pavement as specified in shall be used for reinforced concrete side walk, where applicable.

2.1.26.6.2 Stone Surfaced Tile Sidewalk

Materials and construction of embankment and bases shall be as specified. Embankment and bases shall be compacted to not less than 95% dry maximum density per AASHTO Standards. The tiles shall be gravel surfaced tile, sized 400 x 400 x 50 mm or other sizes as shown on the Drawings. Joints between each piece of tile shall be sealed with sand cement mortar, ratio 1:1, and shall be treated to match with the sidewalk surfaces. Joint lines shall be perpendicular to concrete kerbs.

2.1.26.6.3 Paving Block Sidewalk

Materials and construction of embankment and bases shall be as specified. Embankment and bases shall be compacted to not less than 95% dry maximum density per AASHTO Standards. Paving block shall have the pattern as specified and shall be constructed as follows:

(1) Level sand bedding to the required slopes, allowing for settlement after compaction.

(2) Lay paving blocks to form an interlocking resistance between the blocks.

(3) After the paving blocks have been laid in place, sand shall be placed over the blocks and swept to fill the gaps between the blocks. Plate vibrator shall be applied to compact sand in the gaps.

2.1.26.6.4 Concrete Tile Pavement

The relevant provisions of the Specifications shall apply for concrete of tiles. The concrete shall be grade C25.

Before ordering any tiles the Contractor shall have samples tested, as specified by the Engineer, by a testing authority nominated by the Engineer.

No tile shall be laid within 8 weeks after its casting.

The tiles shall be laid on a base of fill of at least 200mm thick. The fill shall be brought to true profile and level immediately before laying the tiles thereon. The tiles shall each be supported on their whole area by the fill material and after the tiles are laid the difference in height between the top edges of any 2 adjoining tiles shall not be more than 1mm. The tiles shall be laid tightly against each other in stretcher bond or in a pattern as specified by the Engineer.

During the Period of Maintenance the Contractor shall inter alia replace any tiles showing any cracks or any other damage or defects with tiles complying with the Specifications and lay again in accordance with the Specifications any tiles displaced due to settlement or otherwise.

2.1.26.6.5 Limit of Construction and Allowable Tolerances

Sidewalks and paving shall be constructed to the full width and length with the provision of spaces for tree planting or grassing and indicated on the drawings and in the particular specifications.
After construction is completed, levels along the line parallel to the centre line of the side walk shall not deviate more than 10mm every 3.00 m. The elevation shall be deviated from the specified elevation not to exceed 10mm. The allowable tolerances stated above shall not apply to ramp or bending sections.

2.1.26.6.6 Other Requirements

In the laying of the end rows of stone tiles or paving blocks it may be necessary to cut the tiles or the blocks to fit the available spaces. The cutting shall be done by a hydraulic spitter.
Upon completion of sidewalk or paving construction, the gaps between the tiles/blocks and concrete kerbs, manhole walls, building walls and at any locations shall not be more than 10mm wide.
Where concrete kerbs or gutters are constructed in the same contract, the construction of concrete kerbs and gutters must be complete before the construction of side walk is started.

2.1.26.7 Pavement: Kerbs, Edgings and Quadrants

2.1.26.7.1 Materials

(a) Concrete kerbs, edgings and quadrants

(1). Concrete for kerbs, edgings and quadrants shall be Grade 30/20. Concrete for foundations and backings to kerbs, edgings and quadrants shall be Grade 20/20.
(2). Precast concrete kerbs, edgings and quadrants shall comply with BS 7263: Part 1 except that the requirement for testing of water absorption shall not be applied. The nominal length of kerbs shall be 1 m and the nominal length of edgings shall be 750 mm.

(b) Granite kerbs, edgings and quadrants

(1). Granite kerbs, edgings and quadrants shall be worked straight or circular. Corners shall be square and the top front and back edges shall be parallel. The length of granite kerbs and edgings shall be at least 600 mm.
(2). The ends of the kerbs, edgings and quadrants shall be chisel-dressed square to form a close butt-joint with adjacent kerbs. Kerbs shall be chisel-dressed to a depth of at least 140 mm on the front face, at least 75 mm on the back face and for the full width of the top face.

2.1.26.7.2 Construction of kerbs, edgings and quadrants

(a) Construction of precast concrete and granite kerbs, edgings and quadrants

(1) Precast concrete and granite kerbs, edgings and quadrants shall be laid and bedded on a regulating layer of cement mortar. The thickness of the layer shall be at least 10 mm and shall not exceed 40 mm.
(2) Except as stated in this clause, joints between each kerb, edging and quadrant shall not exceed 10 mm in width and shall be filled and flush pointed with cement mortar. Joints in kerbs, edgings and quadrants at expansion joints on bridge decks shall be as stated in the Contract.
Transverse expansion and contraction joints in kerbs, edgings and quadrants laid on or adjacent to concrete carriageways shall be in accordance with Clause 4.6
(3) Radius kerbs shall be used for curves less than 10 m external radius.

(b) Construction of in-situ kerbs, edgings and quadrants

(1). In-situ concrete kerbs, edgings and quadrants shall be constructed in accordance with BS 5931 and shall be laid by an automatic extrusion machine of a type approved by the Engineer.
(2). In-situ concrete kerbs, quadrants and edgings shall have regular sides, edges, arrises and chamfers. The finish to the concrete surface shall be Class U5. Kerbs, edges and quadrants shall not be finished or dressed with cement mortar.
(3). Contraction joints shall be formed at intervals not greater than approximately 4 m. Transverse expansion and contraction joints in kerbs, edgings and quadrants which are laid on or adjacent to concrete carriageways shall be in accordance with Clause 4.6 Joints shall be flush pointed with cement mortar.

2.1.26.7.3 Tolerances

(a) Tolerances: kerbs, edgings and quadrants

(1). The line of kerbs, edgings and quadrants shall be within 3 mm of the specified line.
(2). The level of the top of kerbs, edgings and quadrants shall be within 3 mm of the specified level.

2.1.26.8 Pavement; Traffic Signs

2.1.26.8.1 General

(a) Traffic signs

(1). The design of traffic signs, including letters, characters, numbers, symbols and borders, shall be in accordance with conditions and restrictions imposed by the Commissioner for Transport.
(2). Traffic signs shall comply with BS EN 12899: Part 1: 2001 except that the requirements for marking signs shall not apply.
(3). Traffic signs shall be externally illuminated, internally illuminated, retro reflective, non-retro reflective or a combination of these types as stated in the Contract.

2.1.26.8.2 Materials

(a) Steel

Steel for traffic signs shall comply with the following:
Hot finished seamless tubes: BS 6323: Part 3
Hot rolled sections: BS 4: Part 1
Hot rolled structural steel sections
equal and unequal angles : BS 4848: Part 4
Weldable structural steels: BS 4360

(b) Stainless steel

Stainless steel for traffic signs shall be Grade 1.4401 and shall comply with the following:
Technical delivery conditions for sheet/plate and strip of corrosion resisting steels for general purposes: BS EN 10088-2 Amd 3/2010
Stainless steel tubes suitable for threading in accordance with BS 21: BS 6362

(c) Aluminium alloy

(1). Aluminium alloy for traffic signs shall be EN AW-6082 in the T6, T651 or T62 tempers and shall comply with the following table:

Wrought aluminium and aluminium alloys for general engineering purpose
Standards

- Plate, sheet and strip
  BS EN 485: Part 1: 1994, BS EN 485: Part 2: 2004, BS EN 485 Part 3: 2003 and BSEN 485: Part 4: 1994
- - Drawn tube
  BS EN 754: Part 1: 1997, BS EN 754: Part 2: 1997, BS EN 754: Part 3: 1996, BS EN 754: Part 4:1996, BS EN 754: Part 5: 1996, BS EN 754: Part 6: 1996, BS EN 754: Part 7: 1998 and BS EN 754: Part 8: 1998
- - Bars, extruded round tubes and sections
  BS EN 755: Part 1: 1997, BS EN 755: Part 2: 1997, BS EN 755: Part 3: 1996, BS EN 755: Part 4: 1996, BS EN 755: Part 5:1996, BS EN 755: Part 6:1996, BS EN 755: Part 7: 1998, BS EN 755: Part 8: 1998 and BS EN 755: Part 9: 2001

(2). Aluminium alloy shall be anodized to Grade AA 25 in accordance with BS EN 12373: Part 1: 2001.
(3). Aluminium alloy sheet shall be free of twisting, warping and buckling and the surfaces shall be free of blemishes and other defects.

(d) Bolts, nuts, screws, washers and rivets

(1). Bolts, nuts, screws, washers and rivets for traffic signs shall comply with the following:
ISO metric black hexagon bolts, screws and nuts: BS 4190 ISO metric black cup and countersunk head bolts and screws with hexagon nuts : BS 4933 Metal washers for general engineering purposes : BS 4320
Rivets for general engineering purposes: BS 4620
Wrought aluminium and aluminium alloys for general engineering purposes
- rivet, bolt and screw stock : BS 1473
Mechanical properties of corrosion-resistant stainless-steel fasteners.
Bolts, screws and studs : BS EN ISO 3506-1
Mechanical properties of corrosion-resistant stainless steel fasteners. Nuts : BS EN ISO 3506-2 Amd 3/2010
(2). The length of bolts shall be such that after assembly the threaded portion of each bolt projects through the nut by at least one thread and by not more than four threads.
(3). Rag and indented bolts shall comply with BS 1494: Part 2.
Expansion bolts and resin bonded bolts shall be of a proprietary type approved by the Engineer and shall be capable of withstanding the design working load.
(4). Galvanised bolts, nuts, screws, washers and rivets shall be used with traffic signs secured to galvanised pedestrian guard-railing. Aluminium materials shall be insulated from ferrous materials by a non-conductive insulator at least 2 mm thick of a type approved by the Engineer.

(e) Materials for faces of traffic signs

(1). Retro reflective sheeting shall be Class Ref 1 or Class Ref 2 material complying with BS EN 12899: Part 1: 2001, Tables 8 and 9 or Type IX material complying with ASTM D4956-05.
(2). Non-retro reflective sheeting shall comply with BS EN 12899: Part 1: 2001.
(3). Plastic sheeting shall be of a proprietary type approved by the Engineer.
(4). All materials and finishes shall be mutually compatible.

2.1.26.8.3 Fabrication of traffic signs

(a) Posts for traffic signs

(1). Posts for beacons at zebra crossings shall be painted with alternate black and white stripes. Other posts shall be painted grey in accordance with BS 5252F, Code 18B19 or shall be galvanized in accordance with BS EN ISO 1461:1999.

(2). Galvanized areas affected by cutting and drilling shall be treated using a method approved by the Engineer.
(3). Posts other than posts supporting an external luminaire shall not protrude above the top of signs. The length of posts supporting external luminaries protruding above the top of signs shall be as short as practicable.

(b) Backing plates for traffic signs

(1). Backing plates for traffic signs shall be fabricated from 3 mm aluminium sheet. Backing plates for traffic signs not exceeding 1200 mm high x 2400 mm wide shall be fabricated from a single sheet. If more than one sheet is used, the number of sheets shall be kept to a minimum. The separate sheets shall be rectangular and shall be approximately the same size.
(2). Holes in backing plates shall be drilled before the plate is painted and before retro reflective or non-retro reflective sheeting is applied.

(c) Spill screens for traffic signs

(1). Top and bottom light spill screens shall be fabricated from the same material as the backing plate. The spill screens shall extend for the complete width of the backing plate and the corners shall be cut to the same radius as the corners of the backing plate.
(2). Spill screens shall be considered as part of the backing plate and stiffeners and mountings shall be designed to accommodate the combined size.

(d) Faces for traffic signs

(1). Faces for traffic signs shall be formed using retro reflective or non-retro reflective plastic sheeting. Unless otherwise permitted by the Engineer, a single piece of sheeting shall be used. If more than one sheet is used, the number of sheets shall be kept to a minimum. Sheeting shall be fixed in accordance with the manufacturer's recommendations.
(2). Materials for faces of traffic signs, including the background, letters, characters, numerals, symbols and borders, shall be matched for colour in accordance with the sheeting manufacturer's recommendations at the time of fabrication to provide a uniform appearance by day and by night.
(3). Letters, characters, numerals, symbols and borders shall be clear cut and sharp-edged and shall have no cracks.
(4). Sheeting material, including letters, characters, numerals, symbols and borders shall be fully fixed using adhesive. There shall be no air bubbles, creases, cracks or other blemishes.
(5). The back of traffic sign shall be marked with the manufacturer's name and manufacturing date in month/year as shown in the following manner:
- Manufacturer's name
- Month/year

The marking shall either be printed on non-retro reflective self-adhesive material in accordance with BS EN 12899: Part 1: 2001 or stamped by a punch without damaging the front face of traffic sign or other method approved by the Engineer. The letter size shall not be smaller than 12 mm (h) x 8 mm (w).
(6). For each colour of externally illuminated and trans-illuminated signs, the uniformity of luminance, determined by the ratio of the lowest to the highest level measured at any part of the sign, shall be as shown in the following and in accordance with BS EN 12899: Part 1: 2001, Table 12. Illuminated face area Uniformity of luminance
≤ 1.5 m2 U2
> 1.5 m2 U1

(e) Lacquer coatings

Lacquer coatings to faces for traffic signs shall be uniform and continuous and shall be applied at the time of manufacture of the face.

(f) Painting to faces for traffic signs

(1) Faces of traffic signs to which a painted or stoved finish is to be applied shall be thoroughly cleaned and pre-treated before painting and stoving.
(2) Pre-treatment shall be by anodising or by using an etching primer or by a process approved by the Engineer.
(3) At least one undercoat and at least one finishing coat of paint shall be applied and stoved to a thickness of between 0.0315 mm and 0.0375 mm of enamel over a minimum thickness of 0.025 mm of primer. If light colours are to be applied over dark colours, at least two coats of the light colour shall be applied. The final surface shall have a uniform thickness and an egg-shell flat finish and shall be smooth and free of defects.
(4) The colour of the finished coating shall be uniform. The colours, including white, shall comply with the chromaticity and luminance factors of BS EN 12899: Part 1: 2001, Tables 3 and 5 and, for comparative purposes, shall comply with the following gloss paint colours in accordance with BS 381C: 1996:
- Red : No. 537 – signal red,
- Orange : No. 557 – light orange
- Yellow : No. 355 – lemon yellow,
- Blue: No. 109 – middle blue
- Green: No. 225 – light brunswick green

(5) Parts of faces coloured black shall be non-retroreflective and shall have a luminance factor not exceeding 0.03 as specified in accordance with BS EN 12899: Part 1: 2001.
(6) The Volatile Organic Compound (VOC) content of all paint applied on surfaces of traffic signs shall comply with the VOC limits stipulated in the Air Pollution Control (Volatile Organic Compounds) Regulation. Amd 1/2007

2.1.26.8.4 Submissions

(a) Particulars of traffic signs

(1) The following particulars of the proposed traffic signs shall be submitted to the Engineer:
(a) Name of manufacturer, and
(b) Details of materials and finishes to be used in the manufacture of the signs.
(2) The particulars shall be submitted to the Engineer at least 14 days before fabrication of traffic signs starts.

2.1.26.8.5 Storage of materials

(b) Storage of traffic signs

(1). Traffic signs shall be stored in a dry, weatherproof store. Traffic signs that are stored together shall be separated by slip-sheets.
(2). Traffic signs shall be stored in a manner that will not result in damage or deformation to the signs.

2.1.26.8.6 Construction and assembly of traffic signs

(a) Construction and assembly of traffic signs

(1). Fittings for traffic signs shall be non-corrodible material approved by the Engineer.
(2). Joints for framework and stiffeners that are not an integral part of the backing plate shall be welded or joined using brackets, nuts, bolts and washers.
(3). Materials for rivets and other fixings for joining backing plates to framework and stiffeners shall be compatible with the materials to be joined. The spacing of rivets and other fixings shall be uniform. The spacing shall not exceed 150 mm around the outside edge of sheets and shall not exceed 300 mm on cross braces.

(4). An additional washer of neoprene, nylon or other material approved by the Engineer shall be used to protect the faces of traffic signs from metal nuts, bolts, washers and screws.
(5). Backing plates shall be connected to posts by a method approved by the Engineer. Banding systems shall be stainless steel. Drilling of holes in ferrous components shall be completed before finishes are applied.
(6). A lacquer coating shall be applied to the edges of holes drilled in plates with plastic sheeting immediately before rivets and bolts are inserted. The surfaces of rivets and bolts on the faces of traffic signs shall be covered with a material coloured to match the part of the face with which it is in contact.
(7). Fixings for traffic signs erected on road lighting columns shall be compatible with the column cross-section. Columns shall not be drilled.
(8). When backing plates are stiffened with additional reinforcing members, these members shall be fixed to the backing plates in compliance with Class P2 in Table 1 of BS EN 12899: Part 1: 2001.
(9). Protection to sign edges shall be Class E1 in compliance with BS EN 12899: Part 1: 2001, Table 2.

(b) Covering of traffic signs

(1). Traffic signs which are to be blanked out shall be covered by the following methods:
(a) Plate signs shall be covered using a 1.5 mm thick sheet that is compatible with the material in the sign.
(b) Plate signs that are to be blanked out for a period not exceeding one year may alternatively be covered using a self-adhesive plastic film.
(c) Other signs shall be covered using a loose cover sheet of material approved by the Engineer.
(3) Cover sheets shall be fixed using 5 mm diameter stainless steel bolts, washers and nuts or non-ferrous rivets at spacing not exceeding 600 mm. Bolts shall pass through 5 mm x 12 mm diameter plastic distance pieces between the face of the sign and the cover plate. Holes that remain on the finished face of the sign shall be filled using blocked rivets. The face of the rivets shall be coloured by a method approved by the Engineer.
(4) Self-adhesive plastic film shall be compatible with the material in the face of the sign and shall be fixed and removed in accordance with the manufacturer's recommendations.
(5) Loose covers shall be securely fastened to the back of the sign. Tape or other adhesive material shall not be applied to the faces of signs.
(6) Coverings to traffic signs shall be sufficiently opaque to prevent reflection from the covered sign and shall not be removed until the Engineer so instructs.
(7) Unless otherwise permitted by the Engineer, the faces of traffic signs which have been erected and which do not relate either wholly or in part to the traffic situation which applies at that time shall be blanked out as stated in this Clause.

2.1.26.8.7 Testing: traffic signs

(a) Testing:

(1). The number of traffic signs to be tested shall be as stated in the Contract or as instructed by the Engineer.
(2). The number and type of tests to be carried out on the traffic signs shall be as stated in the Contract as instructed by the Engineer.
(3). Testing shall be carried out in such a manner that the traffic sign will not be damaged.
(4). Testing shall be carried out by the Contractor at a laboratory approved by the Engineer.

(b) Compliance criteria:

The compliance criteria for testing traffic signs shall be in accordance with BS 873: Part 1: 1983.

GENERAL ELECTRICAL SPECIFICATIONS

1 GENERAL ELECTRICAL SPECIFICATIONS

1.1 INTRODUCTION

This section specifies the general requirement for plant, equipment and materials forming part of the Contract Works and shall apply except where specifically stated elsewhere in the Specification or on Contract Drawings.

1.2 GENERAL GUIDING REGULATIONS AND STANDARDS

The Contract Works shall comply with the current editions of the following: -

1) Electric Power Act and the Rules made there under
2) The Electricity Supply Authority Byelaws.
3) Regulations for the Electrical Equipment of Buildings issued by the Institution of Electrical Engineers of Britain (I.E.T.) with Kenya amendment.
4) The United Kingdom Chartered Institute of Building Services Engineers (CIBSE) Guide 'K' on electricity in Buildings.
5) The Factories Act for the Kenya Government.
6) Kenya Bureau of Standards (KEBS) standard specifications and code of practice, or other equal and approved standard specifications and codes.
7) The Local Authority Bylaws
8) The Employers Safety Regulations.
9) General Electrical Specifications

1.3 QUALITY OF MATERIALS

The quality of materials required for completion of the electrical installation works shall be as detailed in this specification and contract drawings unless otherwise instructed. All materials shall be new and of best quality and approved origin.

1.4 TYPE OF INSTALLATION-WIRING SYSTEMS

Electrical installation shall be carried in either one of the following wiring systems;

System A – PVC Insulated and Sheathed Cables Clipped to the Surface of the Walls and Roof Members or to the Ceilings.

The installation shall be carried out in an approved type twin or three core PVC insulated and sheathed cables, the conductors of which shall be of copper. Cables shall be securely fixed to the surface of the walls and in the roof spaces, or fixed to the underside of the ceilings when there is no reasonable access above the ceiling. Non-corrodible saddles or buckle clips and nails shall be used for fixing and at intervals not exceeding 225mm. Where cables pass through holes they shall be bushed. Wooden bits or plastic bits shall be used as plugs in walls for firmly fixing the saddles or buckle clips on walls or other surfaces.

Under no circumstances will joints of conductors be permitted in the run of a wiring cable. Cables shall be connected together only by looping into the terminals of switches, ceiling rose junction boxes or other accessories or by approved connectors installed in suitable junction boxes. Under no circumstances will taped joints be permitted.

In all cases the cable sheathing shall be carried into the switch, ceiling rose, junction box or other accessories.

Surface installed cables shall not be installed within 300mm of a metal roof, unless clipped to the lower side of wooden member of the roof or otherwise protected from radiant heat.

System B- PVC Insulated and Sheathed Cables Clipped to Roof Members and Run in Metal or Plastic Conduits Drops Concealed in Walls

The wiring shall be carried out as system A except that cables shall be enclosed in either steel or plastic conduit where drops are required to switches, distribution board, socket outlets or other accessories.

System C – Cables in Steel Screwed Conduit or Trunking Fixed To The Surfaces Of Walls And Ceilings

The wiring shall be carried out in an approved type of single core, plastic insulated cable enclosed in steel screwed conduit or trunking, mechanically and electrically continuous throughout.

Conduit and trunking shall be run on the surface of the walls and ceilings, or in false ceiling spaces. Conduit shall be secured in position by means of steel galvanized spacer bar saddles, and counter sunk brass screws. Conduit shall run horizontally on the walls or vertically to switches or outlets.

System D – Cables Enclosed In Concealed Steel Screwed Conduit Or Trunking

The wiring shall be carried out in approved type of single core, plastic insulated cable, enclosed in steel screwed conduit or trunking mechanically and electrically continuous throughout.

Conduit shall be buried in the wall and floors of the building and either run in roof space or buried in structural slabs.

System E – PVC Insulated Cables With or Without Earth Continuity Conductor Enclosed In Concealed Non-Metallic Conduit or Trunking.

Wiring shall be carried out in an approved type single core, plastic insulated cable with copper conductor with or without earth continuity conductor enclosed in high impact, heavy gauge, non-metallic conduit or trunking of PVC material or equivalent.

Conduit shall be buried in the walls and floors of building, and either run in roof space or buried in structural slabs.

System F – PVC Insulated Cable With or Without Earth Continuity Conductor Enclosed In Non-Metallic Conduit or Trunking Fixed To the Surfaces of Walls and Ceilings

Wiring shall be carried out in an approved type single core plastic insulated cable with or without earth continuity conductor enclosed in high impact, heavy gauge, non-metallic conduit or trunking.

Conduit shall be installed in similar way as system C.

System G- Mineral Insulated Copper Sheathed Cables

The wiring shall be carried out in single core or multi-core mineral insulated copper sheathed cable run on the surfaces of walls and ceilings, in the roof space or concealed in walls and floors.

System H – PVC Insulated Single Wired Armoured and PVC Sheathed (PVC/SWA/PVC), Cable Laid In Ducts, Trenches and Saddles to Walls

Cables shall either be suspended on purpose made frame and hangers, saddled on walls and roof members, drawn through ducts or laid in trenches. Cables suspended on multiple hangers shall be so arranged that one cable can be removed without disturbing the others. Frames, and hangers shall be galvanized or of non-corrosive material and shall not be fixed in contact with other metals with which they are liable to set up electrolytic action. All spacing of cable hangers and support shall not exceed those laid down for the relevant size and type of cable in the current edition of the I.E.E. Regulations or Kenya Bureau of Standard Wiring Regulations.

1.5 CONDUITS AND TRUNKING

3.5.1 PVC Conduits, Trunking and Associated Fittings

For the purposes of these specifications, all non-metallic conduits shall be of high impact quality rigid PVC conforming to B.S 4607 or KS04-179: 1988 and IEE regulations and all conduit fittings and accessories shall be of the same quality.

Conduit outlet and switchboxes shall be able to receive an Earthing terminal and shall have threaded brass inserts for cover fixings

Solid elbows and tees shall not be permitted without the written approval of the Engineer. No conduit smaller than 20mm (nominal) diameters shall be allowed.

Trunking where required should be of high impact quality rigid PVC of an approved type.

3.5.1.1 **Installation of PVC Conduits**

(i) **Conduit shall be installed** buried in plaster works and floor screed except when run on wooden or metal surface, when they will be installed surface supported with saddles every 600mm. Conduits shall be laid at a time during the building construction as may be approved by the Engineer.

(ii) **Conduits run in chase** shall be firmly held in position by means of mild steel pipe hooks to avoid displacement when plastering. It shall be at least 10mm below plaster level. In poured reinforced concrete floors and roof slabs, the conduit shall first be laid before the concrete is cast in situ. It shall be securely fixed in position to prevent displacement during the pouring process and shall be sealed against the ingress of water and cement during in mechanical vibration.

(iii) **The conduit system when installed** and before wiring, shall be kept plugged with well-fitting plugs and when short conduit pieces are used as plugs, they shall be doubled over and tied firmly together with steel wire. Only after the conduit system has been completely cleansed of bungs, burrs and building debris, shall wiring be carried out.

(iv) **Conduits connection** shall either be by a demountable (screwed up) assembly or adhesive fixed and water tight by solution. The conduit and fittings must be clean and free of all grease before applying the adhesive. When connections are made between the conduit and switch boxes circular or non-screwed boxes, care shall be taken that no rough edges of conduit stick out into the boxes. The conduits shall be fixed to the outlet boxes either by gluing the plain end into the marbled spigot of the outlet box or by using a proprietary adaptor (half threaded couplers) and fixing it to thin walled outlet boxes by means of screwed bushes.

(v) **Conduits and trunking** shall be mechanically continuous and water tight from the point of entry into the building to the final conduit outlet boxes and such joints as are required in the conduit shall be made with plain conduit couplers glued in position. Care should be taken to ensure all joints are made watertight by using appropriate adhesive.

(vi) **Conduits shall be bent and formed** in strict conformity with the manufacturer's instructions. Sizes up to 25mm diameter may be bent cold with the use of appropriate sized bending spring. Larger conduits are to be preheated before inserting the rubber cord to prevent kinking. Conduits badly formed or bent or damaged in any way shall not be used and in all cases the inner radius of the bend shall not be less than 2.5 times the diameter of the conduit. Runs between draw in boxes are not to have more than two right angle bends or their equivalent without the approval of the Engineer. The sub-contractor may be required to demonstrate to the Engineer that wiring in any particular run is easily withdrawable and sub-contractor may, at no extra cost to the contract; be required to install additional draw-in-boxes where required. If conduit installed in straight runs is in excess of 6000mm, expansion couplings as manufactured by Egaweld or equivalent shall be used at intervals of 6000mm.

(vii) **Draw-in-boxes** shall be kept to minimum and where they occur of necessity within the floor area, the Engineer shall approve the type in writing.

(viii) **Conduit fittings** of the inspection type shall be so located that they remain readily accessible upon final completion of the building.

(ix) **Where the conduit loop-in-system is employed**, back outlet boxes shall be used and conduits shall normally be laid in the floor screed on the upper side of the slab. Draw in wires shall not be permitted where the loop-in-system is employed and cables will need to be drawn into conduits with a draw-in-steel tape.

(x) **All spare ways in junction boxes** etc. left for possible future extension shall be fitted with stopping plugs. Where conduits runs are to be concealed in pillars and beams the approval of the Structural Engineer shall be obtained. The electrical contractor shall be responsible for determining the accurate position of all holes, chases etc. on site or if the Engineer so directs shall provide the building contractor with dimensional drawings to enable him to mark out and form all holes and chases. Should the electrical contractor fail to inform the building contractor of any inaccuracies in this respect they shall be rectified at the electrical contractor's expense.

(xi) **It will be the contractor's responsibility** to ascertain from site, the details of reinforced concrete or structural steelwork and check from the builder's drawings and positions of walls, structural concrete and finishes. No reinforced concrete or steelwork may be drilled without first obtaining the written permission of the Structural Engineer.

(xii) The drawings provided with these specifications indicated the appropriate position only of points and switches, but it shall be the electrical contractor's responsibility to mark out and centre on site the accurate position of points and switches where necessary in consultation with the Architect and the Engineer.

(xiii) Where it is necessary to feed surface mounted equipment the concealed conduit shall first be terminated in a concealed conduit box.

1.5.1.2 PVC Conduit Boxes and Accessories

(i) All conduit outlets and accessories of non-metallic material including couplers, ordinary clips, saddles, pipe hooks, reducers, stopping plugs, locknuts and male and female bushes shall be manufactured dimensionally to B.S. 31/1940 BS 4607 part 1, 1970 or to KS 04-179 1979 Part 1.

(ii) Solid tees shall not be used while solid inspection elbows or bends or inspection tees shall be used only in exceptional circumstances and then only with the Engineer's approval. Small circular pattern boxes are to be used with conduits up to and including 25mm outside diameter. Rectangular pattern adaptable boxes are to be used for conduits of 32mm outside diameter and larger. For drawing in of cables in exposed runs of conduits, standard pattern through boxes shall be used.

(iii) Boxes shall be not less than 32mm deep and of such dimensions as will enable the largest appropriate number of cables for the conduit sizes to be drawn in without excessive bending.

(iv) Boxes will not be permitted in floors unless approved. Boxes cast-in situ must face downwards from the ceiling/ floor section.

(v) The circular boxes or equipment loop-in boxes shall be provided and securely fixed for all ceiling points. When the conduit is run on the surface, all circular boxes for ceiling points shall be fixed with screws.

(vi) Where ceiling boxes occur and the ceiling box is recessed below the finished level of the ceiling, suitable extension rings to accommodate the ceiling box must be provided.

(vii) Where ceiling boxes including extension rings are flush with the ceiling surface, break joint rings (biscuit rings) shall be provided to hide the joints.

(viii) In all the cases one ceiling box shall allowed per fitting except where fluorescent fittings are specified when two such boxes per fittings are desirable. When two such boxes per fitting are installed they shall be flush with ceiling and if necessary fitted with break joint rings or dome covers.

(ix) Where a non-metallic outlet box of thermoplastic material is used for the suspension of a lighting fitting care shall be taken to ensure that the temperature of the box does not exceed $60^{o}C$. The weight suspended from the box shall not exceed 3kg. Where it is intended to fix enclosed lighting fitting directly to a box or to suspend a fitting of weight in excess of 3kg, separate steel insert clips shall be used.

(x) All boxes intended for switches, socket outlets, lighting fittings or other outlets shall be fitted with brass ferrules to accommodate the fixing of screws. Ends of lengths of conduit shall be reamed and where they terminate at boxes, trunking and accessories not fitted with sprout entries shall be bushed to prevent damage to cables.

(xi) All draw boxes and inspection boxes shall be covered with appropriate box covers with screws of non-corrosive type.

1.5.1.3 Adaptable Boxes

Adaptable boxes shall be of PVC or mild steel (of not less than 12 SWG) and to be of black enamelled or steel galvanised finish according to location. They shall be square or oblong shape complete with lids secured by four 2BA brass rounded screws. No adaptable box shall be less than 75mm x 75mm x 50mm or larger than 300mm x 300mm x 75mm and shall be adequate in depth in relation to the size of conduit entering it. Conduits shall only enter boxes by means of couplers and bushes.

1.5.2 Steel Conduits and Steel Trucking

a) Where metal conduits and fittings are to be used they shall be of heavy gauge annealed mild steel Class "B" welded or solid drawn to standard specification KS-04-180: 1985 or BS 1387. In

no case will conduit smaller than 20mm diameter is to be used on the works. Conduits installed within buildings shall be black enamelled finish except where specified otherwise. Where installed externally or in damp conditions they shall be galvanized. Conduit fittings, accessories or equipment used in conjunction with galvanized conduits shall also be galvanized.

b) Metal conduit systems shall be electrically continuous and earthed in accordance to IEE regulations section D. All joints shall be made mechanically and electrically continuous by screwing to steel socket or by substantial mechanically clamps and ensuring the threaded joints do not corrode by applying a coat of paint of aluminium or iron oxide. Cables installed in steel conduits shall always be so bunched that the cables of all phases and the neutral conductor (if any) are contained in the same conduit.

c) Where vertical sections of steel conduit used exceed 5m in length staggered bends with draw-in boxes shall be provided at 5m interval to support the weight of the cables.

d) Metal trunking shall be fabricated from mild steel of not less than 18SWG. All sections of trunking shall be rigidly fixed together and attached to the framework of fabric of the building at intervals of not less than 1.2. Jointed trunking shall not have overhang-fixing points of more than 0.5m.

e) All metal trunking shall be made electrically continuous by means of 25x3mm copper links across each joint and where the joints are galvanised the links shall be made by galvanised flat iron strips.

f) All trunking fittings (i.e. bends, tees, etc.) shall leave the main trunking completely clear of obstructions, be continuously open except through walls and floors at which points suitable fire resisting barriers shall be provided as may be necessary. The inner edge of bends and tees shall be chamfered where cables large than $35mm^2$ are employed.

g) Where trunking passes through ceilings and walls it shall be properly secured and the cover solidly fixed. Screws and bolts securing covers to trunking or section of covers together shall be so arranged that damage to cables cannot occur either when fixing covers or when installing cables in the trough.

h) Where trunking is used to connect switchgear of fuseboards, such connections shall be made by trunking fittings manufactured for this purpose and not by multiple conduit couplings.

i) Where the wiring system incorporates galvanized conduit the trunking system shall also be galvanized and where the conduit system shall be painted, the trunking systems shall also be painted.

j) The number of cables to be installed in trunking shall be such as to permit easy drawing in without damage to the cables and shall in no circumstances be such that a space factor of 45% is exceeded. All cables shall be drawn or laid in trunking trough in parallel and untwisted.

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k) Where conduits terminate in fuse gear, distribution boards, adaptable boxes, non-sprouted switch boxes etc. they shall, unless otherwise stated, be by means of a socket and bare male brass bushes, compression washers or couplers and male brass bushes. All exposed threads and abrasions shall be painted using an oil paint for black enamelled tubing, aluminium paint or other approved corrosive resistant paints.

l) All bends and sets shall be made cold without altering the section of the conduit by means of approved pipe bending machine. The inner radius of the bend shall not be less than four (4) times the outside diameter of the conduit. Not more than two right angle bends will be permitted in a conduit run without draw-in box. No tee, elbows, sleeves either of inspection or solid type will be permitted as part of conduit installation. Where straight runs of conduit are installed, draw-in-boxes shall be provided at distances not exceeding 5metres.

m) Conduit shall be swabbed out prior to drawing in cables and they shall be laid so as to drain of all condensed moisture without injury to end connections.

n) All boxes shall conform to KS04-668: 1986, be malleable iron and black enamelled or galvanized according to the type of conduit specified. All conduit boxes shall have threaded brass inserts. Box covers where required shall be of heavy guage metal, secured by means of zinc plated or cadmium plated steel screws.

o) Boxes used on surface installation works shall be tapped or drilled to line up with the conduit fixed with spacer type saddles, allowing clearance between conduit and wall, without the need for setting the conduit.

p) Where used in conjunction with mineral insulated copper sheathed cable, galvanizes boxes shall be used and painted after erection.

q) Draw-in-boxes in the floors are generally to be avoided but where they are essential they must be grouped in positions approved by the Engineer and covered by a suitable floor traps, with non-ferrous trays and covers. The covers are to be recessed and fitted in with a material to match the floor surface.

r) Where buried in the ground outside the building the whole of the buried conduit is to be painted with two coats of approved bitumastic composition paint before covering up. Where run on the surface, unpainted fittings and joints shall be painted with two coats of oil bound enamel applied to dust and grease free metalwork.

s) Non-inspection bends shall only be used in special circumstances such as behind a lighting fitting or outer box.

t) When drawing cables into the conduit care must be taken to ensure that they are drawn in parallel throughout the conduit run with no cables twisted round each other.

u) Steel conduits must not be in contact with water pipes, gas pipes or alarm circuits, radio or telephone circuits or other metal works, and where this is unavoidable the conduits shall be bonded to the metalwork of this circuits. All conduits unless installed to be gas-tight must be self-ventilating and provided with means of drawing condensed moistures. Where conduit passes through a wall, ceiling or floor the hole must be made good to full thickness of the material of which the wall or partitions are build.

v) A square adaptable box shall be used where a number of conduits running together change direction. Proper mechanically and electrical continuity must be maintained when using such boxes.

w) Where extra low voltage cables such as telephone services, radio services alarm circuits, run in the same direction with low voltage cables for lighting or for power each category of the cables shall be segregated and run in different compartments or channel of the trunking.

1.5.3 Cable Ducts

The electrical contractor shall provide and lay pitch fibre or concrete cement ducts under roadways, concrete walkways etc., through which cables are to be routed. Where called upon the electrical contractor shall haunch or place concrete around the ducts to protect the ducts.

ii) The building contractor will supply and install ducts where required in footings of buildings but it will be the electrical contractor's responsibility to provide accurate details to the building

contractor of the required positions of these ducts and to ascertain that they are laid to the correct falls.

iii) After the installation of cable all ducts shall be adequately sealed to restrict the ingress of moisture. The number of cables to be installed in ducts shall be specified in the contract drawings but where not specified they shall be such as to permit easy drawing-in without damage to the cables and a space factor of 35% will not be exceeded.

1.5.4 Capacities of Non-Metallic and Steel Conduits

The cable shall be run in the conduits so as not to exceed the capacities as set in latest edition of IEE Regulations. For groups of cables, the numbers and sizes of cables installed shall be such that a space factor of 40% is not exceeded.

Conduits of sizes less than 19mm shall not be used without the written authority of the Engineer.

1.6 CABLES AND ASSOCIATED WORKS

3.6.1 PVC/XLPE Insulated Cables and Flexible Codes

All cables used in this contract shall be manufactured in accordance with the current appropriate Kenya Standard Specifications and British Standard. The standards are: -

- PVC insulated cables and Flexible Cords Ks 04-192:1988 or BS 6004
- PVC insulated Armoured Cables KS 04-194: 1990 or BS 6346
- Armouring of electrical cables KS 04-290: 1987

The electrical contractor will be required to submit samples of cables for the Engineer's approval; the Engineer reserves the right to take the samples to Kenya Bureau of Standard for testing at contractor's expense. If the supplied cables fail to meet the required standard the Engineer reserves the right to call for installation of cables of an alternative manufacture without any extra cost being incurred.

PVC installed cables shall be 100/1000 volt grade. No cable smaller than 1.5mm2 shall be used unless otherwise specified. The colour of cables shall conform to the details stated in the "cable markers and installation colours" Clause 1.14

3.6.2 Installation of Cables

(i) In wiring system where cables will be drawn in conduit, it is only after the conduit system has been completely installed, cleansed of bungs, burrs and building debris and moisture free, shall the cables be drawn into conduits.

(ii) The type of insulation protective cover, if any, shall be selected so as to allow compliance and precautions be taken against Mechanical damage, damage by heat, damage by fire or explosion, damage by dampness or corrosive atmosphere and electrical leakage.

(iii) For these general specifications unless otherwise specified all cables shall be of copper conductors and PVC insulated. All final sub-circuit cables shall be copper conductors with PVC insulation. Conductors for main and sub-mains distribution shall however be either copper or aluminium and PVC insulation as shown in the contract drawings.

(iv) Cable sizes shall be those specified in the contract drawings and Bills of Quantities but the lowest size of cable shall not be less than 1.5mm^2.

(v) All cables shall be suitable for operation at system voltage and be able to withstand currents equivalent to those specified for the current protective devices.

(vi) All cables connected in parallel circuit shall be of the same size and length to ensure proper division of the current.

(vii) Special care shall be exercised when terminating aluminium conductors. Such conductors shall not be placed in contact with terminal of brass or other metal having high copper content unless the terminal is suitably constructed to prevent electrolytic corrosion.

(viii) Conductors terminated in a pillar type terminal shall be mechanically swaged and fitted with a phosphor bronze sleeve whilst those to be terminated with lugs shall have these lugs fitted to them with a purpose made compression tool.

(ix) Cables shall be drawn into conduits by means of draw steel tape unless otherwise specified. However where there are numerous inspection boxes, it may not be necessary to employ draw wires or tapes. Where draw wires are to be used to draw cables into conduits, they shall be inserted during the erection of the conduit.

(x) All cables drawn must not twist round each other but must be parallel throughout the run. Care should be taken to ensure cable insulation is not mechanically damaged when drawing the cables. Cables whose insulation has been damaged in any part of the length shall not be taped or shrouded but the whole length shall be replaced in full. No cable joints shall be permitted along the length of the conduit but joints shall only be made at terminal boxes.

(xi) For these general specifications, wiring shall be carried out on the looping-in principal. All joints shall be made at the terminals of the main switches, distribution boards, ceiling roses, switches, sockets outlets and fixed apparatus only. No joint shall be permitted in inspection boxes, but jointing of cables shall be permitted at terminal boxes. No joints shall be made in any other boxes unless approved and no joints shall be drawn into conduit.

3.6.3 **Armoured PVC/XLPE Insulated and Sheathed Cables**

(i) Unless otherwise stated, armoured cables shall be of copper conductors of PVC SWA PVC type having a rating of 600/1000 volts and manufactured to KS 04-194: 1988 and KS 04-187/1988 with an overall extruded PVC insulation covering.

(ii) The Steel Wire Armour (SWA) of the cable shall be used wholly as an earth continuity conductor and the resistance of the wire armour shall not be more than twice of the largest current carrying conductor of the cable.

(iii) PVC/SWA/PVC cables shall be terminated using approved glands and a PVC tapered sleeve shall be provided to shroud each gland.

(iv) Where cables rise from floor level to switch gears etc. they shall be protected by PVC conduit to a height of 600mm from finished floor level, whether the cable is run on the surface or recessed into the wall.

(v) Where PVC/SWA/PVC cables are outside the building they shall be laid underground 750mm deep with protecting concrete interlocking cover tiles. The concrete tiles shall be 300mm by 150mm and with a minimum thickness of 25mm and of concrete mix of 1:2:4. The tiles shall be labelled 'HATARI'. The cables shall be laid on 50mm of sifted soil then covered with 50mm of sifted soil and interlocking tiles. The trench shall be carefully backfilled. As a caution cables

shall be snaked along their route to allow for ground subsidence or settlement and a 2% allowance shall be given on the measured route length before backfilling.

(vi) The electrical contractor will carry out all necessary excavations and reinstatement of ground. The cover tiles shall be continuous and without gaps between.

(vii) Where armoured cable is specified on the contract drawings, the electrical contractor shall ensure continuity of the armouring and it's cross bonding to other metal work and services.

(viii) All PVC/SWA/PVC cables run inside the building shall be fixed in rising ducts or on ceilings by means of die cast cables hooks or clamps, of appropriate size to suit cables, fixed by studs and back nuts to their channel sections support. The channel sections shall be fixed at an interval of 1500mm by means of rawlbolts for concrete ceiling, or wall and appropriate screws for wooden ceiling.

(ix) Where the cables are to be suspended from the concrete ceiling or wall, fixing shall be by BICC claw type cleating system with die-cast cleats and galvanised mild steel back straps or similar approved equal method. For one or two cables run together the cleats shall be fixed on a special channel section supports or backstraps which shall in turn be secured to walls or ceilings of ducts by rawlbolts.

(x) In excessively damp or corrosive atmospheric conditions special finishes may be required and the electrical contractor shall apply to the Engineer for further instructions before ordering cleats and channels for such areas. The above type of hooks and clamps and channels or cleats and back straps shall also be used for securing cables in vertical ducts.

(xi) Precaution should be taken when handling PVC insulated and / or sheathed cables during period of low temperatures to avoid mechanical damage as PVC insulation cracks due to very low temperatures.

(xii) Armoured cables, which might otherwise come into contact with fixed metal works, shall either be segregated or effectively bonded to prevent appreciable voltage difference at such possible points of contact.

(xiii) Where cable pass under roadways, ducts as specified on the contract drawings shall be provided. Cable route markers shall be provided to indicate the route of the underground cable as specified in the contract drawings or as required by the Engineer. After installation of armoured cables, they shall be tested in accordance with GES No. 2 and the result recorded.

(xiv) Single core steel armoured cables **shall not** be installed in cases where the current is alternating current. (NB: if copper cable is used then the armour should be aluminium otherwise use multicore cable for magnetic fields to cancel out)

3.6.4 **Flexible Codes**

i) Circular sheathed white twin TRS flex to BS: 6500:1989 shall be used for plain pendant fittings up to 100watts. For all other types of lighting fittings, the flexible cords shall be silicone rubber insulated. No polythene insulated flexible cord/cable shall be used in any lighting fittings or other appliance.

ii) The type of insulation of the flexible cord shall be such as to minimize risk of damage from high temperature, damp, corrosive situation and mechanical damages. Where flexible cords and cables are likely to be damaged by heat, heat resisting flexible cords shall be used, alternatively conductors shall be sleeved with heat resistant sleeves.

iii) The contractor shall ensure that exposed unsheathed flexible cables of the flexible cords shall be as a short as possible where unavoidable.

iv) Care shall be taken to ensure flexible cord does not support lighting fitting exceeding 3kg. The flexible cord size and rating shall be as described in the Bills of Quantities or contract drawing. Where the cord is not rated it shall be assumed to be capable of carrying 12Amps. Minimum size of flexible cable to be not less than 1.5mm^2.

v) The colour code for the flexible cord shall be brown for live, Blue for neutral or negative and Green and Yellow for earth

3.6.5 **Mineral Insulated Copper Sheathed Cable (MICSC)**

The wiring shall be carried out in single core or multi-core mineral insulated copper sheathed cable run on the surfaces of walls and ceilings, in the roof space or concealed in walls and floors.

3.6.6 **Cable Makers and Identification Colours**

(i) All cables ends connected in switchgear, Main Distribution Board, panels etc. shall have the insulation carefully cut back and the ends sealed with hellerman rubber slip as cable end markers. The markers shall be of appropriate phase colour. The insulation cable colours and cable end markers shall be in accordance with details stated below unless otherwise specified.

(ii) Every cable used for wiring shall be identified at its terminations throughout in length by colour of its insulation and / or cable end markers.

(iii) The method of identification shall be as below: -

Final Sub Circuit

Single phase	Cable end markers	Cable insulation Colour
a) Phase	red	red
b) Neutral	red	black
c) Earth	green	green

Three Phase & Neutral

a) Phase	red/yellow/blue	red
b) Neutral	black	blue

Main & Sub Main

Single phase

a) Phase	red	red
b) Neutral	black	black
c) Earth	green	green

Three Phase

Mains

a)	Phase	red	red
		Yellow	yellow
		Blue	blue
b)	Natural	black	black
c)	Earth	green	green

Three Phase & Neutral Multicore Cable

a)	Phase	red	red

		Yellow	yellow
		Blue	blue
b)	Neutral	black	black

iv) Where multicore armoured cables have the same insulation colours the cable shall be numbered with 1, 2, and 3 to signify live phase conductors and the number 0 shall be for the neutral cable. The cable end makers shall be insulation sleeves of appropriate colours or discs.

v) All cores of flexible cable including flexible cord shall be coloured throughout in accordance to the table below.

1.6.7 Cable Support

i) To ensure there is no appreciable mechanical strain on any cable termination adequate support shall be provided to conduits runs with cables drawn in them.

ii) Where conduits vertical runs exceed 5 metres there shall be a horizontal bend, which shall be supported as a precaution against undue compression of the insulation of the cable.

iii) Cables laid on trunking with vertical runs exceeding 5m in length shall also have adequately intermediate support. All PVC/SWA/PVC cables in horizontal runs in accessible trunking shall be supported by clips at spacing not exceeding the appropriate value stated in table B.2M of the IEE regulation.

iv) Where it is in an inaccessible position and unlikely to be disturbed support shall be provided at the top of the run by a clip and a rounded support of a radius not less than the appropriate value stated in table B.IM of IEE regulations.

3.6.8 Cable Lengths, Types Sizes Termination and Joints

(i) The cable type and sizes shall be as specified in contract drawings.

(ii) The length of the cable shall be as measured from supply point (meter board, distribution board, consumer unit etc.) to the intended terminal point (switches, lighting, fitting, apparatus etc.). No joint shall be allowed in between. The electrical contractor shall be deemed to have allowed for supply of sufficient cable lengths of each type and size to complete wiring system and for making allowances for any additional lengths due to cutting and waste.

(iii) All terminations of cable conductors and bare conductors shall be mechanically and electrically sound. Care should be taken to ensure there is no undue mechanical pressure applied to the conductor by over tightening of a clamping screw or others. The terminal point shall have anchors to secure all the wires. The electrical contractor shall allow sufficient length of cable inside the termination points to avoid undue strain of cables when terminating.

(iv) At every cable termination, the insulation shall be removed no further than is necessary. For braided, taped, sheathed or armoured cables the sheath shall be cut as far back from the end of the conductor insulation as may be necessary to prevent undue leakage from live parts of the braid, tape, sheath or armour.

(v) Where soldering is to be used for termination the type of solder fluxes shall be non-acidic or corrosive. Cores of sheathed cables from which the sheath has been removed and non-sheathed cables at the termination of the conduit duct or trunking shall be enclosed in a non-combustible material. In dump situation the enclosure shall be damp and dust proof and corrosive resistant.

(vi) In a flammable and/or explosive dust, flammable volatile liquid or vapours or gas situation termination shall be avoided but if necessary the terminations shall be enclosed in a flameproof fitting complying with **BS.229**.

(vii) Cable glands shall regularly retain the outer sheath or armour of the armoured cable without damage and shall incorporate adequate means of maintaining earth continuity between the armour and the threaded fixing component of the gland.

(viii) In termination point where high temperatures are to be encountered insulating sleeves or beads suitable for such temperatures shall be fitted over the individual cores of the cables or flexible cord in such a way that the normal insulation of the cores is not affected by the temperatures and are relied upon to prevent a short circuit between conductors and metallic part of termination enclosure or cause earth fault.

(ix) Terminations of mineral insulated cables shall be provided with sleeves having temperatures rating similar to that of the seals. Bare conductors in terminations of switches, bushes, consumer units etc. which are expected in normal service, shall be protected against accidental contact by screens or barriers or by adequate clearance. Special care shall be exercised when terminating Aluminium conductors. No overdue mechanical pressure should be applied on its conductor by over tightening of the clamping screw. Aluminium conductor shall not be placed in contact with a terminal of brass or other metal having a high copper content to avoid corrosion.

1.7 SUB-CIRCUITS

1.7.1 Sub-Mains

These shall be sub-circuits running from fuses or circuit breakers on the main switchboard or meter box to distribution boards or consumer units, and the cable sizes for these circuits shall be as to comply with IEE regulations and as shown in the contract drawings. No cables less than $4mm^2$ shall be used in these sub-mains circuits. Live, neutral, and earth continuity conductors, for these circuits shall all be drawn in the same conduit or enclosure.

3.7.2 Final Sub-Circuit-General

i) General or consumer circuit final sub-circuit from one distribution board will not serve outlets in an area served by another distribution board or consumer unit fed from the same meter.

ii) No fuse or circuit breakers shall be installed at any point other than on a distribution board, consumer unit, switch fuse or main switchboard except for fused spur boxes.

iii) Bell transformers shall be connected to separate way of a distribution board and form a separate final sub-circuit.

iv) Fire alarms systems shall also be from a separate final sub-circuit.

v) When the sub-main circuit protection comprises HRC fuses, final sub-circuit protection shall either be fuses or MCB's

vi) In all final sub circuits the neutral conductors shall be connected at the distribution board in the same order as that in which the live conductors are connected to the protective devices. All final sub-circuits for lighting points, sockets outlets points etc., wiring shall be carried out in the loop-in-system with no joints whatsoever along the run of cables.

vii) Each final sub-circuit shall be adequately protected against excess current and voltage at the beginning of the circuit. The size of the protective devices for each final sub-circuit shall be as shown in the drawings.

3.7.3 Lighting Final Sub-Circuits

i) All lighting points shall be wired with cables not less than 1.5mm^2 in size. Each final sub-circuit number for lighting points, in the drawing, indicate lighting points which shall be served or connected to the same final sub-circuit and protected by the same protective device.

ii) No lighting circuit shall comprise more than 20 points when protected by 10A MCB.

iii) All lighting fittings with metal enclosure shall be provided with an earth terminal, which shall be connected, to earth continuity conductor of the same size as the live conductor cable. The earth continuity conductor shall be looped to all such fittings in the same manner as the live and neutral conductor.

iv) All lighting fittings shown in the drawings as being switched by the same switches shall be so wired as to be switched and controlled by the same switch.

3.7.4 Ring Final Sub-Circuit for Socket Outlets

The ring sub-circuit shall run in the form of a ring commencing from a way in a distribution board or consumer unit etc. looping into the terminals of socket outlets and returning to the same way of the distribution board or consumer unit etc. The earth continuity conductors shall also run in the form of a ring having both ends connected to earth terminal at the distribution board or consumer unit etc.

The protective device for the final ring sub-circuit for socket outlet or any power points shall be as shown in the contract drawings.

1.8 EARTHING AND BONDING

1.8.1 Earthing

The Earthing of the installation shall comply with the following requirements: -

a) (i) it shall be carried out in accordance with the appropriate sections of the current edition of the regulations for Electrical Engineers of Britain.

(ii) Electricity Supply Authority bylaws.

b) (i) Every item of apparatus and every conductor operating at voltage exceeding extract low voltage shall be effectively protected from giving rise to dangerous earth leakage current.

(ii) All metal required to be earthed under statutory rules shall be effectively earthed.

c) (i) all consumer's units, Distribution Boards metal boards and switchgear shall have Earthing bus bar terminal. Throughout every circuit of such an installation an earth continuity conductor shall be provided and connected to the consumer's Earthing terminal.

(ii) All exposed metalwork of all apparatus in electrical installation shall be connected to the appropriate earth continuity conductors.

(iii) All metal works of wiring systems other than current carrying parts, including cable sheaths armour, conduit, ducts, trunking, boxes, and caternary wires shall be connected to the appropriate earth continuity conductors.

(iv) The Earthing terminal of every socket outlet shall be connected to the Earthing continuity conductor of the final sub-circuit. At every lighting point an Earthing terminal shall be provided and connected to the Earthing continuity conductor of the final sub-circuit unless the fitting is of all insulated enclosure.

(v) Metal works other than current carrying parts and one point of the secondary winding of any transformer shall be connected to the appropriate earth-continuity conductors unless otherwise specified.

d) (i) At all main distribution panels and main services position, a 25mm x 3mm minimum cross section area copper tape (earth bus-bar) shall be provided and all equipment including the lead sheath and armouring of cable distribution boards and metal frames shall be bonded thereto.

(ii) The earth tape (earth bus-bar) of the consumer Earthing terminal in Clause d(i) above shall be connected to the earth electrode by means of a copper tape or cable of suitable cross sectional area (earth lead). The minimum cross sectional area of the earth lead shall be 2.5mm and the maximum being 70mm^2. The connection of the Earthing lead to the earth electrode must be readily accessible and soundly made by soldered joint or clamp. The size of earth lead cable or tape shall be as specified in the contract drawings.

(iii) Where the earth electrode is located outside the building, a removable test link shall be provided inside the building as near as possible to the entry of the tape for isolating the electrode for testing purposes.

(iv) Where necessary, Earthing connection shall be protected against chemical damage and corrosion.

(v) All tapes to be soft high conductivity copper, untinned except in corrosive sites or where otherwise specified and where run underground, on or through walls, floors etc. it shall be served with corrosion resisting sleeve or coated with corrosion compound and braided

(vi) Where an earth rod is used for Earthing its earth resistance shall be tested in the manner described in the latest edition of the IEE regulation in the presence of the Engineer. The sub – contractor shall provide test equipment.

(vii) Where copper tape is fixed to the building structure it shall be by means of purpose made nonferrous saddles which space the conductor away from the structure at a minimum distance of 10mm. Fixings shall be made using purpose made plugs. No fixing requiring holes to be drilled through the tape will be accepted.

(viii) Joints in copper tape shall be tinned before assembly fitted with a minimum of two copper rivets and seated solid.

(ix) Where connections are made to the earth bus-bars connecting surface shall be tinned and bolts and nuts shall be of copper or brass. Cables to be bolted to the bus bars shall have appropriate termination non-ferrous lags.

(x) The earth rod shall be 1.5m long by 15mm diameter extensible type. The head of the earth rod shall be driven to 300mm below the surface of the ground and enclosed in a concrete box with concrete inspection covers, that is, Earth Inspection Chamber, as per contract drawings. The rod shall be fitted with hardened steel tip and driving caps and appropriate cable clamp of copper

(xi) In rocky soils conditions the electrical contractor shall obtain approval from the Engineer for an alternative Earthing system.

(xii) All Consumer Units, Distribution Boards and switchgear shall have Earthing bus-bars terminal.

(xii) Should the site condition be such that no effective Earthing can be achieved by means of earth electrode rod the Engineer shall instruct the electrical contractor the alternative Earthing system.

1.8.2 Bonding

(i) All metallic conduits, trunking, metal enclosure, the metallic sheathing of cables, the cases and enclosures of switchgear boxes fusegears and apparatus of an electrical nature, shall be so bonded as to be directly connected to the respective consumer's earth.

(ii) All Earthing terminals of every socket outlet and lighting point shall be connected to earth conductivity conductor of the final sub- circuit. Earthing assessments and the resistance of the earth continuity conductor shall comply with IEE regulations.

(iii) All lighting switches shall have Earthing terminal, which shall be connected to earth continuity conductor unless the switch plates themselves are of plastic moulded type.

(iv) All metallic work shall be bonded by earth continuity conductor expect where the metallic works is in isolation or is to be isolated.

(v) Isolated switches and incandescent lighting fittings using filament lamps installed above non-conducting ceiling need not be bonded.

(vi) The bonding connection to water and gas services (if any) shall be made as near as practicable to the point of entry of these services into the premises.

(vii) All consumer metal shall also be bonded. The minimum size of copper bonding lead to bond metalwork shall be 2.5mm2.

(viii) To avoid a situation where fortuitous faulty contact can occur between electrical apparatus and live conductors, metal works of the apparatus shall be bonded.

(ix) The bonding and connections to earth continuity conductor shall be such that no fault of negative impedance of earthed metal work shall be sustained so as to cause danger and electric shock or the risk.

(x) No bonding to metal works, water pipes, or members of structural metal works shall be done before the earth continuity conductor is connected to effective Earthing installation.

1.8.3 Protective Multiple Earthing

Where protective multiple Earthing (PME) is provided by the Supply Undertaker, the Earthing lead shall be connected to the consumer's Earthing terminal together with the neutral conductor of the installation and all shall be so arranged that connection to the neutral conductor of the incoming supply can be carried out linking the earth terminal of the consumer to the neutral terminal of the Supply Undertaker.

1.9 ELECTRIC POWER DISTRIBUTION

3.9.1 MV Main Switch Boards and Switchgear

The Main Switchboard is intended to ensure safety during operation, inspection, cleaning and maintenance of the entire electrical installation of the building protected by the board. The Board shall be so arranged as to minimise the risk of fire arising and spreading. It shall incorporate means of insulation, excess-current protection and earth leakage protection of the entire electrical installation.

1.9.1.1 Switchboard Construction

The switchboard shall be of free standing type manufactured in accordance with KS04-226, 1985(or BS 162), which coordinates the requirements for electrical power switchgear and associated apparatus. It is not intended that this K.S should cover the requirements for specified apparatus for which separate Kenyan Standard exist. All the other equipment and materials used in the switchboard shall be in accordance with appropriate Kenya Bureau Standard.

The switchboard shall comprise the equipment shown on the drawings together with all current transformers, auxiliary fuses, labels, small wiring, measuring instruments, if any, and interconnections necessary for the satisfactory operation of the switchboard.

The main switchboard shall be of modular construction type, of flush fronted, enclosed back, connected, all of steel construction and neat appearance, painted, with full front or rear access or both, as called for in the particular specifications. It shall be suitable for indoor use, sectionalized as necessary to facilities easy transportation and erection. The switchboard shall first be assembled at the factory, fully wired and checked before being installed on site in order to minimize installation work.

It shall be floor mounted with maximum height of the switchboard being approximately 2.0 metres. A suitable connection chamber containing all field terminals shall be provided at the top or bottom or special chamber of the switchboard as appropriate.

Before manufacturing the electrical contractor shall submit to the Engineer for approval of detailed drawings, showing the layout construction and connection of the switchboard.

Unless otherwise specified the switchboard shall be constructed from not less than **10guage** welded bright zinc plated mild steel for frame work and structural sections, and **12 gauge** zinc plated steel sheet for doors and panels which shall be adequately stiffened by folding or welded stiffeners. All doors shall be properly stiffened and fitted with heavy cadmium plated or any other non-corrosive concealed hinges and flush catches. Removable stiffened zinc plated steel sheets covers shall be provided elsewhere on the switchboard for full access. All doors and covers shall be fitted with cemented neoprene gasket seals to provide a dust proof enclosure. All hardware and fastening shall be heavily cadmium plated or any other non-corrosive fasteners.

No self-tapping screws shall be used. All steelwork shall be clean and free of burrs, scale and blemishes with all raw edges hidden and shall be finished with rust inhibiting treatment, one primer or undercoat and final coat of first quality zinc powder sprayed and baking enamel finish the colour of which shall be to approval.

The switchboard shall be arranged to provide the maximum of safety to personnel and equipment. All electrical wiring and bus-bars shall be completely enclosed, closure panel, isolating and insulating barriers, and interlocks shall be provided as required for maximum safety. All fuse switches or switch fuses shall be capable of being padlocked in “off” and the “on” positions.

The switchboard shall have provision of removable cross sections for easier cable installation and termination, adequate supports shall be provided for all bus-bars. Other terminations shall also be provided with adequate support.

All switches shall be operatable from floor level with maximum height of the switchboard not exceeding 2500mm from the floor level. The flush mounted indicating meters shall be within 1650mm height.

Mounting arrangements shall be such that individual complete fuse switches or switch fuse may be disconnected and withdrawn when necessary without extensive dismantling work. When switches are arranged in their formation all-necessary horizontal and vertical barriers shall be provided to ensure segregation from adjacent units.

Where spaces on the switchboard are provided for future circuit components to be installed, as shown on the drawings, all ancillary parts shall be provided and installed so that future components may be installed and connected in the least time possible. Full safety precautions shall be provided with all such spaces.

The mild zinc plated steel angle or channel forming the bottom rear edge (for rear access switchboard) or bottom front edge (for front access switchboard) shall be made up in sections and bolted into position such that any one section may be removed to facilitate installation of cables.

1.9.1.2 Bus-bars General

All bus-bars shall be of high conductivity copper and be provided in accordance with KS 04-226: 1985 (or BS 158 and BS 159). The bus-bars shall be clearly marked or painted with the appropriate phase and neutral colours, which should be red, yellow, blue for live phases and black for neutral. The switchboard shall be such that the bus-bars are so arranged that the extensions to the left and right may be made in the future with ease should this need arise.

The bus-bars, bus-bar connections and bare conductors forming part of the equipment of the switchboard shall be of current ratings as specified in the drawings, they shall also be able to withstand temperatures limits encountered during the normal operations of the switchboard and comply with BS. 159.

Each bus-bar shall be of adequate strength to withstand the electro-mechanical forces that may be set up by the designed prospective short circuit fault current and they shall be so installed that they are free to expand and contract as the temperature changes without any damage to themselves or to any other part of the installation.

The bus-bars shall be mounted fully enclosed within the main enclosure of the switchboard in separate chambers. They shall be fully separated from the incoming and outgoing cable areas. Except for instruments, potential or current connections to fuse switches, switch fuses etc., which shall be clamped in position and be of minimum length, no circuit wiring shall be within the bus-bar chamber.

Most parts of the bus-bars shall be sheathed in approved, insulating materials in their respective phase colours and secondary insulation shall be provided where they pass through supports to prevent tracing paths.

Interconnections between bus-bars and switchgears shall be of minimum length, properly insulated and rigidly supported. All contact areas of the bus-bars and the connection fastened to the bus-bars shall be either be of heavily silver-plated or solid copper bolts. Joints and connections shall be rigidly made with clamps and high tensile zinc plated steel bolts and nuts used with spring washers to maintain uniform pressure and flat washers to prevent cupping. Ready access to all joints and connection shall be provided. Bare aluminium conductors when terminated into copper bus-bars shall be suitably protected against corrosion.

The bus-bars and its interconnections shall be mounted and screened such that with fuse switch or swtichfuse door open it shall not be possible to make contact with live parts. All cables terminations shall have PVC deep moulded shrouds to prevent contact with live parts.

Small wiring emanating from bus-bars will be neatly arranged, cleated and shall be arranged in accordance with BS 158, the insulation of the wiring shall be coloured according to whether it is phase or neutral cable.

1.9.1.3 Phase Bus-bars

Termination of cables conductors on all phase bus-bars and all other bus-bars shall be through suitable manufactured technical clips. No holes shall be drilled on bus-bars for the purpose of terminating cables conductors. The clips shall be of cadmium plated, silver plated steel or pure copper suitable to match bus-bar materials to avoid corrosion in damp conditions.

1.9.1.4 Earth Bars

A high conductivity copper earth bars of adequate current rating for the anticipated earth fault current, shall be installed the full length of the switchboard in the outgoing cable area within the switchboard enclosure.

Connection to the earth bar shall be made with approved cable lugs and high tensile terminal clips with galvanised steel nuts and bolts with washers as specified for the phase bus-bars. No holes shall be drilled on the bus-bars for the purpose of terminating cables on the bus-bars.

1.9.1.5 Neutral Bars

A high conductivity copper neutral bar adequately rated and supported for normal and fault conditions shall be installed in the outgoing cable area in the switchboard enclosure. These bars shall be mounted on insulators and shall be divided into sections according to the design of the switchboard.

Copper links double bolted to each section shall connect the section.

Connection on the neutral bars shall be made as specified for the phase bus-bars. All points of contact on the neutral bars shall be silver-plated.

3.9.2 Labelling

3.9.2.1 Switchgear, Distribution Board, Consumers Units

All switchgear distribution boards consumer units etc. shall be clearly and properly labelled in accordance with IEE regulations. Fuse ways and circuit breakers feeding final sub-circuit shall be labelled to indicate power or lighting sub-circuit, the area served, or the equipment served, the circuit number etc., the details of which shall be as given in the contract drawings.

This shall be done by writing neatly on the label normally provided on the distribution boards consumer units etc., the area served and the circuit number etc., with a ball pen (not pencil or felt tip). If no label is provided the electrical contractor shall fix a special made label of the ''trifoliyte''type. (Dymotape will not be accepted)

The outside cover of all switchgear, distribution boards, consumer units etc shall be clearly labelled with a ''trifoliyte''type label (not dymotape) showing the service provided and any circuit reference number which may be given in the drawings current rating etc.

3.9.2.2 Switchgear, Switchfuse, Switches and Isolators

a) Switches or circuit breakers the purpose of which is not obvious shall be labelled to indicate equipment, appliances or apparatus it controls.

b) In labelling Switch fuse, fuse switches and isolators the information required shall include:-

i) Reference number of switch

ii) Special current rating

iii) Where circuit cables have been rated on the basis of close circuit protection the label shall include indication that the fusing factor must not exceed 1.5. in this case labelling shall be of ivorine engraved block on white plate screwed by R.H brass screws

iv) Where more than one phase of supply shall be brought into a multi gang switch box a label shall be fixed to show maximum voltage present and labelled "DANGER".

All labelling shall be completed before testing commences and the Engineer will accept no test certificates unless this has been done. Other labels shall be fixed where deemed fit and as instructed by the Engineer.

3.9.3 **Distribution Boards and Consumers Units**

All enclosures of distribution boards and consumer units shall be metallic with the case made of zinc metal clad steel sheet (galvanized), or zinc powder coated steel sheets. They shall be of surface or recessed mounting pattern. They shall have hinged lids fitted with foam rubber gasket, with enamelled finish. Where called for in the specification, the cases shall be provided with locks.

Removable undrilled gland plate shall be provided on the top and bottom of the cases for incoming cable terminations. Where the requirement for fuses is indicated on the contract drawings the distribution board shall be fitted with high quality porcelain fuse carriers and bases lined with heatproof material, and removable insulated shields or shrouds to provide adequate protection against accidental contacts with live metal. They shall also have circuit-indicating labels fixed inside the cover. Such Distribution board shall be complete with HRC fuses to B.586 1952 category 440 volts A.C.5

Where the requirement for Miniature Circuit Breakers (MCBs) is indicated in the contract drawings the Distribution Boards shall be fitted with moulded thermoplastic units of the combined thermal overload and magnetic short circuit tripping type to KS O4-311 Part 1 1987 or B.S 3871 part 1, having a minimum short circuit breaking capacity of 3000 Amps (3KA). The tripping mechanism shall be of inverse characteristics to prevent temporary overloads tripping and shall not be affected by normal variation in ambient temperature. The operating dolly shall be trip free with a positive movement in both make and break position. Clear indication of the position of the handle "ON and OFF" shall be incorporated.

In all the distribution Boards a complete list of circuits detailed on typed cartridge paper glued to stiff cardboards and covered with a sheet of Perspex and held in position with four suitable fixings, shall be fitted to the inner face of lids. The appropriate HRC fuse or MCB ratings shall be stated on the circuit chart against each circuit in use. Insulated barriers shall be fitted between phases and neutrals in all boards to shroud live parts. Neutral cables shall not be connected to fuses or MCB's. This shall also apply to earth bars.

All consumer units shall be metal clad steel sheet or zinc-coated sheet of steel enamelled with hinged covers. They shall be either flush or surface mounted. They shall be suitable to be fitted

with MCB's. All metallic cases of distribution boards and consumer units shall be effectively bonded to earth continuity conductor.

The Engineer has already carried out short circuit level calculations when preparing contract drawings but the electrical contractor is advised to check or calculate and assure himself that the prospective fault currents at each level does not exceed the short circuit protection capability of the switch or distribution gears he intends to install as it is his responsibility to sign the appropriate declaration in accordance with section E of the IEE regulations.

3.9.5 **Fused, Switchgear and Isolators**

All fused switchgear and isolators shall conform to the requirements of KS04-226 PART 1:1985, or KS IEC 61439 Part 1-5. All contacts are to be fully shrouded and are to have a breaking capacity on manual operations as required by KS-04-182: 1980.

i) Fuse links for fused switches are to be of high rupturing capacity cartridge type class 21 confirming to KS04-183: 1978 or BS 88.

a) The Isolators and fuse links shall be contained in metal clad, dust proof, gasket sealed individual enclosures. Isolators shall be load breaking/ fault breaking isolators without fuses. The fuse links shall be contained in metal clad, dust proof, gasket sealed individual enclosures. Mechanical interlocks are to be provided between the door and, main switch operating mechanism shall be so arranged that the door may not be opened with the switch in the "ON" position, similarly it shall not be possible to close the switch with the door open except that provision to defeat the mechanical interlock and close the switch with the door in the open position for test purposes. The "ON" and OFF positions of all switches and isolators shall be clearly indicated by a mechanical flag indicator or similar device.

ii) In T.P.N fused switch units, bolted neutral links are to be fitted.

iii) The fuse switch units shall have fault rating at least equal to the fault rating of the switchboard in which they are to be installed. It shall have fast make/break design suitable for on board operations.

v) The handles of the fuse switch shall be non-detachable steel handles capable of being locked in either the "on" or the "off" position. The switch contacts shall be separately and fully shrouded and shall be renewable.

vi) The fuses and miniature circuit breakers (MCBS) shall be the protective devices to the Electrical Installation.

vii) The fuses shall be fitted in Switchfuse, Distribution Boards etc. where they are readily accessible. They shall be so connected as to be in series with circuits they are designed to protect. The current rating of the fuse shall be as shown in Bills of Quantity or contract drawing. All fuses shall be inserted in live conductor only and shall offer class Q1 protection with the fusing factor not exceedingly 1.5 for close protection.

viii) The fuse shall make the circuit dead when the current exceeds 2.4 times the rating of the fuse. They shall be of High Rapture Capacity(HRC) type to **BS 88 or BS 1361** with silver strip as the breaking element and Quartz or Silver Sand filler in a ceramic tube with metal and caps and or/without fixing tags. They shall preferable have fuse blown indicators. The prospective short circuit current of the fuse shall generally be 80 KA for alternating current.

ix) Miniature Circuit breakers shall be used for excess current protection in single phase or triple pole, 240V or 415V finals sub-circuits or sub-mains with HRC fuses as backup in the mains switchboards. The MCBs shall easily be opened and closed by hand and open automatically

when overloaded. The MCB shall incorporate both thermal and magnetic overload tripping mechanism such that the bi-metal strip shall offer time – effect for load tripping, while high speed protection against short circuit is given by magnetic operation. The time response against overload and short circuit currents shall be as specified in particular specifications.

3.9.6 **Residual Current Circuit Breakers**

(i) The Residual Current Circuit Breakers or Earth Leakage Circuit Breakers shall be installed whenever indicated on the drawings and required by the regulation. However wherever a socket outlet is placed within 2 metres from a sink irrespective of the type of building, an Earth Leakage Circuit Breaker shall be installed to protect the ring main where the socket outlet forms part.

(ii) The current operated Earth leakage circuit breaker shall be installed if the product of its operating current in amperes and the earth loop impedance in ohms exceed 40. The operating current of the current operated Earth leakage circuit breaker in this specification shall not be more than 30mA and shall be of high sensitivity such that they shall trip in less than 30ms for a leakage current of 30mA(equal to the operating current). They shall be of the type not requiring a mains supply to operate the trip mechanism under fault conditions. The current operated Earth Leakage Circuit Breaker shall also be able to trip automatically when the neutral of the supply is absent, thus ensuring that there is no likely danger of a live-to earth fault being present on the neutral side of the load. The Earth Leakage Circuit Breaker shall incorporate a test button and shall also protect the installation against excess current and short circuit fault in addition to earth leakage faults.

iii) Where the installation involves current operated earth leakage circuit breaker the consumer Earthing terminal shall be connected to a suitable earth electrode.

iv) Where voltage operated earth leakage circuit breaker is specified for single phase installation the operating coil of the circuit shall be connected between the consumer earth terminal and an earth electrode through the earth lead. The earth electrode used with any voltage operated earth leakage circuit breaker shall be placed outside the resistance area of any parallel earth which may exist. The Earthing lead between the operating coil and the earth electrode shall be effectively insulated. The Voltage Operated Earth Leakage Circuit Breaker shall incorporate means of testing through a finger operated test button.

v) For three phase voltage Earth Leakage Circuit Breaker, connection to consumer earth terminal is not necessary. The Earth Leakage Circuit Breaker may be arranged to work in place of MCCB or MCB, or operate as a backup protection. The voltage operated Earth Leakage Circuit Breaker shall be necessary when the earth loop impedance exceeds the values applicable to fuses or MCBs. For example, for fuse of current Rate 100A the measured earth loop impedance is required to be 0.8Ohms. Value above that will necessitate installation of voltage operated Earth Leakage Circuit Breaker or improvement of Earthing installation.

1.9.8 **Electrical Fittings**

3.9.8.1 **Lighting Fittings**

i) The electrical contractor shall allow for the provision of handling charges, taking the delivery, safe storage, wiring (including internal wiring), assembling and erection of all lighting fittings shown on the drawings.

ii) All fittings and pendants shall be fixed to the conduit boxes with brass R/11 screws. These shall be in line with metal finish of fittings. The lighting fittings specified are detailed for the purpose

of establishing a high standard of finish, but equal and approved alternative fittings shall be accepted. The metallic parts of the fittings shall be bonded to earth continuity conductor.

iii) In case of rectangular shaped ceiling fittings, the extreme ends of the fittings shall be secured to suitable support in addition to the central conduit supply box. Supports shall be provided and fixed by the electrical contractor. Minimum size of internal wiring cables shall be 1.5mm^2. Where these cables are likely be exposed to risk of damage by heat generated in the fitting, especially for lamps rated 300W and above, silicone rubber sleeves shall be fitted to the cables.

iv) Where sub- circuit cables are not continued into the lighting fittings terminals, they shall be connected to the fittings wires through **Connectors** of approved type (see clause on Connectors.). The insulation of fittings cables employed shall be capable of withstanding the maximum temperature rise of the fittings enclosure.

v) Lighting fittings with chain or tube suspension shall be so mounted that they are in no way supported by the conductors and the whole weight of the fitting shall be borne by the chain.

vi) Lighting fittings should be installed at height indicated in the drawings.
Where not indicated these shall be mounted on the ceiling. Fluorescent fittings mounted on combustible material of the ceiling shall be spaced by 25mm minimum from the ceiling by space couplers or dome covers.

vii) It is very essential that the light fitting supplied by the electrical contractor are those specified in the drawings and particular specification for the fittings. However equivalent and approved type shall be accepted unless otherwise specified elsewhere.

viii) The type of lighting fitting supplied shall be as described in the Bill of Quantities and of a particular catalogue number and manufactured by the company indicated. Equal and approved equivalent fittings shall have similar architectural configuration as the one specified, have equal rated lighting lumens output , and of the same colour rendering as those specified and also with similar characteristics as the required fitting, such as dust proof, corrosive proof, etc. In case of LED fittings or discharge fittings, the starting mechanism of the equivalent lighting fittings must also be similar to the one specified. The electrical contractor must indicate the country of origin of all lighting fittings (in the Technical Schedule) which are deemed to be equivalent to those specified. The type of fitting provided shall be such that spares such as chokes, starters, capacitors etc. are available in the local market.

ix) The electrical contractor shall install the lighting fittings oriented as shown in the drawings. The electrical contractor shall not change the orientation without the approval of the Engineer.

x) Each lighting fitting shall be provided with number type and size of lamps as detailed in the drawings. The colour rendering of the lamps supplied shall be as required and specified in drawings or particular specifications.

3.9.8.1.1 **Ceiling Roses**

i) All ceiling roses shall either have three terminal connection plate or four terminal connection plates as specified in the contract drawings. All ceiling roses shall have inbuilt barriers between the terminal. They shall be semi-recessed for direct fixing to conduit boxes. They shall be plastic moulded type with shrouded live terminals. All terminals shall be such that conductors and flexible cords can be easily looped in.

ii) Not more than one flexible cord shall be attached to a ceiling rose unless otherwise specified. Each ceiling rose shall be fitted over a biscuit ring of similar colour. All ceiling roses shall have provision for cord grips.

iii) When specified, the ceiling rose shall have an earth terminal which shall be connected to earth continuity conductor of the final sub circuit. The rating of the ceiling rose shall be as specified in the contract drawings and Bills of Quantities. The ceiling rose shall be so wired that no terminal remains alive when the associated switch is off. All the terminals of the ceiling rose shall be of heavy brass, phosphor bronze or any other high conductive corrosive resistant material.

3.9.8.1.2 **Lighting Switches**

i) The lighting switch shall be of tumbler type. For direct current (DC) they shall be of quick break type, while for alternating current they shall be of the "Microgap" type. All switches shall be manufactured to KS04-247: 1988 standard. Where wiring systems is surface wiring, surface switches complete with boxes shall be installed and where conduits are concealed in the fabrics of buildings, flush type of switches shall be installed with boxes recessed.

ii) Single cord ceiling switches, where required, shall be of the type where one pull shall put the switch ON the next pull shall put the switch OFF. The switches shall be fitted with shock absorbing springs in the pull cords. All switches shall be mechanically robust able to withstand the constant operation, and the contacts shall be heavy brass and firm enough to carry the rated circuit current without overheating.

iii) Switches controlling discharge lighting fittings shall be so rated as to operate under likely inductive loads of the fittings. All switches shall be inserted on the live conductors of final sub-circuits only.

iv) The switch boxes shall either be plastic moulded or steel/alloy and the current rate of the switches shall be as described in the drawings or Bill of Quantities. All switches installed external to the building and exposed to the weather shall be of weatherproof type.

v) All switches shall be mounted at a height described in contract drawings and in any case they shall be at least at a height of 1.4m above floor level and in a readily accessible position, at least 220mm from the frames on the unhinged side of the door.

vi) Time delay switches where specified shall be able to operate on an "ON" position for at least two minutes and always on the "OFF" position unless operated. Where more than one flush switch is to be installed under one plate in a multigang assembly and where the live conductors are supplied from more than one phase the plate shall be marked "danger 415 Volts".

vii) The switch plates shall be either plastic moulded and coloured as specified or metal clad and coloured as specified. The contact parts shall be enclosed in plastic mould insulation material and be of pure copper hard drawn brass.

3.9.8.1.3 **Lamps and Tubes**

a) The electrical contractor shall supply and fit all lamps, LEDs lamps, etc., as required for installation.

b) The lamps and tubes shall be suitable for normal stated voltage and frequency and they shall have power rating as shown in the contract drawings and particular specification. For LED Lamps the power factor shall be as specified in particular specifications but not be below 0.8.

c) Colour rendering of LED lamps shall be specified in particular specifications or Bills of Quantities. However where not specified the LEDs shall be as assumed to be of "white" variety. Lumen output of the lamps and tubes shall also be specified but where not specified the sub – contractor shall notify the Engineer of the omission

3.9.8.1.4 **Lamp holders**

i) Lamp holders shall be of extra heavy gauge skirted type and shall be either be Bayonet Cap (B.C), Edison screw (ES), or Goliath screw (GS) variety, as specified in the drawings.

ii) All the lamp holders shall have heavy brass type electric solid plunge contacts separately sprung by rust proof steel plunger springs. All lamp holders shall be constructed of or shrouded in insulating materials to prevent contact with the live parts. They shall be so designed for quick removal and replacement of lamp and also be able to hold the lamp in firm metal electrical contact to prevent overheating.

iii) B.C type lamp holder shall comply with BS 52. Where lamp holders are supplied by flexible cord, the holders shall have "cord grip" arrangements and in the case of metal shades, Earthing screws shall be provided in each of the holders. The screwed cap of the ES and GS holders shall be connected to neutral. When wiring the lamp holders, care must be taken in bearing the flexible cord. The flexible wires must be well twisted together and should not be allowed to splay, as loose single strand may touch either the metal frame of the holder or the opposite terminal. The braiding should be neatly cut away to prevent cotton fibre touching the terminals.

iv) The current rating of the lamp holder shall be as specified in the contract drawings or Bills of Quantities. Lamps that are likely to draw more current than the current rating of lamp holder shall not be used or permitted to be connected to the lamp holder. Where not rated the lamp holder shall be assumed to be 5A, 240 Volts, 50Hz variety. BC lamp holders shall be used with tungsten lamps rated up to 150 W while for lamps up to 200W ES lamp holders are suitable and above 200W all lamp holders shall be GS variety.

v) Lamp holders shall be either insulated type of Bakelite, Plastic moulded type, or the brass type with porcelain interior, as specified.

3.9.8.2 **Sockets Outlets and Plugs**

i) Socket outlets and plugs shall be of the types appropriate to the system of wiring employed. They shall be rated 13Amps of 3Pin shuttered, and switched, manufactured to KS04-246: 1987 standard.

ii) For flush pattern the boxes shall either be steel or plastic moulded while for the surface installation the boxes shall be of steel, steel alloy galvanised or enamel painted with corrosive resistant paint, and also plastic moulded type. The number of gangs and type shall be as specified in the drawings.

iii) The socket base shall be of virtuous porcelain or tough insulation material and the contact tubes which must be self-adjusting to the pins shall either be of phosphor bronze or hard drawn brass with sound terminals. The exposed ends of the tubes shall be below the level of the base to prevent them from being touched accidentally.

iv) The shutter mechanism shall be such that the insertion of the earth pin of the plug shall allow the opening of the live and neutral tubes of the socket outlet.

v) All plugs shall be of substantial construction to clamp to the socket outlet tubes firmly. The plug cover shall be of tough rubber plastic non-combustible materials. All plugs shall have 13A cartridge fuse manufactured to BS1363.

vi) The socket outlet plates shall either be plastic mouldered and coloured or metalclad as specified. All outlets shall be installed at height of 300mm from the finished floor level or in special in cases, especially above benches, at 1.4m. All the earth contact tube shall be connected to earth continuity conductors. The insulation of the socket outlet shall be so constructed as to withstand temperatures likely to be encountered during normal operation and at rated current and voltage.

vii) The plug pins shall clearly be identified by "L" for live contact, "N" for neutral contact and "E" for earth contact. Both the plug and socket outlet shall be so constructed that it shall not be possible for any one pin of the plug to be in live contact with socket outlet while the other pin is exposed.

viii) Where two or more points are shown adjacent to each other on the drawings e.g. socket outlet and telephone outlet they shall be lined vertically or horizontally on the centre lines of the units.

3.9.8.2.1 **Fused Spur**

i) These shall be flush or surface mounted, metal clad or plastic moulded plate of single or double pole switched type, in steel/ plastic moulded box and type and make as specified in the drawings complete with pilot light to KSO4 –247:1988 standard.

ii) The fused spurs box shall be for connection and supply to permanent Electrical Appliances installed or likely to be installed. The rating of HRC fuse shall be as per contract drawings or Bills of Quantities but shall not exceed 13A. Where the fused spur is to be used to supply a hot water heater system in the bath or kitchen, it shall be positioned out of reach of a person using the bath or sink.

3.9.8.2.2 **Cooker Control Units or outlets**

i) These shall be flush mounted with 13A switched socket outlet and neon-indicators. The cooker control units shall be manufactured to KS O4-247: 1988. The construction of the cooker outlet shall be such that all terminals shall be easily accessed and shall be shrouded to avoid accidental contact.

ii) The current and voltage rating of the cooker outlet shall be equivalent to those of the cooker to be connected and the cooker outlet shall be capable of normal operations at ambient temperatures of 20^0 c to 45^0 c.

3.9.8.2.3 **Water Heaters**

a) Unless otherwise specified water heaters shall be of the self-contained type.

b) Where water heater cylinders are made up locally for immersion heaters, the plain cylinder shall be effectively lagged. Adequate thickness of thermal insulation shall be applied to the entire surface of the cylinder.

c) Each water heater shall be supplied by a separate final sub-circuit from the distribution board or consumer or where its rating equal or exceed 3kw, it shall separately metered by the Power Undertaker. In which case the Final sub-circuit shall be from a Double pole switchfuse (or Double Pole MCB) in the Meterboard. The wiring shall be complete from the distribution board, meterboard, or consumer unit to water heater switch without introduction of a plug and socket outlet. An approved heat resistant cable of butyl rubber insulated as CMA reference 610 butyl of voltage rating 600/1000 volts shall then connect the water heater switch to the immersion heater terminals.

d) All water heater switches shall be placed out of reach from a person using the bath or sink. The water heater shall be properly earthed from an earth terminal on the apparatus plate to the

general earth connection or earth continuity conductor. The pipe work of the hot water systems should not be relied upon as an earth continuity conductor, but shall be bonded.

e) The final sub-circuit of the water heater shall be protected by HRC fuse or MCB of appropriate current rating as shown in contract drawings.

3.9.8.2.4 **Telephone Outlets**

i) The electrical contractor shall install conduit for telephone wiring as shown in the drawings. The minimum conduit size shall be 25mm diameter PVC or steel conduit as specified

ii) Draw wires shall be left in all the conduits for telephone installation, in case telephone wiring shall be required to be installed later. The conduits shall be terminated to suitable Telephone outlet boxes of steel/alloy or Plastic moulded.

iii) Where telephone lines are to be installed along trunking they shall be installed in a separate channel or compartment of the trunking to ensure segregation from other cables of high voltage supply.

iv) Outlet plates shall be as specified in contract Drawing and Bills of Quantities and in any case shall be of the type complying to **KS 1588-3:2001.**

v) Where telephone points are to be wired the cables used shall conform to **KS 1588-3:2001.** The cables so installed shall be terminated in appropriate termination Block or Discase.

3.9.8.2.5 **Connectors**

(i) Where specified in Bills of Quantities and drawings, connectors shall be installed for the purpose of joining cables. When not specified, connectors shall be fitted for joining of looped PVC insulated cables with cables in lighting fittings or any other apparatus. The joint so formed shall be both mechanically and electrically sound.

(ii) The connector's insulation shall be as effective as that of cables forming the joint. Care shall be taken in the choice of connectors in joining conductors of dissimilar metal to avoid corrosion. In particular when joining aluminium and copper conductors, the connectors contacts shall be cadmium alloyed variety to prevent electrolytic corrosion.

(iii) The connector's screws shall be appropriately shrouded and the whole construction shall comply with KS IEC 60947 Part 1-7 2001 or B.S.196, BS1778 or B.S.4343.The terminals shall be of phosphor Bronze or hard drawn brass complete with screw.

(iv) The connector terminals shall be insulated with PVC or porcelain and be shrouded to prevent accidental contact of live parts.

(v) When the temperatures are not high Rubber insulated connectors may be used.

3.9.9 **Position of Electrical Plant and Apparatus**

The routes of cables and approximate positions of switchboards etc. as shown on the drawings shall be assumed to be correct for purpose of tendering but exact positions of all electrical equipment and routes of cables must be agreed on site with the Engineer before any work is carried out.

3.10 **PROSPECTIVE CURRENTS AND DISCRIMINATION**

3.10.1 **Prospective Currents**

Prospective current of the installation or Short Circuit Current Fault level is the RMS value of the alternating component of an Alternating Current (AC) that would flow in a circuit due to applied voltage, when a link is placed between the live and neutral conductors at any position of the circuit.

Thus when the live and the neutral conductor of a final sub-circuit is shorted through a link and voltage applied the RMS value of the short circuit current which shall flow shall be short circuit Current Fault level or the **prospectiv**e **current level of the final sub-circuit at the position of the shorted point**.

The value of the current is limited by the impedance of **Supply Transformer**, winding impedance, cable impedance, impedance of joints and equipment between the transformer and the fault position.

Generally the short Circuit Fault level at the Final sub-circuit is not expected to be higher than 3KA while at the Main Distribution Board the fault level may be as high or approximately 14KA. The Engineering design of the installation is such that all excess current protective device specified in Bills of Quantities and contract drawings are of specified prospective fault current level and any change in the installation with different protective devices introduced by the contractor could affect the design.

The contractor shall notify the Engineer of any changes he is likely to incorporate in the installation of protective device for approval before installation especially if the devices he intends to install are of different make from those specified. The installed fuses and MCBS must conform to the specified prospective fault current levels.

3.10.2 **Discrimination**

The installation shall be considered to offer effective discrimination when only the faulty final sub-circuit or a particular faulty apparatus is isolated.

Discrimination between two or more protective devices in series shall be proved to occur when, on the incidence of a short circuit or an over-current, only the device intended to operate does so.

Where HRC fuses are used as protective device in conjunction with MCBS the fuses shall provide backup protection to cut off high prospective currents rapidly thus reducing damage to the installation. The MCB shall offer rapid interruption of low prospective short circuit current in the Sub-main and Final sub-circuits. In general discrimination between two devices shall occur when **pre-arcing (1^2t)** of the major device, say HRC fuse-device of high current rating is greater than the total operational **(1^2t)** of the minor device of lower current rating, say an MCB, at its designed **prospective short circuit fault level current(I).**

The electrical contractor before installing the prospective devices shall ensure that the characteristics and specifications of such devices comply with the above criteria as well as the specifications drawn in particular specification for fuses and MCBS. **(1^2)** shall be the square of Ampere RMS value of **prospective short circuit fault level current** and **(t)** the time period in seconds.

3.11 **AS INSTALLED DRAWINGS**

The installation shall not be considered complete until test certificate and "As installed" drawings have been submitted and approved by the Engineer.

3.12 ON-SITE TESTING AND COMMISSIONING

The electrical contractor shall conduct, during and, at the completion of the installation and if required again at the expiration of the maintenance period, tests in accordance with the relevant section of IEE regulations and also to rule 3 of the Electrical Power Act, for additional test not covered by the regulations, and the Electricity Supply Authority by-laws.

The results of the tests shall be recorded on a test and commissioning certificate supplied by the Engineer or his representative. Two copies of each certificate shall be provided.

Additionally, in the case of underground cables, test shall be carried out to establish continuity, phase sequence and high voltage tests if required by the Engineer.

a) Tests shall be carried out to prove that all fuse and single pole switches are installed in the "Live" Conductor.

b) Tests shall be carried out to prove that all socket outlets and switched socket outlets are connected to the "Live " conductor in the terminal marked as such and that each Earth pin is effectively bonded to the earth continuity system.

c) Tests shall be carried out to verify the continuity of all conductors of each "Ring" circuit.

d) Phase tests shall be carried out on completion of the installation to ensure that correct phase sequence is maintained throughout the installation. Triplicate copies of the results of the above tests shall be provided within 14days of the witnessed tests and contractor will be required to issue to the Engineer the requisite certificate upon completion as required by the regulations referred above. In case of underground cables, tests shall be carried to establish the continuity, phase sequence and high voltage tests.

e) Inspection shall be carried out to ensure;

   i) No terminal in the Ceiling Rose is "LIVE" when the corresponding switch for that Ceiling Rose is in off position.

   ii) All conduit termination, conduit boxes, consumer unit, Distribution Boards, Adaptable boxes etc., shall not have rough edges and are bushed.

   iii) All fixed metal works close to Electrical installation are bonded to earth continuity conductor

f) Other tests may be conducted to test whether the arrangement of protective devices can afford Discrimination i.e., a fault in the furthest power point or lighting point does not blow or trip Fuses or MCBs respectively in the Meter Board, as an example, but blows or trips those that are in the consumer unit that are protecting the respective Final sub-circuits with the faults.

g) Other tests shall include;

   i) Installation Resistance Tests to various circuits and conductors and apparatus,

   ii) Earth-continuity conductor impedance tests,

   iii) Earth loop impendence tests,

   iv) Earth Electrode resistance tests.

h) Any apparent fault, defects or omission or faulty Workmanship, incorrectly positioned or installed parts of the installation found by such inspections or tests shall be rectified by the contractor at his own expense.

i) The electrical contractor shall provide accurate instruments and apparatus and all labour required to carry out the tests. The instruments and apparatus shall be made available to the services Engineer to enable him to carry out such tests as he may require. The contractor shall generally attend on other contractors employed on the project and carryout such electrical tests as may be necessary.

The Engineer and the contractor shall also participate in testing and commissioning of all other equipment plant and apparatus forming part of the works, in particular insulation tests, before connecting any power or other supply and setting to works such plant or apparatus.

Where such equipment etc. forms part of or is connected to a system whether primarily of an electric nature or otherwise (e.g. Air conditioning systems) the electrical contractor shall attend on and assist in balancing regulating, testing, and commissioning the systems to the service Engineer's approval.

3.12.1 **Space Factor and Bundling Of Cables**

Ensure not many Electrical cables are drawn in the same conduit and a space factor of 40% is maintained.

3.12.2 **Illumination Level**

The illumination level shall be as per design specification. A Lux meter may be used to test the illumination level of various rooms in the building.

3.12.3 **Manuals**

Obtain from the contractor all the maintenance manuals as required by the specifications.

3.12.4 **Earthing**

Inspect the Earthing Chamber to ensure the earth lead is enclosed in conduit up to the point of connection to the Earth rod Clamp. Ensure the earth lead cable termination at the earth rod clamp is be corrosive resistant.

3.12.5 **Radial Circuits**

Inspect and ensure that for all Appliances, Equipment, Apparatus etc. that are required to be supplied by radial circuits directly from Distribution boards, Consumer Units etc., without the circuit supplying any other equipment, this requirement is achieved.

PARTICULAR SPECIFICATIONS

2 PARTICULAR SPECIFICATIONS AND CONDITIONS

2.1 PARTICULAR CONDITIONS

2.1.1 Location of Site

The site of the proposed Sub-Contract works shall be at The Nairobi Hospital, along Argwings Kodhek Road.

2.1.2 Description of Project

The project comprises of the Fit-Outs and Reorganization for The Nairobi Hospital Labor Wards.

2.1.3 Commencement of Works

The Sub-Contractor in submitting his tender shall be deemed to have included for Commencing any necessary work on site at such a time as will comply with the Main Contractor's programme.

2.1.4 Scope of Works

The Sub-Contract Works shall comprise the supply, delivery, erection, testing, commissioning and setting to work of the Electrical Engineering Services as detailed in this Specification and the accompanying Contract Drawings.

The Sub-Contractor shall include for all apparatus and appliances not particularly called for in this Specification or on the Sub-Contract Drawings but which are necessary for the completion and satisfactory functioning of the Sub-Contract Works. No claims for extra payments shall be entertained from the Sub-Contractor due to his failure to adhere to the above requirements.

It is deemed that if in the opinion of the Sub-Contractor at the time of tendering, there existed a discrepancy between the Specification and the Contract Drawings, that the Sub-Contractor clarified this difference with the Engineer before tendering.

The work to be undertaken under this Sub-Contract shall comprise but not restricted to the following: -

(a) Supply and Installation of incoming electricity power supply system

(b) Supply and Installation of a New Distribution Board each area.

(c) Supply and Installation of distribution cables and sub-main cables.

(d) Supply and installation of small power system

(e) Supply & Installation of Lighting Fixtures.

(f) Small power wiring in new compartmentalised trunking.

(g) Supply & Installation of cable ducts, cable trays and trunking.

(h) Supply and installation of fire Detection and Alarm System

(i) Supply and installation of UPS Unit.

(j) Receiving, installing, commissioning of the client supplied items

2.1.5 Ordering of Materials

The Sub-Contractor shall order materials from the quantities taken from his own approved working drawings and not from the quantities shown on the Contract Drawings or in the Specification.

2.1.6 Environmental conditions

The installation shall be suitable for continuous operation under the following service conditions without both damage and performance de-rating:

Altitude: > 1000m

Temperature:

- Average temperature during 24hours: 35°C
- Max temp. +40°C
- Min temp. -5°C

Humidity:

- Max 50% at 40°C

2.2 INCOMING ELECTRICITY POWER SUPPLY AND DISTRIBUTION SYSTEM

The incoming electricity power supply for the Labour Ward shall be derived from the NHMP Low Voltage Switchgear located in the Power Centre.

The supply to the various sections of the Labour Ward works shall be through armoured electrical cables through overhead cable trays as shown on contract drawings.

From the respective Sub-Boards or Main Distribution Boards (DBs), power will then be distributed in the respective loads as shown on contract drawings.

2.2.1 Distribution Boards Consumer Units

The distribution boards and consumer units shall conform to the requirements of Clause 4.16 of this Specification and shall be as manufactured by M/S Schneider or equal and approved.

Distribution boards and consumer units shall be flush/surface mounted.

Residual Current Circuit Breakers [RCCB] where specified shall be incorporated in the distribution boards and consumer units' outgoing ways in place of MCBs for individual final circuit protection and shall be as ABB or equal and approved.

Schematic of individual distribution boards and consumer units have been prepared. The Sub-Contractor should note that power boards consist of single phase and three phases sub-circuit ways.

All neutral conductors in a single phase distribution boards and consumer units shall be connected in the same circuit sequence as its phase conductors, i.e. phase wire No.1 connected to No.1 terminal on the neutral bar.

In addition to this requirement for every distribution board each phase and neutral conductor shall have clipped to its sheath in the distribution board a clip-on numbered tag corresponding to its circuit number. The tags shall be of a type manufactured by M/S Critchley Brothers Limited. All circuit numbering shall commence from left to right.

2.2.2 L.V. Earthing

The Sub-Contractor shall provide a complete and effective system of Earthing for the L.V. electrical installation.

The system of Earthing shall comply with the IET wiring regulations and the recommendations stated in CP 1013, except where detailed otherwise in this Specification and the drawings. Where the IET wiring regulations and CP 1013 differ then the former shall take precedence.

Metallic services including gas mains, dry risers, etch, entering or leaving the building or structure shall be effectively bonded to the main Earthing terminal at their point of entry or exit. Connections shall be made to the services with purpose-made Earthing clamps to BS 951.

The lightning conductor system for the building or structure shall be effectively bonded to the main Earthing terminal in accordance with the requirements of CP 1013. The bonding conductors shall not be smaller than 25mm x 3mm. A suitable label shall be provided adjacent to this bonding connection at the main Earthing terminal.

Where the building is comprised of a steel framed structure or has metallic cladding then these shall be effectively bonded to the main Earthing terminal.

The cross-sectional area of all Earthing, bonding, and protective conductors shall comply with the requirements of the IET wiring regulations. Except where detailed otherwise in this specification or on the drawings all conductors for Earthing shall be copper manufactured in accordance with BS 1432, from strip and BS 4109, for cables.

Single-core cables forming part of the Earthing system shall be of stranded copper, insulated to 450/750V standards with green/yellow PVC. These cables shall comply with BS 6004, Table 1. Bare protective conductors in twin and three core cables included in BS 6004, Table 5 will be acceptable.

Mechanical joints between aluminium and copper shall have the joint faces lightly coated with a suitable compound to prevent corrosion, before the connection is made.

Where conduits or small glands for mineral insulated or armoured cables, terminate on switchgear, distribution boards, starter panels or other apparatus then brass compression washers shall be used to ensure an effective earth connection.

Where connections are made between sections of trunking then the manufacturer's earth continuity links shall be installed across the joint. Connections made between trunking sections crossing a building expansion joint shall be made with a flexible copper braid.

Sections of cable tray shall be thoroughly cleaned before overlapping and securing with a minimum of two screwed fixings. The remote ends of the cable tray shall be effectively bonded to the Earthing system.

The armouring of plastic sheathed cables terminate in a suitable compression glad fitted with a purpose-made earth tag. A suitable protective conductor shall connect the earth tag with the apparatus Earthing terminal. The earth tag shall be manufactured from a high conductivity material compatible with the cable gland.

The armouring of metal sheathed cables shall be securely clamped to the gland at the cable termination with a purpose-made bolted clamp. A protective conductor shall be installed to connect the armour clamp or gland fixing bolts to the apparatus Earthing terminal.

For an outdoor termination the armouring shall be suitably protected to prevent corrosion.

Metal sheaths and/or armouring of multi-core cables connected to a cubicle type switchboard shall be effectively connected to the switchboard earth bar as described in later clauses.

The earth terminal of all socket outlets shall be connected to the main protective conductor of the final sub-circuit. Where the protective conductor is formed by conduit, trunking or the metal sheath and/or armouring of cables then the earth terminal of the socket outlet shall be connected to an earth terminal in the box or enclosure associated with the conduit, trunking or cable.

Connections between earth bars, equipment frames, etc. and stranded copper cables shall be made with the appropriate lug, bolt, washers, nut and lock nut. The cable shall be seated into the lug and the contact surfaces shall be thoroughly cleaned and tinned prior to connection.

The washers shall be of sufficient size to prevent any distortion of the copper strip.

The diameter of fixing holes shall not exceed one-third the width of the earth bar or strip. Where a larger hole is required in an earth bar then connection shall be made to a suitable copper flag welded to the bar.

Copper strip joints shall be riveted and soldered using hard silver solder and suitable copper rivets, four to a joint and not less than 6mm from the edge of the copper strip. The amount of overlap of the two strips to the jointed shall not be less than the width of the larger conductor.

2.2.3 Test Requirements

Tests shall be made and recorded on the electrical installation Earthing system in accordance with chapter 6 and appendices 14, 15 and 16 of the IET wiring regulations and the results recorded on copies of the 'Schedules of Test Results' attached to this Specification. Tests shall be made both during and upon completion of the works.

The schedule shall be completed for each final sub-circuit and at each main and sub-main distribution point. Six typed copies of the completed schedules shall be available for inspection within fourteen days of the test completion.

These tests shall also be made on all plant and equipment supplied, installed and connected to the electrical installation under this sub-contract and/or existing plant and equipment connected to the electrical installation provided under this sub-contract.

The works Sub-Contractor shall re-set the Earthing system provided under this sub-contract thirty days prior to the end of the Defects Liability Period. The Works Package Sub-Contractor shall give seven days' written notice prior to visiting the site to make these tests. Tests shall be carried out as aforementioned on the following basis: -

(i) All socket outlets installed under this sub-contract shall be tested for earth fault loop impedance.

(ii) Two and a half per cent (2.5%) of all lighting points installed under this sub-contract with a minimum of five, shall be tested for earth fault loop impedance.

Should any point not comply with the test requirements then a further two and a half per cent (2.5%) shall be tested, when failure of any one will require testing of all lighting points.

(i) All miscellaneous plant machinery and equipment supplied and installed under this sub-contract shall be tested for earth fault loop impedance.

2.2.3.1 Schedule of Test Results for the Electrical Earthing Installation.

Job No: **Schedule No.**

Job Title:

Building:

Department:

Switchboard/Distribution Board Ref:

Method of Main Earth Connection:

cable or circuit ref.	**Circuit fuse or breaker rating (Amps)**	**Protective conductor resistance (Ohms)**	**earth fault loop impedance (Ohms)**

Sub-Contractor:

Date:

2.2.4 Moulded Case Circuit Breaker (MCCB):

2.2.4.1 General

The Circuit breakers shall be with thermal-magnetic or MICROLOGIC® electronic trip units as specified on the associated drawings. Circuit breakers shall have voltage and interrupting ratings that meet the application requirements. Interrupting rating shall be available up to 200 kAIR at 240Vac, 480Vac and up to 100 kAIR at 600Vac without fuses. Circuit breakers shall be available in frame sizes as follows: H-frame (150A), J-frame (250A) Q-frame (225A) L-frame 600A, M-frame (800A), P-frame (1200A) and R-frame (3000A).

2.2.4.2 References

Circuit breakers shall be constructed in accordance with the following:

a. CSA 22.2 No 5 / UL® 489 Low-voltage AC and DC circuit Breakers
d. [IEC 60947, "Low Voltage Switchgear and Control Gear – Part 2: Circuit Breakers]
e. [IEC 60947, "Low Voltage Switchgear and Control Gear – Part 3: Switches]

2.2.4.3 Equipment, Components and Accessories

2.2.4.3.1 Circuit Breaker:

Circuit breakers shall be constructed using glass reinforced insulating material. Current carrying components shall be completely isolated from the handle, and the accessory mounting area.

Circuit breakers shall have an over centre, trip free, toggle operating mechanism which shall provide quick-make, quick-break contact action. The circuit breaker shall have common tripping of all poles.

From 150 A to 600 A rating frame, MCCBs breaking unit shall be made with a double rotary contact to limit let through energy on the installation

MCCBs shall be designed to trip the circuit-breaker in the event of high-value short-circuit currents. This design shall be independent of the thermal-magnetic or electronic trip unit.

The circuit breaker handle shall reside in a tripped position between on and off to provide local trip indication. Circuit breaker escutcheon shall be clearly marked on and off in addition to providing international I/O markings. The maximum ampere rating and CSA, UL, IEC, or other certification standards with applicable voltage systems and corresponding interrupting ratings shall be clearly marked on face of circuit breaker.

Each circuit breaker shall be equipped with a push-to-trip button, located on the face of the circuit breaker to mechanically operate the circuit breaker tripping mechanism for maintenance and testing purposes.

Circuit breakers shall be factory-sealed with a hologram quality mark and shall have date code. MCCB's shall be able to receive a device for locking in the isolated position.

[Circuit breaker/circuit breaker] [Fuse/circuit breaker] combinations for series connected interrupting ratings shall be listed by UL as recognized for Canada component combinations. Electronic components shall withstand temperatures up to 221 °F (105 °C).

Circuit breakers shall be UL-listed to accept field installable/removable mechanical type lugs. Lugs shall be CSA/UL-listed to accept solid and/or stranded [copper and aluminum conductors] [copper conductors only]. Lugs shall be suitable for [140 °F (60 °C) rated wire on 125 ampere circuit breakers and below] [167 °F (75 °C) rated wire] [194 °F (90 °C) rated wire, sized according to the 167 °F (75 °C) temperature rating in the CEC/NEC].

Circuit breakers shall be capable of accepting bus connections. For rating frame higher than 250 A MCCBs shall be fitted with metallic filters to reduce effects perceptible from the outside during current interruption

For a MCCB rating frame given, MCCBs dimensions shall be the same whatever the AIR. H-, J-, L-, P-frame shall be available in manually operated version and electrically operated version

The P-frame electrically operated version shall be of the stored-energy type only and will be equipped with anti-pumping function

The P and R-frame circuit breakers shall be equipped with a safety interlock, which keeps the circuit breaker open if the trip unit is not installed.

2.2.4.3.2 Trip Unit

MCCB's with ratings up to 400 amperes shall be equipped with [thermal magnetic] [electronic] trip units.

MCCB's with ratings over 400 amperes shall be equipped with electronic trip units. Circuit breakers with permanent trip units shall be CSA/UL-listed for reverse connection without restrictive line, load markings, and be suitable for mounting in any position

MCCBs with field interchangeable trip units shall have trip units that are easily interchangeable and easily secured to the MCCB

The trip units shall not augment overall circuit breaker volume. Thermal Magnetic (400 Ampere Frame and Below):

Thermal trip elements shall be factory preset and sealed. Circuit breakers shall be true RMS sensing and thermally responsive to protect circuit conductor(s) in a 104 °F (40 °C) ambient temperature.

Circuit breaker frame sizes above 150 amperes shall have a single magnetic trip adjustment located on the front of the circuit breaker

Where indicated on drawings, Circuit breakers shall be equipped with a ground fault module (GFM) with 20 ampere to 200 ampere sensitivity level or earth leakage module (ELM) with sensitivity ranges between 30 mA and 3 amperes, or approved equal.

2.2.5 Miniature Circuit Breakers (MCB)

2.2.5.1 General.

Miniature Circuit Breakers (MCBs) shall be rated for uninterrupted duty at 240/415 volts and shall comply with BS 3871: part 1 and IEC 60947, plus any additional requirements of this specification.

MCBs shall be type tested by ABB or an equivalent approved coordination testing authority. All MCBs shall be of the same manufacture. Manufacturer's tripping characteristics shall be provided for each type of MCB specified.

Service and ultimate short-circuit capacities, impulse withstand voltages and insulation levels shall be suitable for the location to the MCB in the system and the backup protection provided.

MCBs shall be fitted with fixed, non-adjustable, direct-acting thermal and magnetic trips and shall trip instantaneously (within 0.1 seconds) at currents above 5 and up to 10 times normal current rating, (C-type in IEC 898), unless otherwise specified.

Energy limiting MCBs shall break the circuit within 5ms. The 1.2 energy let-through shall be stated for each energy limited MCB. In multi-pole MCBs, including 4-pole, all poles shall open, close and trip simultaneously.

Mechanisms shall be quick-make, quick-break, over-centre type which are trip-free. The contact position shall be positively indicated by coloured bands and/or entering to show whether the contacts are open or closed. If the rating or the incoming supply to an MCB board exceeds 200A on any phase, then moulded case circuit breakers shall be used in place of MCBs. As required by IEC 898 1987 plus amendments, the following information shall be provided for each MCB: -

1. Rated current
2. Rated operational voltage and rated insulation voltage
3. Number of poles
4. Rated services and ultimate short-circuit capacities.
5. Type according to tripping characteristic i.e., Type B, C or D.
6. Method of mounting
7. Method of connection
8. Protection against external influence.
9. On request, the I^2t tripping characteristic curve.

Each MCB shall be marked as follows: -

a) On the front of the MCB so that it is visible when mounted: Rated current, without the symbol 'A' preceded by the symbol of instantaneous tripping (B, C or D) e.g. B 16

b) Rated voltage

c) Manufacturer's name or trade mark

d) Type designation, catalogue number of serial number

e) Rated service short-circuit capacity in amperes

f) Reference ambient temperature if different from 30^0C.

2.2.6 L.V. Cable Distribution System

This section of the specification covers the supply, installation, testing and commissioning of the main and sub-main cables, distribution boards and consumer units in accordance with the contract drawings and specification.

The sub-main cables and methods of installation shall be as shown on the Schematic and Layout Drawings and/or specified of this Specification. The cables shall be from an approved manufacturer.

Distribution cables shall be run in trenches externally and on cable racks within the factory.

Types of cables

2.2.6.1 Power Cables

The most common cable conductor material used in building installations is copper. In some types of cables, the copper may be tinned to prevent the copper from reacting with the insulation material. Aluminium is often used for power cables, particularly by the electricity companies. These require different termination and jointing techniques.

Cables for specialist applications such as trace heating or underfloor warming may use materials such as copper-nickel or nickel-chromium alloys.

BS 6360 defines four classes of cable conductor:

- Class 1 has solid conductors
- Class 2 has stranded conductors
- Classes 5 & 6 are flexible cables and cords, with class 6 being more flexible than class 5.

The classes apply to both single core and multicore cables.

The British Standards for the various cable types cover which classes of conductor are allowable for the different cross sectional areas. The standards covering most of the cables used for fixed wiring can have either solid or stranded conductors up to 10 mm sq. CSA. However, in practice it will be found that these cables generally have solid conductors only for cables up to 1.5 mm sq. or 2.5 mm sq. and stranded conductors for the larger sizes.

Flexible conductors are commonly found in small sizes in multicore cable connections to luminaires and fixed equipment but are also used in large single core cables for the final connections to vibrating equipment such as generator.

2.2.6.2 Cable Insulation

The following cable insulation materials shall be used wherever specified.

1. Polyvinyl Chloride (PVC):

2. Thermosetting materials (XLPE & EPR):

3. Mineral Insulated (MI):

4. LSF & LSOH Insulation& Sheaths:

5. 'Fire-Resistant' Cables:

2.2.6.3 Contactors

Wherever possible, contactors shall be incorporated on the sub-main board, distribution boards or other switchgear.

Contact ratings, number of poles and coil ratings shall be as shown on the Contract Drawings. The Sub-Contractor shall ensure that the Contactors are adequately rated for the maximum prospective fault level in the particular part of the distribution system.

2.2.6.4 Isolators

Isolators shall conform with the requirements detailed in Clause 4.07 Part B of this Specification. Unless otherwise specified, isolators shall be designed for load making/load breaking duties.

2.2.6.5 Cable Schedule

The Sub-Contractor shall prepare a suitable cable route schedule for all major l.v. cables within the building. The schedules shall be submitted with working drawings after contracts have been exchanged. During the course of installation, each major cable shall be suitably identified along its route by traffolite cable markers, in accordance with the Sub-Contractor's Cable Schedule.

2.2.7 Electrical Services Associated with Mechanical Services

Work to be carried out under this section includes the supply, installation, wiring to and connection, testing and commissioning of the electrical services associated with the mechanical services and medical equipment. These shall include ventilation, water pumps, kitchen equipment, air conditioning units, medical equipment etc.

The Mechanical Services Sub-Contractor or medical equipment supplies will supply and install the equipment and the associated control panels as shown on the Contract Drawings. The Mechanical Services Sub-Contractor shall be responsible for the interconnection wiring between the power isolator and their equipment via the control panel in accordance with the requirements of the Mechanical Engineer.

2.3 LIGHTING AND SMALL POWER INSTALLATIONS

This section of the specification covers the supply, installation, connection, testing and commissioning of the lighting and single-phase power installation in accordance with the contract drawing and specifications.

2.3.1.1 Wiring System

Final sub-circuit wiring shall be carried out using PVC single core insulated copper cables enclosed in a system of high impact heavy gauge surface metallic conduits and embedded PVC in the fabric of the building. An insulated earth continuity conductor shall be enclosed in all non-metallic conduits.

Wiring in the factory and plant rooms shall be in surface mounted galvanised conduits, trunking or cable trays.

A system of three compartment PVC surface mounted trunking shall also be installed with office areas as shown on the contract drawings as part of the floor cable management system to distributed power, information, and communication and signal cables. Sub-contractor shall supply and install the necessary power outlets mounted on the trunking. The information, communication and signal outlets shall be by others.

All single phase 13 ampere power socket outlets shall be wired using 30 ampere ring main circuit system for raw power while all 'clean line' (UPS Supplied) 13A socket outlets shall be wired using 10A radial circuit system. No more than 4 No. twin socket outlets shall be wired in one radial circuit. All socket circuits shall be wired in 2.5mm^2 pvc insulated single core cables.

2.3.1.2 Accessories - General

Accessories shall comply with the relevant British Standards quoted in the later clauses referring to specific accessories. All accessories shall comply where applicable with the general requirements specified in BS 5733 and BS 6220.

Each type of accessory where applicable shall be of the same manufacture and where necessary of the same maker's catalogue number or description to provide consistent appearance and finish.

Flush mounting accessories shall be fitted into purpose made metal boxes, only and surface mounting accessories shall be fitted onto metal or all insulated moulded boxes as shown on the drawings or in the schedules.

All boxes or sections for use with accessories must incorporate a suitably marked earth terminal accessory plates shall be secured to boxes by not less than two fixing screws. Where these screws do not provide adequate earth continuity to metal plates or plates including parts to be earthed continuity to metal plates of plates including parts to be earthed bonding connection shall be provided from the earth terminal to insulated sleeve. The above requirement shall not apply to the earth terminal on a socket outlet when directly connected to protective conductor. Where more than one phase of a supply exists in a multigang box the following requirements shall apply:

A clearly visible label showing the maximum voltage present shall be arranged as a warning notice before access can be gained to live parts. Wiring and accessories connected to each phase shall be separated from each other by fixed screens or barriers.

2.3.1.3 Switches

All switches for lighting and associated circuits shall comply with B.S. 3676 and shall be quick make and break for use on d.c. supply, pole and rated not less than 20A, 240V for use only on a.c. BS 3676.

Switches for control of water heaters, radiators, and so forth shall be double pole and rated 20A, 240V for use only on a.c. systems and shall include neon pilot lamp.

Switches shall be one-way or two-way or intermediate as indicated on the drawings. Switches for lighting shall be of the metal grid switch system with rocker operation, and in single or multigang formation as detailed on the drawings or in the schedules. Architrave type switch units shall only be fitted if shown on the drawings or in the schedules.

Switches installed in damp areas or outside shall of non-tracking plastic, single pole, operated by external means. The switch enclosure shall be either weatherproof of galvanised metal construction or designed to protection level IP54 of BS 5490 or splash proof plastic to IP54 requirements.

Ceiling switches shall be of the all insulated pull cord type suitable for mounting on a British Standard conduit box and having an overlapping plate. Each unit shall be complete with 1.5m white cord terminating in a white/red accord. The unit shall be rated at 20A at 240V and suitable for inductive fluorescent or resistive loads to BS 3676.

Push buttons in single units or forming part of a multigang unit shall be rated at 20A at 240V. The switch shall be single/double-pole and arranged for push to make/to break the contacts. The bezel shall be marked by an appropriate symbol legend symbol and have a white finish.

The time delay switches shall comply where applicable with the general requirements for switches.

The switch shall be suitably rated to control tungsten filament lighting at 240V a.c. up to a load of 400 watts. The switch shall be of the push on type and returning automatically to off after the time delay. The time delay setting shall be internally adjustable over a time range up to 10 minutes.

Lighting switches shall be flush-mounted, single pole 10 or 15 ampere rating, rocker operated with wide rockers as MK Logic Plus white in door. Grid switches flush-mounted may also be necessary in certain situations.

Circuits on the uninterruptible power supply (UPS) shall comprise of non-standard 13-amp socket outlets complete with non-standard plug tops. The outlets shall be white as MK Logic and shall be indelibly engraved “CLEAN UPS SUPPLY”. The non-standard socket outlets ‘EARTH’ terminal shall not be bonded to the normal power metallic distribution system to facilitate ‘CLEAN EARTH’. A separate earth system shall be provided at the sub-circuit consumer unit and distribution boards specifically for the clean earth system which shall eventually be bonded to the general building externally.

2.3.1.4 Cable Management System

A system of two compartment metal trunking shall be installed as shown on the Contract Drawings in offices.

The system shall be used to distribute power, telephone services and computer data cables. The Sub-Contractor shall supply and install 13A non-standard and standard socket outlets and telephone outlet plates which shall be mounted on removable sections of the trunking cover plate.

Sizes, proposed fixing arrangements and routes of two compartment cable trunking have been detailed on the layout drawings. Proposed routes at each area, in relation to mechanical services, have been detailed but it is the Sub-Contractor’s responsibility to verify the routes of other services before submitting working drawings and commencing with the installation.

The Sub-Contractor shall tape together at 2 metre intervals all single core cable circuits which are enclosed within the cable trunking.

Surface high level and wall fixed metallic cable trays and ladders shall be employed for power distribution as indicated on drawings

The powder coating shall be of uniform thickness of about 180 microns throughout the entire system. Colour uniformity shall also be strictly maintained through the entire system. Where trunking will not be possible for installation, hence floor chasing and feeding from above using special chrome plated columns, in case furniture will not have cable management system.

The trunking we required shall have no sharp edges (edges shall be bend where possible) and shall be reinforced to ensure that it shall not buckle.

Particular attention shall be paid to those areas, where conduits enter the trunking to ensure a dirty and neat installation where power, voice and data cable ways are completely and neatly segregated. A sample section shall be prepared before installation commences.

The Sub-Contractor shall allow for all trunking inter-connecting conduits.

2.3.1.5 Luminaires (Lighting Fixtures)

Luminaires shall be of the type and manufacture as detailed in the schedule of Luminaires.
The luminaires have been itemized with a suggested manufacturer and the statement "equal and approved". "Equal and approved" shall mean equal in electrical characteristics, photometric data, size, cross-sectional area, finish and fixing details.

Luminaires in the factory shall be surface mounted on ceiling slabs. Where suspension is called for the pricing of the luminaire shall be complete with the suspension as specified.

All luminaires shall be supplied complete with gear, lamps and tubes of the voltage specified and shall be power-factor corrected (NPF) in the case of fluorescent luminaires.

All Luminaires will be complete with rated LED lamps (SMD technology only) with 50000 Lifetime L70 (hrs), SDCM ≤ 6.

2.3.1.6 Emergency Lighting

The emergency lighting system shall comprise of maintained luminaires containing one or more lamps, which operate from the internal emergency battery supply only upon failure of the normal mains supply. In addition emergency lighting shall also incorporate sustained (combined emergency luminaires) non-maintained and maintained 'EXIT' lights.

The system design shall conform to BS 5266 parts 1 and 7 1999.

2.3.1.7 Information, Communication and Signal System

Installation of conduit ways and trunking systems shall be installed by the Electrical Sub-contractor to facilitate installation of information, communication and signal system cables and accessories.

The installation of information, communication and signal cables and accessories shall be by others. The Electrical Sub-contractor shall offer these specialist due attendance and shall be deemed to have allowed for the same in his tender.

2.3.1.8 Socket outlets

Socket outlets for 240V a.c. supplies shall be of the 13A rectangular pin single pole switched type complete with shutters and shall comply with BS 1363. Each socket outlet shall be provided with a plug of the appropriate rating. Plugs for 13A socket outlets with sleeved insulated pins shall be made in hard plastic

complying with BS 1363 and shall be supplied compete with 13A or 3A fuse links to BS 1362 in accordance with the drawings. Plugs for ratings of 2A, 5A, or 15A shall comply with BS 546 and be made in hard plastic. Where detailed on the drawings or in the schedules plugs made of resilient material shall be supplied.

Weatherproof switch socket outlets and plugs for outside use shall be of all metal enclosure for surface mounting. The switch shall be singe pole/double pole having a substantial operating arm with ON/OFF positions clearly indicated. The outlet socket shall be protected when not in use with a screw-on metal cap attached to the unit by a chain/hinged spring closing flap incorporating a gasket. The metal enclosure shall have a hop dip galvanised finish and shall be protected by 30mA RCD devices.

2.3.1.9 Cable Outlet Units

Outlet plates for cables or flexible cords shall be similar to switch plates with 60.3mm fixing centres and complete with not less than two fixing screws. Terminals shall be provided to accommodate incoming wiring and outgoing cables or 1.5mm^2 flexible cord. The unit shall be unfused and shall incorporate an outgoing cable clamp or cord grip. The cover plate of white moulded plastic shall have a smooth aperture for the cable/flexible exit.

2.3.1.10 Earthing

The whole of the protective system shall have combined resistance to earth not exceeding 10 ohms. Should the values exceed 10 ohms, reduction in resistivity shall be achieved by linking earth electrodes below ground.

Each down conductor shall be provided with a testing joint in such a position that while not inviting unauthorised interference, is conveniently situated for testing.

Earth electrodes shall be situated at least 1m from foundations.

The Earthing network for the lightning protection system shall be bonded to the switchboard's Earthing system in the various blocks.

2.3.1.11 Continuity Tests

The entire networks shall be tested for continuity including the testing of each down conductor.

2.3.1.12 Testing of the Installation

After completion and before commissioning, the entire installation shall be subjected to the following tests and any faults found shall be rectified.

(a) **Polarity:**

All fuses and control devices shall be connected in live conductors only.

(b) **Insulation Resistance:**

When tested with a 500 V.dc. supply the insulation resistance between conductors of live lines, lines and neutral, line and earth, neutral and earth shall not be less than 1 megohm.

(c) **Earth Continuity Resistance:**

Resistance of earth continuity measured from a consumer unit to the farthest end of a circuit shall not exceed 0.5 ohm.

2.3.1.13 Testing and Commissioning

Testing and commissioning shall be carried out in accordance of this specification. All tests shall be carried out in the presence of and to the certification of the Engineer.

2.4 FIRE DETECTION AND ALARM SYSTEM

2.4.1 Type of System

The system shall be operable manually and automatically and shall be suitable for protection of life and property. It shall cover those parts of the building where there is a high risk to life in event of a fire anywhere in the building.

The system shall be of the Analogue Addressable type, with **Continuous** monitoring of analogue quantities and automatic adjustment of Alarm Threshold, designed in accordance with this Specification. The system shall allow continuous monitoring of data from the detectors by the control panel and shall be able to identify call points, detectors and interface units and pin-point sounders, repeat and mimic panels if any. The system shall be based on **the principle of central processing**.

Microprocessor systems shall be of modular design and consist of suitable standardized hardware and software packages. It shall thus be possible to expand and modify systems in future easily and without tampering with the existing working modules. In addition software routines shall be designed to provide automatic restart after power failure etc., so that the system will become fully operational without manual intervention. The main operating system, system configuration data and monitoring software shall be contained in battery-backed ROM, may be left in the ROM or automatically copies into the RAM area on booting up. Field-programming shall be carried out by means of fixed or plug-in keyboards or by hand held computers. The user data shall be safe-guarded by permanently fixed Lithium batteries or by storage in EPROM's.

The capacity of the data-processing system shall include 25% spare capacity.

2.4.2 Data Transmission

The communication faults shall be announced on both sides with transmission errors being indicated on the fire panel. Such faults shall not lead to deterioration of the Fire Panel Operation.

Transmission errors detected by a receiver shall deny acknowledgement of the message and request repetition by the sender. Receipt of three consecutive errors shall result in the fault message being displayed at the fire panel.

The system shall incorporate means for monitoring and circuit isolation complying with this specification.

2.4.3 Zoning

The zone divisions and associated circuiting shall comply with BS 5839. The complex shall be divided into zones as specified.

Where cable loops are specified, each leg of cable between the Control Panels and the first device enroute shall pass through different zones as soon as practicable after leaving the panel.

A single fault in any zone shall not prevent the operation of other zones and shall not remove protection from areas greater than permitted by this Specification.

Equally a single short or open circuit fault on any part of the loop shall not cause system malfunction, loss of operation, power or ability to report an alarm in the unaffected areas.

2.4.4 Training

The Tenderer shall allow for the training of two of the Client's Technicians to a level where they are sufficiently confident and proficient in managing, trouble-shooting and maintenance of the system including programming of the system and devices as desired.

2.4.5 Standards and Regulations

The design, manufacture, selection, installation, testing, commissioning and subsequent maintenance of all equipment and materials described in this Specification shall comply with the requirements of:

- The current editions of BS 5839, BS 5445 and BS 5446,
- The current editions of EN54,
- The current editions of BS 5266, BS 2560 and BS 5499.

All equipment, apparatus and devices shall be as Menvier, GE Security (Aritech) or equivalent and approved.

2.4.6 System Operation

2.4.6.1 Access Codes

The system shall be designed to operate at 4 security levels, as follows:

Level 1:	No access Code-operator
Level 2:	Access Code – Maintenance
Level 3:	Access Code – Commissioning
Level 4:	Access Code – Supervisor

Access codes shall be allocated and entered into the panel by the Supervisor, who shall have the ability to change codes at any time. Facilities must be provided for entering operator names against each access code.

2.4.6.2 Operation

The system shall be designed to operate with the minimum of operator training. Basic fire alarm functions shall be completely self – explanatory, and shall be understood by a person with no training.

The occurrence of a fire alarm shall indicate all relevant text and zone information without operator intervention.

The operation of a fire or fault signal, or a keyboard operation carried out by an operator, shall not inhibit or delay in any way the receipt of additional alarms.

Should any part of the system be isolated, disabled, or placed in a maintenance mode, then a lamp on the front of the panel must illuminate to indicate the systems abnormal status.

When the system is normal with no event to report, the main control panel LCD shall display time and date, the name of the site, make and model of the system control equipment.

2.4.6.3 Fire Operation

An alarm received from a fire sensor or other devise shall cause the following actions to occur immediately:

- Common Fire lamps to illuminate
- Zone/Super zone lamp to illuminate

- The LCD display shall indicate in text the following:

    - The zone
    - Device type
    - Actual location and address
    - Event number
    - Date
- Panel buzzer to sound continuously
- Common sounders to operate in a pre-determined manner.
- Zone sounders to operate (if applicable)
- Required control functions to operate
- Remote text or lamp displays to operate
- Graphics computers to indicate alarm status
- Fire Brigade signal to operate.

Pressing an appropriate key shall silence the alarms, except the panel buzzer, which must sound intermittently for 0.5 second, every 20 seconds.

Pressing the "Reset" button shall reset the system to normal. Should an alarm condition still exist, then the above sequence of events must re-occur.

2.4.6.4 Fault Operation

A fault signal received from a fire sensor or other device, or from the panel or battery charger, shall cause the following to occur immediately, where appropriate:

- Common Fault lamps to illuminate
- Zone/super zone lamp to illuminate
- Display to indicate in text:

    - Fault Description
    - Zone Number
    - Detector Number
    - Exact Location

- Panel buzzer to sound continuously
- Required control functions to operate
- Remote text or lamp displays to operate
- Graphics computers to indicate alarm status.

Pressing an appropriate key shall silence the alarms. The visual alarms are to remain. In the event of more than one fault signal occurring simultaneously, then the test display must rotate between the alarms.

Should a fire alarm occur while a fault is displayed, then the fire alarm must replace the fault signal, which must restore after the fire alarm has reset.

Pressing the "Reset" key must reset the system to normal. Should a fault condition still exist, then the above sequence of events must re-occur.

2.4.6.5 Key Features of the System:

- 2 Zone L.E.D. indication with facilities to expand display if required.
- Alphanumeric 8 line 40-character liquid crystal display.
- Integral printer.

- An Amber system common "fault" L.E.D. indicator with individual Amber L.E.D.'s for the following:

  a) Pre-alarm
  b) Disabled devices/loop/alarm lines.
  c) System test.

- Push button control of Sound Alarms, Silence Alarms, with L.E.D. indication and Reset.
- A manual evaluation (sound alarms) push button shall be provided to operate the external sounders without causing other panel control relays to be activated. However, should a true alarm occur, all functions would occur as programmed.
- The alarm activation of any initiation circuit shall not prevent the subsequent alarm operation of any other initiation circuit.
- System control access shall be limited by programmable 4-digit numeric security code.
- The system shall operate on 24 volts DC provided by power supply unit, which is transformer, fed by mains voltage. In the case of mains failure, the system shall switch automatically to the stand-by batteries. These shall have enough capacity to support the system for 24 hours with 30 minutes of general alarm ringing.

It shall be possible to increase this to 72 hours with 30 minutes of general alarm ringing if required.

The batteries shall be monitored for low batter condition/disconnection and shall be audible and visually indicated on the control panel.

- Each loop shall be capable of driving up to 120 addressable devices over a maximum loop distance of 2 km.
- The system shall be capable of providing alarm and relay extensions, which can be connected at any address on the loop thus eliminating the need to wire directly from the panel. All extensions should be fully programmable via the control panel software.
- All external circuits shall be monitored for open circuit, short circuit and fuse failure.
- Loop address locations shall be monitored for device type fitted and any deviations from programmed allocation visually and audibly indicated.
- Loop address locations shall be monitored for device removal.
- System shall have a minimum of 2 independently monitored alarm lines per loop.
- It shall be possible to disable/enable individual devices, zones, loops and alarm lines for maintenance purpose.
- Panel shall have the facility for 1 man test mode. In this mode, external alarms will sound for 3 seconds then reset and give 3-second alarm to indicate reset has taken place. Each device test shall be indicated on Control panel printout as a test activation.
- It shall be possible to view the Analogue level of each detector from the control panel without initiating an alarm.
- Panel shall have Dirty Detector and Pre-alarm facilities with adjustable pre-alarm and full alarm thresholds.
- The system shall have day/night facilities to provide an esensitized level of detection programmable to clients' requirements.
- The system shall be capable of onsite programming to accommodate system expansion and facilitate changes in operation.
- All software operations shall be stored in non-volatile programmable memory within the control panel.
- Loss of primary and secondary power shall not erase the instructions stored in memory.
- The system shall have the capability of recalling alarm and fault conditions in chronological order for the purpose of creating an event history.
- Should a fault condition be present an audible fault Buzzer will sound. If silenced; the buzzer will resound at pre-programmed time intervals to act as a reminder that the fire alarm system is not fully functional.

- The control panel shall have 2 x R.S. 232 ports to allow programming and connection to ancillary equipment.
- The Control panel shall have facilities to operate repeater/mimic panels from a dedicated output and also capable of supporting repeater panels wired directly on the loop.
- It shall be possible to network analogue panels to give configuration of 24 loops.
- All panels and peripheral devices shall be the standard produce of a single manufacturer.

2.4.6.6 History Recording and Reporting

The AACIE shall contain a history buffer that will be capable of storing input/control events. Each of these events will be stored and time and date stamped with the actual time of the activation. The contents of the History Buffer may be manually retrieved, one event at a time, on the LCD or the printer.

The History Buffer shall use non-volatile memory. System that uses volatile memory or battery-backed memory for history storage shall not be acceptable.

2.4.7 System Components

The system shall comprise of but not restricted to the components outlined below:

2.4.7.1 Annunciator and Control Panel

The Control Panel shall incorporate a QWERTY keyboard and printer, fire indicator, user instructions and controls, power indicator, warning indicator, fault indicator, function keys, liquid crystal display (LCD) with automatic backlighting and integral power supply system.

The fire alarm control panel shall be mounted on the wall. The cabinet shall be made of sheet steel, with lockable door, viewing panel and solid state microprocessor based electronics.

The main annunciator/control panel shall be located at the Ground floor entrance lobby.

2.4.7.2 Interface Units

These shall be used to interface the fire detection and alarm system with remote sites and devices such as the fire brigade, firefighting systems etc.

2.4.7.3 Printer

The control panel shall incorporate an inkjet printer with an audible signal for end of paper and fault.

The printer shall be the automatic type, printing time, date, location, device description, category and condition. The printer shall provide a hard copy print out of all changes in status of the system and shall time stamp such minutes with the current time of day and date. The printer shall be incorporated in the main analogue addressable control and indicating equipment (AACIE) housing.

2.4.7.4 Break Glass Unit

The break glass unit shall be mounted at a height of 1350mm from FFL and shall be suitable for flush mounting. The break glass unit shall be addressable with an LED indicator incorporated as standard to confirm that the unit has operated.

2.4.7.5 Heat Sensors

The heat detector shall be analogue intelligent addressable type capable of being configured by the control panel to operate as a rate of rise heat detector. The base shall be lockable and common with that of the

smoke detector. It shall also incorporate a fixed temperature element operating at a predetermined temperature.

2.4.7.6 Smoke Detector

The smoke detector shall be analogue addressable optical type with in-built processing capacity. The base shall be lockable type and common with that of the heat detectors.

2.4.7.7 Electronic Sounder

The sounder shall be weatherproof type, suitable for 24V DC, low current consumption with high output.

2.4.7.8 Visible Flash Light

The unit shall be weatherproof type, suitable for 24V DC, low current consumption with high visible flash light

2.4.7.9 Short Circuit Isolators

Short circuits isolators shall be provided to protect loop integrity in the event of a short circuit fault occurring on the loop. They shall latch out either side of the short circuit fault, effectively disconnecting the faulty cable.

The short circuit isolator shall have an indicator LED visible throughout the front cover, which will illuminate when latched out due to short circuit cable fault.

The loop should be divided into sections not greater than a conventional zone and each section of the loop separated by a short circuit isolator, to a maximum of 20 per loop.

2.4.8 Software Control

2.4.8.1 General

The System shall at all times be under software control. Two types of software shall be provided, the operating programme and the configuration programme.

2.4.8.2 Auto Configuration

Upon switch-on, the panel shall, automatically and without manual intervention, programme itself to operate as follows:

1. Be fully functional (Fire and Fault)
2. All device addresses present to be recorded in memory
3. All device types to be recorded in memory
4. Devices to be automatically calibrated.
5. Common fire lamps must operate
6. Common sounder outputs (2) must operate
7. Common fault output must operate
8. Display must operate

2.4.8.3 Manual Programming

Additional configuration data, to tailor the system to the individual application, must be able to be programmed into the system. This programming must be able to be done both via the panel keypad, and by means of an external computer. In both cases it must be possible to save the programme to disk.

2.4.8.4 Storage of Software

All software, both the operating programme and the configuration data, shall be held in solid state memories. In particular, software shall not be held on magnetic tapes or discs, or any device requiring mechanical moving parts.

2.4.8.5 Operating Programmes

The operating programme must be held in permanent, non-volatile, read-only, EPROM memory, which shall not be erasable or alterable. Each EPROM shall be permanently labelled with a part number, and a version and issue number, which shall be traceable to a software manual.

The operating programme shall provide all auto-start and self-programming features to provide an operational system, without any manual programming, as described above.

2.4.8.6 Configuration Data

All configuration data shall be stored in non-volatile, EEPROM read-only memory, which can be electrically erased for editing purposes. The EEPROM used must retain all programmed data, even when the system is completely powered down.

Printed circuit mounted batteries, such as lithium cells, for retaining memory contents, are not acceptable.

All configuration data must be able to be edited through the keyboard.

2.4.9 Control and Indicating Equipment

2.4.9.1 General

Equipment shall be provided for the reception, indication, control and relaying of signals originating from detectors or call points connected to it and for the activation of alarm sounders, signalling devices and transmission/receipt of signals to/from remote locations.

Control panels shall be of modular design employing plug-in cards allowing future expansion and tailoring of detection zones and outputs to meet the Engineer's requirements.

Where plug-in zone modules are used, these shall operate independently of other zone modules.

Operation of the control panel in case of alarm or fault shall be achieved by simple guided instructions with visual indicators on the control buttons.

It shall be possible to set any zone to test mode for testing of detectors and call points without raising an alarm condition. It shall also be possible to test sounder circuits, by operation for one second and off for 10 seconds, repeated for as long as required.

Monitoring of detection and alarm circuits shall be provided in accordance with BS 5839.

In all systems the electrical power for operation of detectors shall be provided through the loop circuit wiring.

2.4.9.2 Workmanship

The installation and method of fixing of all devices covered by this section of the Specification, shall be co-ordinated with the building fabrics and finishes to which they are fixed.

All devices covered by this section of the Specification, shall be fixed true and level to the surfaces on which they are mounted to a tolerance of ±5mm.

Under no circumstances shall Detectors and Alarms be fixed to temporary or movable parts of the building fabric, including doors and furniture.

2.4.10 Integration with Other Systems

2.4.10.1 General

The Fire Alarm system where required shall be integrated with associated and ancillary systems. These shall include lifts, Public Address, Security System, sprinkler system, HVAC System.

Ancillary equipment shall be equipped with means of isolation and disabling of Automatic operation so that servicing and maintenance can be carried out in complete safety.

Unless otherwise specified, power supplies for associated and ancillary equipment shall be provided by means completely independent of the Fire Alarm System Power Supply. These power supplies shall comply with this Specification where their operation is essential to the functions of the Fire Alarm System.

Indicators and detectors associated with ancillary equipment shall be taken into account in calculating the maximum load of the Fire Alarm System power supply.

Faults in equipment for other functions shall not affect the performance of the Fire Alarm System.

Extension and alterations to associated systems including the isolation and removal of parts, shall be possible without affecting the operation and performance of the Fire Alarm System.

2.4.10.2 Interface Units

Interface units shall be provided to send signals to and receive signals from associated and ancillary systems. Unless otherwise specified, all signals shall be via volt-free relay contacts.

The volt-free relay contacts shall be provided by means of addressable input and output modules of the fire alarm detection loop, each module representing a single address.

Addressable input and output modules shall be compatible with the system to which they are connected, and shall be of the type that draw their power supply from the detection loop.

Contacts shall have a minimum rating of 5 Amp inductive at 240V a.c.

The Sub-Contractor shall be responsible for the interface and all wiring and connections between interface units and the system to which they are being interfaced.

2.4.10.3 System Requirements

Fire alarms in integrated systems must always take priority over all other systems and must not be delayed in operation by any manual or automatic event.

The layout of control panels in integrated systems shall be arranged so that Fire Alarm controls cannot be confused with other controls.

Operation of other system controls shall have no effect on the operation of the Fire Alarm System.

2.4.10.4 System Monitoring

All wiring systems for communications, detection and alarms shall be monitored for open and short circuits, removal of detectors as well as Alarm/Healthy conditions.

All faults shall be registered by audible and visible fault alarms, the latter being yellow coloured LED's.

Alarms due to system fault as opposed to a fire condition shall be restricted to the panel buzzer only.

2.4.10.5 Wiring Systems

The Sub-Contractor shall be responsible for the supply, installation, testing and commissioning of all the wiring/cabling systems required to provide a complete and operable system.

All wiring shall be in highly durable fire resistant cables as Pirelli FD200 complying with IEC 331, BS 6387, IEC 1034, BS 7622, IEC 754 – 1, BS 6425 – 1, IEC 332 – 1, BS 4066 – 1, IEC 332 – 3 and BS 4066 – 3. Cables shall be drawn in high impact heavy gauge PVC conduit installed in ceiling spaces, chased into walls or cleated onto surfaces and shall be routed through areas of low fire risk.

Voltage drops in cables shall not exceed the limit which will prevent devices operating within their specified range at all times.

Cross-sectional area of any conductor shall be at least 1.5mm2.

Overhead lines shall not be used for any Fire Alarm System Interconnections.

The routing of cables shall be arranged so that damage to a cable in a single compartment does not affect the correct operation of devices in any other compartment.

Conductors carrying fire alarm power or signals should be separated from conductors used for other systems.

Cables should be installed in accordance with good practices recommended in the latest edition of the IET Wiring Regulations.

2.4.11 Power Supplies

2.4.11.1 General

Power supplies shall be obtained from the 415/240V 50Hz, single or three-phase mains supply with a backup from an automatic connected battery powered standby supply provided by the Sub-Contractor in case of mains supply failure.

The mains supply shall be obtained from the main distribution panel at the point of supply, via an acceptable switch/fuse, fuse/switch or circuit breaker dedicated for that purpose and which is lockable, coloured red and labelled `FIRE ALARM SUPPLY DO NOT SWITCH OFF'.

A fault alarm shall be raised if the battery voltage falls below 84% of the nominal specified voltage.

Upon restoration of the mains supply following an interruption, the power supply shall automatically revert to normal operation.

2.4.11.2 Batteries

Batteries shall have a guaranteed minimum life expectancy of 10 years, under the specified loading and environmental conditions.

The batteries used shall be of the sealed gas-tight lead-acid type specifically designed for emergency power sources and complying with the relevant standard. The outer container shall be made of acid resistant high impact strength ABS plastic. The electrodes shall be of high purity lead separated by a gel electrolyte enabling full recombination of gases evolved during charging. An automatic safety valve shall be provided.

Each battery shall have a storage capacity sufficient to maintain the system plus 20% spare capacity for 72 hours in the standby mode and to supply the full alarm load for one hour, without the terminal voltage falling below 84% of its nominal value.

2.4.11.3 Battery Chargers

Battery chargers shall comply with this Specification and be suitable for operation from 415/240V 50Hz, single or three phase systems as required.

The battery charge shall be of the automatic two-rate constant voltage type operating of the float charging principle. The charge shall be designed to compensate for variations in ambient temperature in accordance with this Specification.

Provision shall be made for a boost charge, under manual control, at a current sufficient to fully recharge a completely discharge battery in not more than 24 hours.

The battery charger shall have a monitoring system connected to the Fire Alarm panel which will raise an alarm in the event of a battery and/or charger fault or malfunction.

The monitoring system shall raise an alarm if the battery voltage falls to 84% of its nominal value and if the voltage falls to 80% of the nominal value the battery shall be automatically disconnected.

The transformer shall be double wound with an earthed metallic screen between primary and secondary windings, which shall be wound for the specified voltage, rating and supply system frequency.

2.4.11.4 Enclosures

Each battery and its charger shall be housed in a substantial steel cabinet or cubicle with the battery in a separate compartment.

Cabinets with a total installed weight not exceeding 25kg shall be wall mounted.

The Sub-Contractor shall ensure that the wall and/or floor supporting the cabinet or cubicle is adequate for the purpose.

Enclosures shall be rigidly constructed from zinc-coated sheet steel, stiffened by folding or reinforcement. The sheet shall not be less than 914mm thick for wall mounted enclosures. After thoroughly degreasing all enclosures shall be finished with an oven baked epoxy powder paint.

The interior surfaces of the battery compartment shall be treated with an acid and alkali resisting finish.

Access to the enclosures shall be via an easily accessible door with adequate space for replacement of batteries and any other parts of the charger. Doors shall be double hinged and stiffened to ensure adequate rigidity.

The batteries and charger components shall be arranged for ease of access and any maintenance required.

Warning labels shall be provided drawing attention to the presence of mains voltages. Incoming and outgoing cables shall be specially separated.

Enclosures shall be suitably ventilated to ensure proper ventilation of both the battery and charger compartments. The ventilation system shall be arranged to ensure that the concentration of Hydrogen within the enclosure shall not exceed 1% and that the internal temperature does not exceed 40°C.

2.4.11.5 Workmanship

The installation of power supply equipment, shall be fully co-ordinated with the Fire Alarm Control Panels, building fabrics and finishes provided by others, in an acceptable manner.

The method of fixing and the mounting height of flush and surface mounted power supply units, shall be properly coordinated with the fabrics and finishes.

Provision shall be made for the easy entry and termination of incoming and outgoing cables.

All power supply units shall be fixed true and level to the surfaces on which they are mounted with a tolerance of ±0.5mm.

2.5 SPECIALIST WORKS

2.5.1 Scope of Works

This section of the specification covers the supply and installation of conduits, cable trays, trunking systems, draw and adaptors boxes underground ducts and lead pipes necessary for the distribution cables in accordance with the contract drawings and specifications for the following specialist services:

- Structured Cabling Installations
- CCTV Surveillance and Access Control Systems
- Audio Visual facilities and Public Address systems
- *Mechanical Services* Installations
- etc.

All conduits shall be adequately sized to suit system and shall be complete with draw-wire. Conduits less than 25 mm dia shall not be acceptable.

2.5.2 Attendance

The Sub-Contractor shall allow for attendance to the respective specialist in the appropriate price schedule of the Bills of Quantities.

The equipment for the above systems shall be supplied by others under separate Sub-Contractors.

PRICE SCHEDULES

3 PRICE SCHEDULES

3.1 General Notes to Tenderers

1. The Bills of Quantities form part of the contract documents and are to be read in conjunction with the contract drawings and general specifications of materials and works.

2. The prices quoted shall be deemed to include for all obligations under the sub-contract including but not limited to supply of materials, labour, delivery to site, storage on site, installation, testing, commissioning (**excluding 14% VAT**).

3. All prices omitted from any item, section or part of the Bills of Quantities shall be deemed to have been included to another item, section or part thereof.

4. The brief description of the items given in the Bills of Quantities are for the purpose of establishing a standard to which the sub-contractor shall adhere. Otherwise alternative brands of **equal** and **approved** quality will be accepted.

5. Should the sub-contractor install any material not specified here in before receiving **written approva**l from the Project Manager, the sub-contractor shall remove the material in question and, **at his own cost**, install the proper material.

6. The grand total of prices in the price summary page must be carried forward to the **volume 1**.

7. The Bills of Quantities are divided generally into three sections:-

   a. Contractual Requirement – Bill 1

   The sub-contractor shall study the conditions and make provision to cover their cost in this Bill. The number of contractual items to be priced by the Tenderer have been limited to tangible items such as site office, temporary works and others. However the Tenderer is free to include and price any other items he deems necessary taking into consideration conditions he is likely to encounter on site.

   b. Installation Items – Other Bills

   The brief description of the items in these Bills of Quantities should in no way modify or supersede the detailed descriptions in the contract Drawings, conditions of contract in volume 1 and specifications. The unit of measurements and observations are as per those described in the contract documents.

   c. Summary

   The summary contains tabulation of the separate parts of the Bills of Quantities carried forward with provisional sum, and any prime cost sums included. The sub-contract shall insert his totals and enter his grand total tender sum in the space provided below the summary.

   The grand total tender sum shall be carried forward to form of Tender

3.2 Bills of Quantities

(Continue to the next page)

PROPOSED LABOUR WARD IMPROVEMENTS.

GENERAL ELECTRICAL INSTALLATIONS

PRICED BILL OF MATERIALS

SECTION D.W. 1.0 TITLE: PRELIMINARIES AND CONTRACTUAL REQUIREMENTS

Item	Description		Qty	Rate (Kshs)	Total (Kshs)
D.W.1	**CONTRACTUAL REQUIREMENTS**	-			
A	Preparation of 'Working Drawings", printing and distribution as specified. Drawings to include:	Sum	1		-
B.	Preparation of 'As Built Drawings", printing and distribution as specified. Drawings to include:				
	(a) Blue Prints - 4 sets of each.	Sum	1		-
	(b) AutoCAD on CD – 2 No.	Sum	1		-
	(c) Operational Instructions, Manuals and Test Certificates	Sum	1		-
C.	Provision of Performance Bond as stated under clause 5 of the published conditions of sub-contract.	Sum	1		-
D.	Allow for removal of existing equipment/items and handing over to the client.				-
E.	Any other item necessary to complete the installations in this section (please state)				

Total Carried to Main Summary of Prices **-**

	SECTION DW 2; Power Distribution System				
S/N	**Description**	**Unit**	**QTY**	**Rate (Kshs)**	**Total (Kshs)**
A.	35mm² XLPE/PVC Four (4) Core Copper cable from the NHMP Power Centre to the Proposed Labour Ward Main Power DB	M	150		-
C.	12 way 125A TPN Raw Distribution Board Complete with Outgoing Breakers, Spareways and Blanking Plates as shown on the Contract Drawings.	No.	1		-
D.	8 way 63A SPN UPS Distribution Boards Complete with Outgoing Breakers, Spareways and Blanking Plates as shown on the Contract Drawings.	No.	1		-
E.	16mm² XLPE/PVC Four (4) Core Copper cable from the Raw Power DBs to Clean Power DBsVia UPS BYPASS & UPS	M	100		-
F.	Any Other item (s) needed to complete the installation in this section (Please state)				
	Sub - Total Carried Forward to the Main Summary Page				-

SECTION D.W. 3.0: ARTIFICIAL LIGHTING					
S/N	Description		Qty	Rate (Kshs)	Total (Kshs)
	ARTIFICIAL LIGHTING	-			
	Lighting points wired in 1.5mm2 pvc/sc copper cables drawn in 20mm diameter pvc heavy gauge conduits complete with switching accessories, Switches, etc as shown on drawings.	No	112		-
	The following luminaires complete with rated LED lamps (SMD technology only) with 50000 Lifetime L70 (hrs), SDCM ≤ 6 as specified:				
A.	TYPE (J4) - IP43 38W, 600 x 600mm Backlit LED Light Panel Luminaire as Specifications and Approved by Engineer	No	2		-
B.	TYPE (J4E) - IP43 38W, 600 x 600mm Backlit LED Light Panel Luminaire as Specifications and Approved by Engineer	No	1		-
C.	TYPE (J2) - IP43 38W, 300 X 1200 mm LED Backlite Skyblue Panel Luminaire as Specifications and Approved by Engineer	No	2		-
D.	TYPE (J2E) - IP43 38W, 300 X 1200 mm LED Backlite Skyblue Panel Luminaire as Specifications and Approved by Engineer	No	7		-
E.	TYPE (N) - IP65 18W, 240V Low Profile Surface Mounted luminaire fitted with microwave sensor and Emergency Kit	No	8		-
F.	TYPE (D) - IP65 20W, 240V, 120mm Backlit Surface/ceiling Mounted LED Donlight Light Luminaire	No	40		-
F.	TYPE (DE) - IP65 20W, 240V, 120mm Backlit Surface/ceiling Mounted LED Donlight Light Luminaire	No	6		-
G.	TYPE (S)-15W LED, IP65 Polycarbonate Triple Ant-corrosive luminaire	No	8		-
H.	TYPE (L) 9W, IP20 LED Downlighter luminaire to Specification.	No	12		-
I.	TYPE (EL) - 8W Dual Sided Ceiling Mounted LED Exit Light to specifications.	No	2		-
J.	TYPE (EL) - 8W One Sided Ceiling Mounted LED Exit Light to specifications.	No	1		-
K	Light Motion sensor (occupancy sensor).	No	15		-
L	Wiring to Bed Head Luminaire and room light switching compete with two way switching (separate circuits).	No	8		-

Total Carried Forward to Next Page -

SECTION D.W. 4.0 TITLE: POWER INSTALLATIONS					
S/N	**Description**		**Qty**	**Rate (Kshs)**	**Total (Kshs)**
	The following power outlets complete with 25mm diameter PVC Heavy gauge conduits, all accessories and wiring as specified:	No.	109		-
A.	13A Twin Water Tight Metal Glad Socket outlet	No	2		-
B.	13A Twin Standard Socket outlet in "White" Color for Normal power	No	25		-
C.	Work Station 1 comprising with Twin Socket Outlet for Raw Power, Twin Socket Outlet for Clean Power and Twin Data Point Outlet.	No	6		-
D	Work Station 3 comprising with 2NO. Twin Socket Outlet for Clean Power and 1NO.Dual Data Point Outlet.	No	10		-
E	Work Station 6 comprising with 1NO. Twin Socket Outlet for Clean Power and 1NO.Data Point Outlet for TV	No	8		-
F	15A Unswitched Spur Socket outlet	No	4		-
G	32A SPN Isolator complete with 2x4.0 Sq mm pvc/swa/pvc CU Cable (cable approx. 45metres) and associated accessories	No	2		-
H	20A D.P. Switch complete with 3x2.5 sq mm SC CU Cables and associated accessories	No	25		-
I	Wiring to Bed Head Luminaire and room light switching compete with two way switching (separate circuits).	No	8		-
J	13A Single Standard Socket outlet for X-Ray Viewer	No	7		-
K	Allow for wiring with 3x2.5sq mm PVC SC CU cables drawn in 25mm dia. pvc conduits to the Bed head unit - Critical Power Supply line (Workstation 2)	No	12		-
L	Wireless Point Outlet complete with Conduit only & Draw wire.	No	2		-
M	TV outlet complete with Conduit only & Draw wire	No	7		-
N	CCTV Camera point Outlet complete with Conduit only & draw wire.	No	2		-
O	Access Control point Outlet complete with Conduit only & draw wire.	No	2		-
P	Nurse Call point Outlet complete with Conduit only & draw wire.	No	9		-
Total Carried Forward to Collection Page					-

SECTION D.W. 5.0 TITLE: CABLE MANAGEMENT SYSTEM					
S/N	**Description**		**Qty**		**Total (Kshs)**
5	**CABLE MANAGEMENT SYSTEM**	-			
	Supply, installation, testing & commissioning of the following complete as specified: -				
A	300x50mm Heavy Gauge Cable Tray complete with angles, bends etc as shown on contract drawings	M	50		-
B	250x50mm 2-Compartment uPVC Trunking complete with external/internal angles, covers, bends etc as shown on contract drawings	M	30		-
C	250x50mm 2-Compartment uPVC Below Worktop Trunking complete with covers as shown on contract drawings	M	10		-
D	32mm Heavy gauge PVC Conduits in Floor Screed	M	150		-
E	Any other item necessary to complete the installation in this section (Please state).	Sum			
Total Carried to Main Summary Page					-

6	SECTION DW 6; FIRE DETECTION AND ALARM SYSTEM				
S/N	**Description**	**Unit**	**Qty**	**Rate (Kshs)**	**Total (Kshs)**
	For the supply and installation of the following complete with associated accessories to complete the installation as specified and shown on the contract drawings:				
	2 Zones, 1 Loops Analogue Addressable fire detection and alarm panel complete with printer and with associated accessories.	No.	1		-
	Combined Ionization and Photoelectric type Analogue Addressable smoke detector mounted on ceiling or on wall complete with 25mm diameter HG PVC conduit work and LSZH fire resistant cabling as specified and shown on the contract drawings as follows;	No.	16		-
	Analogue addressable Fire alarm combination bell/visual strobe complete with 25mm diameter HG PVC conduit work and LSZH fire resistant cabling as specified and shown on the contract drawings as follows;	No.	9		-
	Analogue Addressable Fire alarm combination bell/visual strobe complete with 25mm diameter HG PVC conduit work and LSZH fire resistant cabling as specified and shown on the contract drawings as follows;	No.	2		-
	Allow for programming of the alarm system as described in the fire alarm sequence of operation	Sum	1		-
	Allow for programming of the alarm system as described in the fire alarm sequence of operation to work with the existing Fire Alarm Panel for other floors	Sum	1		-
	Sub - Total Carried to the Main Summary Page				-

7	SECTION DW 7; UPS POWER SUPPLY SYSTEM				
S/N	**Description**	**Unit**	**QTY**	**Rate (Kshs)**	**Total (Kshs)**
	Uninterruptible Power Supply (UPS) Supply & Installation of the following complete as specified:				
A.	20 kVA 3 Phase in 3 phase out True-on-line double conversion uninterruptible Power Supply unit (UPS) complete with 10 Minutes Autonomy, dual power supply unit, Electronic Voltage Booster, Li-on Batteries and accessories as specified and shown on the drawings. The Approved brands are APC, ABB, Eaton or approved equivalent.	No.	1		-
B.	Allow for 40A Change Over Switch for the UPS to allow for Isolation during maintenance.	No.	1		-
C.	Installation, testing & commissioning of the above UPSs	Sum	3		-
D.	Labeling, Documentation, 1year Warranties, associated Training and certification.	Lot	1		-
E.	Allow for interfacing with other System like Fire Detection & Alarm System and BMS as call for and approved by Engineer and shown on the drawings.	Sum.	1		-
F.	Any other item necessary to complete installation in this section (Please state)	Sum			
	Sub - Total Carried to the Main Summary Page				-

PROPOSED FIT OUTS AND RE-ORGANIZATIONS FOR THE LABOR WARDS IN NAIROBI HOSPITAL		
GENERAL ELECTRICAL INSTALLATIONS		
PRICED BILL OF MATERIALS		
Item	**Description**	**Total (Kshs)**
1	**SECTION 1** Preliminaries and Contractual Requirements	-
2	**SECTION 2** Power Distribution	-
3	**SECTION 3** Artificial Lighting	-
4	**SECTION 4** Power Installations	-
5	**SECTION 5** Cable Management	-
6	**SECTION 6** Fire Detection and Alarm	-
7	**SECTION 7** UPS Installations	-
	Sub Total	-
	Rates are Inclusive of VAT	
Summary Carried Forward to Main Collection Page		-

3.3 Schedule of Unit Rates

The tenderers shall provide a schedule of unit rates (under Tables (a) and (b) below) that shall be used to build up rates for variation items not specified in the bill of quantity.

This section, and the terms filled herein shall form part of the contract, and shall be considered locked for the duration of the project.

Rates filled herein shall be evaluated as part of the tender evaluation process. Attention is drawn to the tender evaluation criteria included in this tender package.

The sub-contractor shall disclose the cost of the material offered by the supplier, including or manufacturer or any other sources to the Engineer used to build up the rates in respect to schedule of table (a) and table (b) below. The engineer can reject the disclosed sources where the conflict of interest seems to prevail.

Table (a) and Table (b) shall be deemed to be exhaustive in capturing all cost components and the percentages filled herein shall be considered to be locked for the duration of the contract.

3.3.1 Locally Available Items

Unit rates for items that can be procured locally shall be generated according to table (a) below. Table (a) consists of the below items:

- Material cost – This is the supplier's unit cost for the item, i.e. the cost at the shop/supplier.
- Labour – This is to include all transportation, security, hoisting, installation, tools and consumables, testing, commissioning, costs, etc. The tenderer is to provide his/her labour cost as a percentage of material cost.
- Overheads and Profit – This is to capture all Sub-contractor's overheads, margins, profit, etc. The tenderer is to provide his/her overheads and profit as a percentage of material cost.
- Further to this, tenderers are expected to list all other cost carriers not deemed to have been captured in the table below, as a percentage of material cost.

3.3.1.1 Table (a): Locally Available Items.

Material Cost Kshs. (a)	Labour (as a percentage of material cost) (b)	Overheads and Profit (as a percentage of material cost) (c)	List any other component as necessary (as a percentage of material cost) (d)	Total Installed Cost of item shall Kshs. a + (axb%) + (axc%) + (axd%) (VAT exclusive)
	……..%	……..%	……..%	

3.3.2 Imported Items

Unit rates for items that will require importation shall be generated according to table (b) below. Table (b) consists of the below items:

- Material cost – This is the supplier's unit cost for the item as landed and cleared in Kenya. It includes FOB price, Carriage Insurance & Freight, Inspection Charges, Duty, Port Levies, Clearance Charges and VAT.
- Labour – This is to include cost for transportation from port to site, security, hoisting, installation, tools and consumables, testing, commissioning and associated costs, etc. The tenderer is to provide his/her labour cost as a percentage of material cost.

- Overheads and Profit – This is to capture all Sub-contractor's overheads, margins, profit, etc. The tenderer is to provide his/her overheads and profit as a percentage of material cost.
- Further to this, tenderers are expected to list all other cost carriers not deemed to have been captured in the table below, as a percentage of material cost.

3.3.2.1 Table (b): Imported Items.

Material Cost Kshs. (a)	Labour (as a percentage of material cost) (b)	Overheads and Profit (as a percentage of material cost) (c)	List any other component as necessary (as a percentage of material cost) (d)	Total Installed Cost of item shall Kshs. a + (axb%) + (axc%) + (axd%) (VAT exclusive)
	……..%	……..%	……..%	

…….. **(Signed)**

…….. **(Date)**

…….. **(Official Stamp)**

3.4 Day Work Terms for Labour

(To Be Completed By Tenderer)

Description of Artisan	**Cost Per Hour**
Supervisor	……
Grade A Electrician	……
Grade B Electrician	……
Grade C Electrician	……
Labour	……
Apprentices	……

…… **(Signed)**

…… **(Date)**

…… **(Official Stamp)**

4 TECHNICAL SCHEDULE

4.1 Switchgears Technical Data Sheet

4.1.1 Environmental Conditions

Site location		Nairobi, Kenya
Altitude above sea level	**m**	1795
Highest recorded temperature	**°C**	35
Average recorded temperature	**°C**	19
Lowest recorded temperature	**°C**	4.4
Highest recorded Humidity	**%**	80
Average Recorded Humidity	**%**	65
Lowest recorded Humidity	**%**	30
Corrosion conditions		Normal

4.1.2 Number of units and name tags

Drawing No.	Name tag	Assembly designation / Description

4.2 Testing Requirements

Routine Test – Inspection of the assembly including inspection of wiring	YES
Routine Test – Functional and electrical operation test	YES
Routine Test – Dielectric test	YES
Routine Test – All relevant temperatures, press ures, flows, speeds	YES
Routine Test – Checking of protective measures and of the electrical continuity of the protective circuits	YES
Routine Test – Insulation resistance	YES
Type Test – Verification of the temperature rise limits	YES
Type Test – Verification of the dielectric properties	YES
Type Test – Verification of the short-circuit withstand strength	YES
Type Test – Verification of the effectiveness of the protective circuit (Earthing and bonding)	YES
Type Test – Verification of clearances and creepage distances	YES
Type Test – Verification of the mechanical operation	YES
Type Test – Verification of the degree of protection (IP rating)	YES
Site Test – Functional and electrical operation test	YES
Site Test – Checking of protective measures and of the electrical continuity of the protective circuits	YES
Site Test – Insulation resistance	YES
Special Test – Temperature-rise test	yes
Special Test – Dielectric properties	Yes
Special Test – Short-circuit withstand strength	Yes

4.3 Documentation Requirements

Document	With Bid	Before Manufacture	During FAT	Upon Delivery
Preliminary general arrangement drawing (with dimensions)	YES			
QA / QC Plan in accordance with ISO 9001:2008		YES		
General arrangement drawing (with dimensions)		YES		
Schematics/Line diagrams for construction	N/A	YES	N/A	N/A
Recommended Spares List	N/A	N/A	N/A	YES
Routine Test Reports / Certificates			YES	
Type Test Reports / Certificates	N/A	N/A	YES	N/A
Commissioning Procedure	N/A	N/A	N/A	YES
As-built General arrangement drawing			YES	
As-built Schematics			YES	
Site Test Reports / Certificates				YES
Special Test Reports / Certificates	N/A	N/A	YES	NO

4.4 Technical Schedule

The tenderer **MUST SUBMIT** comprehensive manufacturer's technical brochures and performance details for all items listed in this schedule (fill forms attached).

ITEM No.	Description	Remarks
A	Copper cables	
B	Distribution Board	
C	Consumer Units	
D	Conduits	
E	Isolators	
F	Light fittings	
G	Power Sockets	
H	Lighting switches	
I	DP switches	
J	Data/Voice outlets	
K	TV outlets	
L	Trunking	
M	Cable tray/cable ladder	
N	Fire detection system	
O	UPS Unit	
P	Fire Cables	

5 APPENDICES

5.1 Appendix I; Statement of Compliance

Technical Schedules shall be submitted by tenderers to facilitate and enable the Engineer to evaluate tenders but only when the fittings and accessories upon which the tenderer has based his tender sum differs in manufacture, type or performance from the description contained within this specification.

Tenderers shall submit separate leaflets and catalogues giving technical and physical details for all fittings and accessories described in the Technical Schedule at the time of tendering.

Completion of Technical Schedule shall not relieve the Sub-Contractor from complying with the requirements of the Specification except as may be approved by the Engineer.

…….. **(Signed)**

…….. **(Date)**

5.2 Appendix II; Exchange Rate Fluctuations

Adjustment will be made to the price of imported materials to compensate for variations in the foreign exchange rate. For this purpose, the tenderer is required to state the exchange rate in Kenya Shillings for the currency of the Country of origin of imported materials as applied to the actual remittance effecting payment to manufacturers of the materials.

Exchange Rate: ……..

Signed (as in Tender) ……..

Date ……

5.3 Appendix III; System Warranties

The tenderer shall outline the warranties for all systems installed on this site as specified elsewhere.

These shall include but not limited, to the following:

- Copper cables
- Distribution Board
- Consumer Units
- Conduits
- Isolators
- Light fittings
- Power Sockets
- Lighting switches
- DP switches
- TV outlets
- Trunking
- Cable tray/cable ladder
- Fire detection system
- UPS Unit
- Sounders
- Fire Cables
- etc.

5.4 Appendix VI; Technical Schedule

TECHNICAL SCHEDULE

The tenderer must complete in full the technical schedule. Apart from the information required in the technical schedule, the tenderer **MUST SUBMIT** comprehensive manufacturer's technical schedules details for all items listed in this schedule (fill forms attached).

Description	Manufacturer	Country of origin	Remarks (Catalogue No. etc.)
• Copper cables • Distribution Board • Consumer Units • Conduits • Isolators • Light fittings • Power Sockets • Lighting switches • DP switches • TV outlets • Trunking • Cable tray/cable ladder • Fire detection system • UPS Unit • Sounders • Fire Cables • Photocell etc.			

GENERAL SPECIFICATION

1 GENERAL SPECIFICATION

1.1 General:

The site of the proposed Sub-Contract works shall be at The Nairobi Hospital, along Argwings Kodhek Road.

1.2 Reference Sites:

The offered equipment shall have been sold in Kenya in sufficient quantities to provide good proof of a Tenderer's capability of handling similar projects. Tenderers shall supply a detailed record of similar equipment that have been installed by them.

In addition to ensure continued support of the proposed equipment from the manufacturer, the Tenderer must submit documentary evidence that they are indeed authorised and accredited distributor/reseller of the manufacturer.

1.3 Cable Management:

The necessary infrastructure for the Proposed Systems shall be done by the Electrical Sub-Contractor, however additional requirements should be necessary the Sub-Contractor shall provide all the working drawings showing all the necessary conduit/trunking cable ways.

1.4 Systems Requirements:

The systems shall comprise but not limited to the following:

- Structured Cabling

1.5 Commencement of Works:

The Tenderer in submitting his bid shall be deemed to have allowed for commencing the works on site immediately upon appointment.

1.6 Scope of the Sub-Contract Works:

The Sub-Contract Works shall comprise the supply, delivery, erection, testing, commissioning and setting to work of the complete **systems** as detailed in this Specification and accompanying Sub-Contract Drawings.

The Tenderer shall include for all apparatus and appliances not particularly called for in this Specification or on the Sub-Contract Drawings but which are necessary for the successful completion and satisfactory functioning of the Sub-Contract Works.

It is deemed that if, in the opinion of the Sub-Contractor at the time of tendering there exists a discrepancy in the Specification, Drawing or both, that the Sub-Contractor clarifies this difference with the Engineer before tendering.

The Tenderer shall provide as an integral part of his bid a statement of compliance in which he shall clearly declare any items of the Specifications to which his offer does not comply and an alternative which is included in the offer.

The Sub-Contractor shall be obliged to liaise with other parties involved in the project and to provide any necessary information as and when required.

No claims for extra payment shall be accepted from the Sub-Contractor due to his failure to adhere to the above requirements.

The work to be installed under the Sub-Contract shall comprise but not restricted to the supply and installation of the following complete as specified elsewhere in this Specification:

1. Data cabinets
2. Patch cords
3. Cables UTP and fiber
4. Termination modules
5. Active equipment
6. Patch panels
7. Routers
8. Wireless devices
9. IP Telephony Devices
10. Etc.

All equipment as far as is practicable shall be designed and manufactured by a single preferred manufacturer. In any case equipment shall be of uniform standards compatible in operation and spare parts trained support and maintenance facilities being available. In this regard the Tenderer shall produce a letter of guarantee and commitment from the equipment manufacturer for production at tender opening. Any tender without such a commitment letter shall be rejected.

1.7 Ordering of Materials:

The Sub-Contractor shall order materials from quantities taken from his own approved working drawings and not from the quantities shown on the Sub-Contract Drawings or in the Specification.

1.8 Builder's Work Requirements:

All chasing, cutting away and making good of walls and slabs shall be by the Main-Contractor.

1.9 Tender Return Items:

Drawings and publications illustrating the systems and equipment being offered against the schedules shall be returned with the Tender, together with a comprehensive description of the systems being offered to meet the requirements detailed elsewhere in the Specification.

1.10 Standards and Regulations:

The design, manufacture, selection, installation, testing, commissioning and subsequent maintenance of all equipment and materials described in this Specification shall comply with internationally recognised standards.

1.11 Documentation:

Record Drawings, Operating instructions, log book and certificates of installation and commissioning shall be provided adjacent to the control and indicating equipment at the end of the Sub-Contract.

Operating and Maintenance Instructions shall be provided before the system is accepted. The instructions shall describe the system operation, zoning, routine care and maintenance, fault finding procedures and the function and settings of all controls.

The instructions shall include a full set of drawings, other manufacturer's handbooks and proprietary items and a complete list of spare parts provided and which are available. Full details shall be provided of all manufacturers and Sub-Contractors.

1.12 Defects Liability and Spares:

The Sub-Contractor shall provide a comprehensive routine and emergency call out service for the defects liability period, and shall confirm the response time to be provided. This service shall include routine examination and any adjustments, cleaning, replacement of parts as required to keep the system in full working order.

All equipment shall have a minimum 1 year warranty period from the manufacturer.

The Tenderer shall include details of a proposed Maintenance Sub-Contract to provide regular maintenance from the start of the defects liability period, in accordance with this specification. The Client is not bound to accept the offer from the Sub-Contractor.

An appropriate set of spares shall be provided, including consumable and modular items, which can be replaced by on-site maintenance staff. A list of the proposed spare parts shall be provided with the Tender.

1.13 Inspection, Testing and Commissioning:

The Sub-Contractor shall inspect, test and commission the works in accordance with the equipment manufacturer's recommendations. The results of all tests shall be recorded on the standard test forms unless otherwise specified.

Before completion of the installation the Sub-Contractor shall submit to the Engineer for acceptance, a method statement of the procedure to be used for testing and commissioning, which has been agreed with the equipment manufacturers.

Before cables are terminated each cable shall be tested for continuity, insulation resistance, polarity and markings. Following satisfactory testing, cables shall be terminated in the equipment only by the manufacturer's appointed representative.

Power supplies shall be tested prior to making connections to the control equipment. The Sub-Contractor shall allow for all necessary attendance during the testing and commissioning of any ancillary systems interconnected with the security system.

PARTICULAR SPECIFICATIONS

2 PARTICULAR CONDITIONS

2.1 Location of Site

The site of the proposed Sub-Contract works shall be at The Nairobi Hospital, along Argwings Kodhek Road.

2.2 Commencement of the Works

The Tenderer in submitting his bid shall be deemed to have allowed for commencing the works on site immediately upon appointment.

2.3 Scope of Sub-Contract Works

The Sub-Contract shall comprise the supply, delivery, installation, testing, commissioning and setting to work of the complete voice, data and image /video system as detailed in this Specification and accompanying Contract Drawings.

The Tenderer shall include for all apparatus appliances and accessories not particularly called for in this Specification or on the Contract Drawings but which are necessary for the successful completion and satisfactory functioning of the Contract Works.

It is deemed that if, in the opinion of the Sub-contractor at the time of tendering there existed a discrepancy in the Specification, Drawing or both, that the Sub-contractor clarifies this difference with the Engineer before tendering.

The tenderer shall provide as an integral part of his bid, a statement of compliance in which he shall clearly declare any items of the Specification to which his offer does not comply and an alternative which is included in the offer.

The Sub-contractor shall be obliged to liase with other parties involved in the project and to provide any necessary information as and when required.

The Sub-contractor shall, where applicable mark the details of structural, duct or conduit provisions for the installation of their cables or equipment.

No claims for extra payment shall be accepted from the Sub-contractor due to his failure to adhere to the above requirements.

The work to be installed under the Sub-contract shall comprise but not restricted to the supply and installation of the following:

- Structured cabling
- Active equipment
- Unified communication

- IP Telephony Devices

All equipment as far as is practicable shall be designed and manufactured by a single preferred manufacturer.

In any case equipment shall be of uniform standards compatible in operation and spare parts, trained support and maintenance facilities. In this regard the Tenderer shall produce the necessary letter of **Product and Applications Assurance Warranty.**

2.4 Ordering of Materials

The Sub-contractor shall order materials from quantities taken from his own approved working drawings and not from the quantities shown on the Contract Drawings or in the Specification. The tenderer shall ensure that all correct parts are ordered and installed.

2.5 Builder's Work Requirements

All chasing, cutting away and making good of walls and slabs will be by the Main Contractor.

The Sub-Contractor shall however be responsible for ensuring that the Builder's work has been carried out accurately and in accordance with his requirements.

2.6 Orientation

The Tenderer shall allow for the orientation of the Client's representatives to a level where they are sufficiently confident and proficient in managing, trouble- shooting and maintenance of the systems.

The orientation shall be carried out immediately after installation and shall be taken into consideration in assessing the completion of the project and release of payments.

The Sub-contractor shall be deemed to allow for any costs associated with the orientation.

2.7 Tender Return Items

The tenderer shall submit the following together with the tender:

- Drawings and publications illustrating the systems being offered against the schedules.
- A comprehensive description of the control systems being offered to meet the requirements detailed elsewhere in the Specification.

- The Manufacturers Catalogues showing such details as dimensions, colours and configurations.

- Other documents referred elsewhere in this specification.

2.8 Standards and Regulations

The design, manufacture, selection, installation, testing, commissioning and subsequent maintenance of all equipment and materials described in this Specification shall comply where applicable with the requirements of:

[i] Institute of Electrical and Electronic Engineers [IEEE]

[ii] Communication Authority of Kenya (CAK).

[iii] Kenya Bureau of Standards (KBS).

[iv] CENELEC.

[v] International Standards Organisation/International Electro technical Commission [ISO/IEC] IS 11801.

[vi] The following Electronic Industries Association/Telecommunications Industry Association [EIA/TIA] Standards:

(a) 568B – Commercial Building Telecommunications wiring standards.

(b) 569 – Commercial Building Standard for Telecommunications pathways and spaces

(c) TSB-67 – Transmission Performance Specifications for Field Testing of Unshielded, Twisted Pair Cabling Systems.

(d) 72 - Centralised Optical Fibre Cabling Guidelines.

(e) 75 – Cabling Practices for Open Offices.

[vii] Underwriter's Laboratories [UL] Cable Certification and follow up Programme.

2.9 Site Visit

The Tenderer must visit the site and shall be deemed to have satisfied himself with regard to conditions under which the Sub-Contract Works shall have to be carried out.

2.10 Defects Liability, Spares and Maintenance Contract.

The Sub-Contractor shall provide a comprehensive routine and emergency call out service for the defects liability period, and shall confirm the response time to be provided. This service shall include routine examination and any adjustments, cleaning, replacement of parts as required to keep the system in full working order.

The tenderer shall include details of a Maintenance Contract to provide regular maintenance from the start of the defects liability period, in accordance with this specification. The Sub-contractor should note that the Client may wish to enter into a negotiation with him/her and is therefore not bound to accept the charges proposed.

2.11 Warranty

The Sub-Contractor shall submit an extended Product Warranty and Applications Assurance of at least 15 years for the installation where applicable.

The Extended Product Warranty from the Manufacturer shall include but not restricted to the following conditions:

(a) That the registered cabling installation shall be free from manufactured defects in material or workmanship under normal and proper use.

(b) That all approved passive cabling products of the registered installation meet or exceed the (Near End Cross Talk) NEXT, PSNEXT, ELFEXT, PSELFEXT, return loss, bandwidth and attenuation/loss specifications of the ISO/IEC IS 11801 (1995), CENELEC EN 50173 1995 and TIA/EIA 568-B and their approved amendments.

(c) That the installation will meet or exceed the PSNEXT, ELFEXT, PSELFEXT, return loss, attenuation and NEXT requirements of ISO/IEC 11801(1995), CENELEC EN 50173 (1995) and TIA/EIA 568-B and their approved amendments for copper cabling.

(d) That the installation will meet or exceed the attenuation/loss and bandwidth requirements of ISO/IEC is 11801 (1995), CENELEC EN 50173 (1995) and TIA/EIA 568-B and their approved amendments for fibre cabling.

The Applications Assurance shall cover but not restricted to the following conditions:

(a) That the registered structured cabling system will be free from failures, which prevent operations of the specific application(s) for which it was originally designed. This shall not include failures due to electronic hardware and/or software.

(b) Applications specified in the current and future versions of the manufactures structured cabling system performance specifications.

(c) Any application introduced in the future by standards or user forums that use the ISO/IEC IS 11801 or TIA/EIA 568-B UTP or fibre components and UTP or fibre link/channel specifications for cabling.

2.12 Workmanship

The installation and method of fixing of all device covered by this specification shall be co-ordinated with building fabrics and finishes to which they are fixed.

Work shall be done to the highest standards of care within the industry and shall be subject to inspection and acceptance by the Engineer.

Inspection by the Engineer shall not relieve the Sub-Contractor from any responsibility for the proper supervision and execution of the work described in this specification.

All components of the installation shall be installed in a neat manner. Wiring colour codes shall be strictly observed and terminations shall be uniform throughout the system. Identification markings and systems shall be uniform. TIA/EIA 606 administration guidelines shall be used as standard for all structured cabling system wiring.

2.13 Documentation

The Sub-contractor shall provide a theoretical and practical orientation prior to the final commissioning covering the following subjects:

- The generic cabling system [general description, technical specifications, standardizations etc.]
- Link performance measurements (what, how, test equipment etc.).
- Network administration (purpose, needs etc.).
- Maintenance of the generic cabling system (trouble shooting, spare parts etc.).
- Training manuals for all the above installations.
- Troubleshooting manual for all the installed systems.
- Any other documents necessary for the above installation.
- Any other training found indispensable, desirable by the Sub-contractor to recommend by the manufacturers.

The Sub-Contractor shall also provide a complete, organised and uniform documentation. Each document shall be technically correct and shall refer to the quoted equipment only. The contents shall be structured in a logical way. Computer based documentation shall be preferred.

The documentation shall contain but not restricted to:

- General description of the installation and product specification. It shall contain general layouts per floor with locations of outlets, floor distributors and horizontal

cabling. Backbone details, detailed layout of each distributor and its patch panel shall be included.

- Test and measuring reports.
- Connectivity diagrams.
- Network Administration documents.
- Operation manuals.

2.14 Inspection, Testing and Commissioning

The Sub-contractor shall inspect, test and commission the Structured Cabling System works in accordance but not limited to relevant IEEE, TIA/EIA, ISO/IEC, CENELEC, ASTM and Communication Commission of Kenya [CCK] and Telkom Kenya [TKK], the inspection, Testing and Commissioning section of the Main Contract and the equipment manufacturer's recommendations. The results of all tests shall be recorded on the standard test forms unless otherwise specified.

Before completion of the installation the Sub-contractor shall submit to the Engineer for acceptance, a method statement of the procedure to be used for testing and commissioning, which has been agreed with the equipment manufacturers.

Before cables are terminated each cable shall be tested for continuity, insulation resistance, polarity and markings. Following satisfactory testing, cables shall be terminated in the equipment only by the manufacturer's appointed representative.

The Sub-contractor will provide a cabling management system for system administration. This will enable the Client to accurately identify and keep a record of all the components that comprise the cabling system as well as pathways, telecommunication closets and other spaces in which it is installed.

The Sub-contractor shall provide the following to assist the Client in network administration:

- Ensure consistent colour coding per telecommunication outlet, patch panel etc.
- A unique identifier assigned to every part of the cabling system (cables, outlets distributors etc.).
- A label at each telecommunication outlet the numbering of outlets based on floor and work area numbers.
- A label at each cable end to indicate corresponding telecommunication outlet.
- A cable schedule for each distributor indicating the cable number, its source and destination, its type and current use. This schedule shall be ordered both by cable number and destination.

- A complete patch list for all cross-connections.
- A full set of "as built" drawings.(printed and on CD)

The tenderer shall submit a list of equipment/tools for carrying out the installation and testing of the system.

2.15 Structured Cabling

The structured cabling shall consist of the following:

- Incoming services provisions (ISP)
- Backbone installations
- Horizontal cabling installations
- Active equipment (switches, Wi-Fi Access points)
- Protection system

2.16 Incoming Connection (ISP)

Two reliable internet providers shall be engaged to allow for 100% redundancy. The contractor shall allow for attendance to follow up with connection with the ISP.

The ISP's will be configured for the following;

Load Sharing: Use the two links with a distributed load of connections going out from the Security Gateway. Connections coming in are alternated. The bandwidth monitor will have the ability to configure the best relative link for the current load.

Primary/Backup: One link will be used for incoming and outgoing connection one as the Primary and the other as a backup. If one ISP is in use then the other is shut down

2.17 Cabling General

a) All cables must pass through conduits or trunking.
b) All cables and connectors shall be labelled.
c) No distortion due to kinks, sharp bends or excessive hauling tension shall be allowed.
d) Cables shall be run in a manner eliminating any possibility of strain on the cable itself or on the terminations.
e) Cables shall have no joints or splices.
f) Cables shall be kept at a minimum distance of 150mm from items liable to become hot or cold.
g) Bending radii shall be not less than eight times the overall cable diameter.
h) The manufacturers hauling tension shall not be exceeded.

i) All cable ties and fixings shall be tightened to support the cable loom without distortion of the cable sheath.
j) The fibre optic cable shall be multi-mode optimal speed and with graded index, and of nominal size 62.5/125 micron.
k) Fibre optic cable shall have a core/cladding diameter on nominal 850nm and 1300nm optical wavelength.
l) The optic cable shall be of appropriate core with each core terminated on both ends.
m) The enhanced UTP 4 pair shall be of cat 6 grade and exceed ANSI/TIA/EIA-568-Aj and ISO/IEC 11001standards. Cat 6 structured cabling shall be used throughout the entire installation.

2.18 Backbone Installations

2.18.1 Fibre Cable

This shall originate from the **Core Switches** located in the communication room and terminate in the **Access Switches** within the floors.

The Sub-Contractor shall supply and install 8 core multimode armoured fibre optic cable. It shall support all the applications outlined in the system overview. It shall have the following characteristics.

- Wavelength 62.5/125 micron
- 8 core loose tube
- Corrugated armour

The tenderer shall observe the bending radius and pulling strength requirements of all backbone cables during handling and installations. The cable shall run in suitably sized ducts provided by others.

2.18.2 Cabinet/Closets

The new distribution enclosure shall consist of Standard Cabinets with lockable transparent front door and a cooling fan. These shall be located as shown on the contract drawings.

The distribution unit will contain the patch panels with fibre optic and RJ 45 connectors, distribution frames with insulation displacement connection [IDC] modules and the auxiliary equipment (cable organizers, power distribution bar, earthing, fans, etc.)

Cabinets shall be able to contain each type of active equipment for possible future development. The tenderer shall take into consideration the active equipment at the Administration point and shall allow space for this.

The Sub-contractor shall connect the trunk cross-connect and the distribution cross-connect the common equipment such as IPBX or Server computer in the equipment rooms.

The mounting hardware must provide vertical and horizontal wire ways for cross-connect wires.

2.18.3 Modular RJ45 Patch Panel

The patch panel will have standard dimensions (19") in order to guarantee the fitting in a standard rack, box or cabinet. To avoid installation errors the Insulation Displacement Connection [IDC] contacts shall be marked with the same colour code as the cables and the outlets.

Patch panels shall be full CAT 6 with more than 40 dB NEXT measured at 200MHz between every pair combination thus capable of supporting applications of up to 200 MHz as specified in the ISO/IEC JTCI/SC25 IS 11801.

The patch cords will be arranged in a patch guide (cord organizer) to achieve a well-ordered network management.

The RJ45 patch panel shall have RJ45 jack termination in front and Insulation Displacement Connector (IDC) at the rear of the module.

The panels shall be available in different standard port configurations. The modular jack panel will have an insertion life of 750 cycles minimum. When configured in worst case 100 meter channels with full cross-connects and consolidation points with other products proposed in this tender, the connecting block shall be capable of delivering the minimum Guaranteed Channel Performance.

2.18.4 Patch Cords & Work Areas/Cables

Modular Patch Cords shall be provided:

- Between the patch panels and the applications such as IPBX patch panel.
- Between the patch panel and the active LAN equipment.
- Between the patch panel and the video /controllers.

Inspection Displacement Connection patch cords provided shall have built-in exclusion features to prevent accidental polarity reversals and split hairs.

Work area cables shall also be provided for interconnecting the telecommunication outlet and the terminal equipment.

Generic patch cords shall have transmission characteristics specified up to 1200 MHz and have the same nominal characteristics as the cable used in the horizontal cabling to ensure a homogeneous cabling system.

The patch cords and the work area cables shall be of the same type to limit the number of spare parts.

They shall be available in stranded screened version and in different lengths of 3m and 1m. Generic patch cords and work area cables shall consist of 4 pair's flexible cable with fully populated 8 pin module connectors at both ends and equipped with a moulded strain relief. The total length of patch cord, an equipment cable and a work area cable of the same link will not exceed 10m.

All cords shall conform to the requirements of TIA/EIA568-B, IS1180-1 and EN50173, Horizontal cabling Section and be part of the Underwriters Laboratories [UL] LAN Certification and Follow-up programme.

2.19 Horizontal Cabling Installations

2.19.1 Copper Cable

Horizontal cabling shall be run in a star topology format and will not exceed 90 metres from the patch panel to the outlet.

All horizontal cables used for each outlet shall be 4-pair CAT 6 unshielded twisted pair (UTP) unless otherwise stated.

During handling and installation the Sub-contractor shall observe the bending radius and pulling strength requirement of the 4-pair unshielded twisted pair (UTP) cable.

The cable run between the telecommunication outlet and the patch panel shall be continuous without any joints or splices.

In raised floors or suspended ceilings without cable trays/conduits, the Sub-contractor shall bundle the wiring with plastic cable ties at appropriate distances. Where appropriate 'J' hooks shall be used to support the cables.

All communication cabling used throughout this project shall comply with the requirements as outlined in the appropriate local codes. All cabling shall meet the relevant fire performance standards for the environment in which they are installed.

All cables shall be terminated testing and labeled in an alphanumeric sequence at all terminations. All copper cable terminations shall comply with and be tested to TIA/EIA 568-B, TSB-67 standards and TIA/EIA 606 respectively.

Cables shall terminate on the wall or trunking plates as shown on the Contract Drawings.

All cables used shall meet or exceed Guaranteed Class E Channel Performance values when configured as a worst-case channel.

Cables shall be tested for the following parameters:

- Characteristics impedance
- Cross talk attenuation
- DC loop resistance
- Attenuation
- Propagation time
- Immunity to EMI
- EM radiation

2.19.2 Telecommunication Outlets

Voice and data communication outlets shall consist of two gang utility outlet boxes/plates equipped with 8-Pin modular [RJ 45] jacks. All horizontal cabling shall terminate on termination blocks at their associated wiring closet.

All telecommunication outlets for 24 AWG (American Wire Gauge) copper cable shall be modular 8-position/8-conductor outlets. The outlets shall be able to support universal applications in a multi-vendor environment accepting modular RJ 45 plugs.

All unused module locations shall be provided with blank module inserts.

All telecommunications outlets shall conform to TIA/EIA 568-B, IS11801 and EN50173 requirements. Where an outlet is configured in worst-case of 100-metre channel, the telecommunication outlet shall be capable of delivering a minimum Guaranteed Channel Performance of Class E.

Telecommunication outlets shall be compatible with CAT 6 – when the outlet is mated with a CAT 6 plug, the connection performance shall be CAT 6 or better

The Sub-contractor shall supply the wiring and/or cords, connectors and extension cords.

2.19.3 Administration Centres

The administration system shall consist of RJ 45 modular stackable patch frames for termination of copper cables and /or IU combination on shelf for the termination of optical fibre as indicated in the Bills of Quantities.

2.20 Edge/Access Switches

- 10/100/1000BASE-T auto-sensing Gigabit Ethernet switching ports
- Power over Ethernet: Up to 30 watts per port
- SFP+ (10Gb/1Gb) ports
- Switch Fabric Capacity 176.0 Gbps

- VLAN support for tagging and port-based as per IEEE 802.1Q; protocol-
- based VLANs
- Quality Of Service, Multicast, Access Control Lists
- iSCSI optimization and monitoring
- Industry-standard CLI accessible via Telnet, SSH, or local console (RJ45 Yost) and Robust HTTP GUI Management
- Redundant Power Supply
- Lifetime Warranty

2.21 Distribution Switch specifications:

- 10/100/1000BASE-T auto-sensing Gigabit Ethernet switching ports
- SFP+ (10Gb/1Gb) ports
- 2 Stacking Ports
- Switch Fabric Capacity 128.0 Gbps
- VLAN support for tagging and port-based as per IEEE 802.1Q; protocol-based VLANs
- Quality Of Service, Multicast, Access Control Lists
- iSCSI optimization and monitoring
- Industry-standard CLI accessible via Telnet, SSH, or local console (RJ45 Yost) and Robust HTTP GUI Management
- Redundant Power Supply

2.22 Core Switch:

Performance and capabilities shall but not limited to the following minimum requirements;

- Up to 928 Gbps wired switching capacity with 250 Mpps of throughput
- Up to 20 Gbps of wireless termination capacity. Support for up to 100 access points and 2000 wireless clients on each switching entity
- Up to two 40 Gigabit Ethernet uplinks (Quad Small Form-Factor Pluggable Plus [QSFP+])
- Up to 4 no blocking 10 Gigabit Ethernet uplinks (Small Form-Factor Pluggable Plus [SFP+])
- SFP support on uplinks to offer flexibility for up to 4 Gigabit Ethernet ports
- 384 ports of no blocking 10/100/1000
- PoE+ (30W) capabilities on all ports in a line card simultaneously
- Cisco UPOE (60W) capabilities on all line card slots
- Energy Efficient Ethernet (IEEE 802.3az)
- 196 ports of no blocking Gigabit Ethernet SFP (4 uplink ports plus 192 line card ports)
- 100 ports of 10 Gigabit Ethernet SFP+ (4 uplink ports plus 96 line card ports)
- Up to 128,000 FNF entries in hardware
- SD card support for flexible storage options

- 256,000 routing entries for high-end campus access and aggregation deployments
- IPv6 support in hardware, providing wire-rate forwarding for IPv6 networks
- Dual stack support for IPv4/IPv6 and dynamic hardware forwarding-table allocations for ease of IPv4-to-IPv6 migration
- Scalable routing (IPv4, IPv6, and multicast) tables and Layer 2 tables
- Scalable and dynamic allocation of Access Control List (ACL) and Quality of Service (QoS) entries to use 8 queues per port and comprehensive security policies per port
- SD-Access: The Supervisor Engine 9-E forms the foundational building block for SD-Access – Cisco's leading enterprise architecture, which includes:
- Policy-based automation from edge to cloud
- Segmentation and micro-segmentation made easy, with predictable performance and scalability
- Automation through the Cisco Application Policy Infrastructure Controller – Enterprise Module (APIC-EM)
- Policy through the Cisco Identity Services Engine (ISE)

2.23 Protection System - Earthing

The Sub-contractor shall provide adequate earthing (grounding) for both electrical safety and Electromagnetic Compatibility (EMC) Performance, which are subject to national and local regulations.

It is the responsibility of the Sub-contractor to ensure that the cable raceways i.e. trunking, metal ducts are properly earthed to reduce EMI. The Sub-contractor is expected to earth all the cabinets, closure and racks.

It is the Sub-contractor obligation to liaise with the Electrical Sub-contractor to establish the type of earthing used for this particular project.

2.24 IP Telephony System

The Voice over Internet Protocol (IP) PBX System shall be a complete telephony system that will provide telephone calls over IP data networks. All conversations shall be sent as data packets over the network. The technology shall include advanced communication features but will also provide significant scalability and robustness.

The system shall consist but not limited to the following:

- Incoming services connection (ISP)
- IPBX (router ISDN, VioP)
- Telephony Devices

2.25 Incoming Connection (ISP)

The contractor shall allow two or more reliable services providers to be engaged to allow for 100% redundancy. The contractor shall allow for attendance to follow up with connection with the ISP.

The sub-contractor shall allow all necessary accessories not included in the bills of quantities to make the system complete of the provision of the services to clients satisfactorily and to Engineers' approval.

The following is the description of the major components of the IP PBX system.

2.26 Enterprise Call Manager Communication Server Software

The Sub-Contractor shall supply a complete switchboard and Call Manager Communication Software as part of the system capable of delivering the expected feature set. As a minimum the system shall be able to support the following features and services.

2.27 Features

Calling line ID including customization, Call Routing, Least Cost Routing, Call Forwarding on Busy and on No Answer, Call Transfer, Data Network Integration and Click to Dial, Advanced Music on Hold with an option to program music of minimum 2 minutes and capability to have external music on hold interface, Call Waiting, Call Transfer when not online, Call Conferencing with support for multiple 3 party conference and support for meet-me conference (Min. 6 users), Do Not Disturb, Find Me/Follow Me, On the Fly Recording Call Return and Voicemail Call back

2.28 Primary Services

a) Centralized Call Processing
b) The IP PBX system shall be able to support initially 400 IP users with expansion capacity of up to 1,000.
c) The IP PBX system shall be able to support 20 trunk lines.
d) The system shall be able to support full outlook and e-mail integration including voice mail to Email.
e) The system shall have support for business critical applications and unified communication applications which shall include IP Contact Centre/Call Centre, unified messaging.
f) The system shall have support for integrated services such as conferencing, one number follow me, personal call directory, recorded announcement, network-wide attendant and messaging.
g) The system shall have an IP PBX based unified communication security solutions that offer comprehensive threat protection, strict policy enforcement, robust access control, and privacy of confidential data.
h) As the Sub-Contractor plans for the security of the system, they should bear in mind the current security software used at AFA i.e. antivirus, firewall etc.

i) The Sub-Contractor shall indicate the licensing regime applicable to the IP PBX system. AFA shall prefer cost effective licensing which will allow for grow-as you-want - Licensed per extension one-off payment.
j) The system shall be able to interoperate with IP Phones, PSTN Gateways, SIP Trunks, IP Trunks, Analogue Trunks and Microsoft products such as Exchange 2016 or lower versions. The system shall have a CTI server to be able to provide call management on every desktop. The system shall make it possible for the following feature to be integrated:

    a. Pop-up of incoming calls with caller ID on ISDN line, List of incoming/outgoing and answered/unanswered calls.
    b. Click to dial.
    c. Integration with MS outlook to dial from Outlook contacts.
    d. Support in future, unified messaging to have Voicemail as .wav (or equivalent) file in email client.
    e. Support in future, supervision feature to have status Free/Busy/forwarded etc.) of all users.

k) The system shall have multi-party conference with clock to conference and multiparty video conferencing.
l) The system shall be flexible enough to allow AFA configure any preferred numbering plan, including capability to support all extension on Direct Inward Dialing (DID) numbering.

2.29 Secondary Services

- Cell Phone Integration
- Extension Groups
- Time of Day Routing
- Extension Call Recording
- Voice call recording for help desk purposes.
- Extension Range Flexibility
- Voicemail Bypass
- Intuitive VoIP Ready
- Announcement Interface

2.30 Phone Sets

The system shall be able to support extensive user equipment including cordless, soft phones, IP, digital and analogue phone set support to meet diverse end-user requirement. Specifically the system shall be able to support the following; Digital Sets, Analogue Sets, IP phones (IP Key phones / Soft phones), SIP Phones (SIP desk phones / soft phones), DECT Phones and V-WLAN WIFI Sets.

a) The Digital/IP sets shall have large display and permanently-labeled feature buttons: e.g. Speaker, Mute, Volume, Headset, Contacts, Home, History, Message, Phone. Executive phones will have a feature for video calls.

b) The Sub-Contractor shall supply IP Phone sets capable of being powered through Power over Ethernet (PoE).
c) The Sub-Contractor shall supply client software for IP soft phones to be installed on desktop and laptop computers. The Sub-Contractor shall also supply all associated accessories for each IP soft phones that is: - mouth pieces, mikes, earpieces, headphones and holders.

2.31 Operations and Management Console Software

a) The system shall have a secure Web based IP PBX management system for easy system administration. It shall also be password protected and accessible over the network.
b) Multiple Country number selection.
c) Talk Time Management
d) Call Account Management
e) Call Detail Records - Call Logs

2.32 Automated Call Distributor

The system shall be able to support an automated call distributor with the following features;

- Automatic call attendant
- Call menu
- Call forwarding
- Call transfer
- Managing extensions
- Call parking
- Support auto attendant (16 ports) with the option to upgrade it to multiple trees, by way of software upgrade only with no additional hardware.

2.33 GSM Gateway

The system shall have a GSM Gateway which shall be used to route call straight to mobile networks.

2.34 Unified Messaging Gateway

The system shall have a Unified Messaging Gateway which shall be used to link with Microsoft Exchange 2013, higher or lower versions

2.35 Interactive Voice Response System (IVRS)

The system should be supplied with an Interactive Voice Response system to give callers automated support or guide them on accessing various services offered by the Authority.

2.36 Redundancy Requirements

In order to meet availability that is commensurate to world best practices, AFFA proposes a redundancy arrangement as indicated in the high level configuration attached at annex of this document.

2.37 Training Requirements

The Sub-Contractor shall provide a professional certification on Certification Partners Convergence Technologies Professional (CTP) or an equivalent certification relevant to Unified communication systems for five (5) technical staff members before the actual implementation of the Unified communication system.

The training so provided shall be of highest standard, preferably conducted at the manufacturers training facility for the communication system. The training shall be coupled with tours of sites where similar solutions have been implemented.

In additional to this training the Sub-Contractor shall provide on-the-job training to all AFFA technical staff to be assigned to the Unified Communication System project during the implementation of the system.

2.38 Documentation

The Sub-Contractor shall supply, together with the equipment, a set of documentation to be used for purposes of operation and maintenance of the IP PBX systems.

BILLS OF QUANTITIES

3 BILLS OF QUANTITIES

3.1 General Notes to Tenderers

1. The Bills of Quantities form part of the contract documents and are to be read in conjunction with the contract drawings and general specifications of materials and works.

2. The prices quoted shall be deemed to include for all obligations under the sub-contract including but not limited to supply of materials, labour, delivery to site, storage on site, installation, testing, commissioning (**excluding 16% VAT**).

3. All prices omitted from any item, section or part of the Bills of Quantities shall be deemed to have been included to another item, section or part thereof.

4. The brief description of the items given in the Bills of Quantities are for the purpose of establishing a standard to which the sub-contractor shall adhere. Otherwise alternative brands of **equal** and **approved** quality will be accepted.

5. Should the sub-contractor install any material not specified here in before receiving **written approva**l from the Project Manager, the sub-contractor shall remove the material in question and, **at his own cost**, install the proper material.

6. The grand total of prices in the price summary page must be carried forward to the **Form of Tender for the tender to be deemed valid**.

7. The Bills of Quantities are divided generally into three sections:-

a. Contractual Requirements – Bill 1

Sub-contractors contractual requirements as called for the bill of quantities shall be priced and included in the tender. However the Tenderer is free to include and price any other items he deems necessary taking into consideration conditions he is likely to encounter on site.

b. Installation Items – Other Bills

The brief description of the items in these Bills of Quantities should in no way modify or supersede the detailed descriptions in the contract Drawings, conditions of contract and specifications. The unit of measurements and observations are as per Volume 1 or as indicated in the Bills of Quantities.

c. Summary

The summary contains tabulation of the separate parts of the Bills of Quantities carried forward with provisional sum, contingencies and any prime cost sums included. The sub-contract shall insert his totals and enter his grand total tender sum in the space provided below the summary.

3.2 Bills of Quantities

SECTION D.W. 1.0 TITLE: PRELIMINARIES & CONTRACTUAL REQUIREMENTS

Item	Description	Unit	Qty	Rate	KShs.
D.W. 1	**CONTRACTUAL REQUIREMENTS**				
A.	Preparation of working drawings, printing and distribution.	Sum	1		-
B.	Preparation of 'As Installed Drawings", printing and distribution as specified. Drawings to include:				
	(a) Blue Prints - 4 sets of each.	Sum	1		-
	(b) AutoCAD on CD – 2 No.	Sum	1		-
	(c) Operational Instructions, manuals and test certificates	Sum	1		-
C	Allow for Necessary Insurances (WIBA, etc) for the Works execution	Sum	1		-
D	Provision of Performance Bond as stated under clause 5 of the published conditions of sub-contract.	Sum	1		-
E	Allow for removal of existing equipment/items and handing over to the client.				-
F	Any other item necessary to complete the installations in this section (please state)	Sum			
					-

SECTION D.W. 2 TITLE: BACKBONE CABLING

Item	Description	Unit	Qty	Rate	KShs.
D.W. 2.1	**BACK BONE CABLING**				
A.	8 Core Outdoor singlemode fibre optic cable from Existing Data Centre to 9U Cabinet located in Linen Store	M	250		-
B.	Pulling and termination of the above cables.	Sum	1		-
C.	Labelling, Documentation and Certification of the above works.	Sum	1		-
D.	Testing & Commissioning of the above works.	Sum	1		-
E.	Fibre consumables (connectors, adapters, termination kit etc) for the above cables.	Item	1		-
F.	Any other item to complete the installation in this section [Please state].	Sum			
Total Carried Forward to Main Summary of Prices					-

SECTION D.W. 3.0 TITLE: HORIZONTAL CABLING

Item	Description	Unit	Qty		KShs.
D.W. 3.0	**Horizontal Cabling**				
A.	CAT 6A UTP cable:				
	• Data Points	Rolls	12		-
	• WAP	Rolls	1		-
	• Public Address	Rolls	1		-
	• CCTV Points & Access Control & Video Intercom	Rolls	2		-
	• Nurse Call Points	Rolls	4		-
B.	Data Cabinet as Giganet or approved equivalent: 9 U c/w with fan and 3 No 13A power outlets as ANSI for server room	No.	1		-
C.	CAT 6A UTP Copper 1 M patch cords for data cabinets	No.	67		-
D.	CAT 6 UTP Copper 3 M patch cords for work stations	No.	56		-
E.	Cable Managers:	No.	4		-
F	Sieomon Z6as -pnl-24k ZMAX 24 Port CAT 6 Shielded Patch Panel or equal and Approved	No.	4		-
G.	Twin outlet CAT 6 CT coupler shuttered with blue and red icons complete with gang horizontal plastic face plate:	No.	32		-
H.	RJ45 point wired to Nurse Call points complete with necessary termination kits (wiring already included in item A above):	No.	11		-
I.	RJ45 point wired to CCTV points complete with necessary termination kits (wiring already included in item A above):	No.	6		-

I.	RJ45 point wired to PA points complete with necessary termination kits (wiring already included in item A above):	No.	5		-
J.	Pulling of above Cables.	Sum	1		-
K.	Termination and testing of above cables.	Sum	1		-
L.	Labelling both patch cords and outlets.	Sum	1		-
M.	Documentation and certification.	Sum			
N.	Any other item to complete the installation in this section [Please state].	Sum			

Total Carried Forward to Main Summary of Prices	-

SECTION D.W. 4.0 TITLE: ACTIVE EQUIPMENT

Item	Description	Unit	Qty		KShs.
D.W. 4.0	**Active Equipment**				
A.	Supply and Installation of Either 24Port auto sensing POE switch compatible with CAT6A systems complete as CISCO 9200L - 24P - 4G - A or CISCO 9200 - 48T - 4X - E Series with copper cable connectors; ♠ 24P and 48P 10/100/1000 mbps data poE + Models ♠ Five optional uplink modules with 4XGE, 1 X 10GE, 4X10GE, 8X10GE or 2X40GE QSFP + ports ♠ Cisco Stackpower technology ♠ Dual Redudant modular power supplies and thre modular fans ♠ Fiber Input Ports and UTP Outputs				
A.1	Network Points Switch	No.	3		-
B.	WI - FI Access Point 5GHz Support, 4G LT Coexistence 802.11ac Wi-Fi Access Point as Cisco 3800i Access Point or equal and equivalent.	No.	1		-
C.	Any other item necessary to complete the Installation (Please state). All Active equipment shall carry minimum 2 year warrant on parts and labour.	Sum			
Total carried forward to Main Summary of Prices					-

SECTION D. W. 5.0 - DIGITAL TELEVISION

Item	Description	Unit	Qty	Rate	KShs.
D.W. 5.0	**DIGITAL TELEVISION** Allow for supply, Installation, testing, configuration & Commisioning of the following items complete as specified:				
A.	RG 11 Pure Copper Cable in Roll of 300M	Roll	4		-
B.	Amplifier	No.	3		-
C.	8 Splitter Channel	No.	1		-
D.	2 Splitter Channel	No.	1		-
E.	F Connectors	No.	7		-
F.	Single Television Outlet complete woth Back Box	No	7		-
F.	TV brackets	No	7		-
H.	Termination and testing of above system.	No.	1		-
I.	Labelling of the above system.	No.	1		-
J.	Documentation and certification.	No.	1		-
K.	Any other item necessary to complete the installation in this section	sum			
					-

PROPOSED FIT OUTS AND RE-ORGANIZATIONS FOR THE LABOR WARDS IN NAIROBI HOSPITAL

DATA & VOICE SYSTEMS INSTALLATION
MAIN SUMMARY OF PRICES

Item	Description	Unit	Qty	Rate	KShs.
D.W.1	**SECTION 1** Preliminaries & Contractual Requirements				-
D.W.2	**SECTION 2** Backbone Cabling.				-
D.W.3	**SECTION 3** Horizontal/Internal Cabling				-
D.W.4	**SECTION 4** Active Equipment				-
D.W.5	**SECTION 5** Digital Television				-
	Sub - Total				

Total Carried Forward to Main Summary of Volume I **-**

TECHNICAL SCHEDULE

4 TECHNICAL SCHEDULE

4.1 Documentation Requirements

Document	With Bid	Before Manufacture	During FAT	Upon Delivery
Preliminary general arrangement drawing (with dimensions)	YES			
QA / QC Plan in accordance with ISO 9001:2008		YES		
General arrangement drawing (with dimensions)		YES		
Schematics/Line diagrams for construction	N/A	YES	N/A	N/A
Recommended Spares List	N/A	N/A	N/A	YES
Routine Test Reports / Certificates			YES	
Type Test Reports / Certificates	N/A	N/A	YES	N/A
Commissioning Procedure	N/A	N/A	N/A	YES
As-built General arrangement drawing			YES	
As-built Schematics			YES	
Site Test Reports / Certificates				YES
Special Test Reports / Certificates	N/A	N/A	YES	NO

4.2 Technical Schedule

The tenderer **MUST SUBMIT** comprehensive manufacturer's technical brochures and performance details for all items listed in this schedule (fill forms attached).

ITEM No.	Description	Remarks
A	Access Data Switch	
B	Telecommunication outlet	
C	Fibre Cables	
D	Patch panel	
E	Data cabinet	
F	ODF	
G	UTP cables	

APPENDICES

5 APPENDICES

5.1 Appendix I; Statement of Compliance

Technical Schedules shall be submitted by tenderers to facilitate and enable the Engineer to evaluate tenders but only when the fittings and accessories upon which the tenderer has based his tender sum differs in manufacture, type or performance from the description contained within this specification.

Tenderers shall submit separate leaflets and catalogues giving technical and physical details for all fittings and accessories described in the Technical Schedule at the time of tendering.

Completion of Technical Schedule shall not relieve the Contractor from complying with the requirements of the Specification except as may be approved by the Engineer.

…….. **(Signed)**

…….. **(Date)**

5.2 Appendix II; Exchange Rate Fluctuations

Adjustment will be made to the price of imported materials to compensate for variations in the foreign exchange rate. For this purpose, the tenderer is required to state the exchange rate in Kenya Shillings for the currency of the Country of origin of imported materials as applied to the actual remittance effecting payment to manufacturers of the materials.

Exchange Rate: ……..

Signed (as in Tender) ……

Date ……

5.3 Appendix III; Declaration

We …….. (Name of Tenderer) do declare as follows:

(i) That we shall adhere to the Specifications or any alternatives as may be approved by the Engineer.

(ii) That we have visited the site and fully understand and appreciate the prevailing site conditions and the terms and conditions under which the works detailed in the Specifications and drawings shall be carried out.

(iii) That we have studied the relevant drawings to the project and understand them fully and any discrepancies have been clarified.

(iv) That we have enclosed a Letter of Bond from an approved and recognized Surety (Reputable Insurance Firm or Bank) willing to be bound to (Name of the Project) in an amount equal to 10% of the contract amount.

Name of Surety ……..

Amount Bound to Employer:

Kshs. ……

In Words ……..

…….. (Signed by Surety).

…… (Date).

…… (Official Stamp of Surety).

(v) That we understand the tender validity period to be **90 days** from the date of submission of tenders.

5.4 Appendix IV; System Warranties

The tenderer shall outline the warranties for all systems installed on this site as specified elsewhere.

These shall include but not limited, to the following:

- Structured Cabling
- Data Switches
- Cables

Etc.

5.5 Appendix V; Schedule of Unit Rates

The sub-contractor shall provide a schedule used to build up rates for items (randomly selected in preceding pages) listed in the table (a) below.

5.5.1 Table (a): Randomly selected items listed in the preceding pages.

Item	Material Cost Kshs. (a)	Labour (as a percentage of material cost) (b)	Overheads (as a percentage of material cost) (c)	Inflation (as a percentage of material cost) (d)	Total Cost of item Kshs. (VAT exclusive) (a+b+c+d)	Signature
IP Based 91dB, 9W RMS, 5" ceiling						
Cisco C9500-24T data switch						
42U Data Cabinet						
4 core Singlemode Outdoor fibre optic cable						

The sub-contractor shall provide a breakdown schedule to be used to build up rates for any other item not listed in the preceding pages as outlined in the table (b) below. **Sub-contractor shall disclose the cost of the material offered by the supplier or manufacturer or any other sources to the Engineer used to build up the rates in respect to schedule of table (b) below. The engineer can reject the disclosed sources where the conflict of interest seems to prevail.**

5.5.2 Table (b): any other item not listed on the preceding pages.

Material Cost Kshs. (a)	Labour (as a percentage of material cost) (b)	Overheads (as a percentage of material cost) (c)	Inflation (as a percentage of material cost) (d)	Total Cost of item Kshs. (VAT exclusive) (a+b+c+d)	Signature

5.6 Appendix VI; Day Work Terms for Labour

(To Be Completed By Tenderer)

Description of Artisan	**Cost Per Hour**
Supervisor	……..
Grade A Electrician	……..
Grade B Electrician	……..
Grade C Electrician	……..
Labour	……..
Apprentices	……..

GENERAL REQUIREMENTS

1 GENERAL REQUIREMENTS

1.1 General:

The Security systems shall be controlled and maintained at the Security Control Room. The system and equipment used will be the state-of-the-art technology available today, reliable and robust and of open protocol for integration with other vendor's systems.

1.2 Reference Sites:

The offered equipment shall have been sold in sufficient quantities to provide good proof of a Tenderer's capability of handling similar projects. Tenderers shall supply a detailed record of similar equipment's that have been installed by them.

The Sub-contractor shall in the preliminary section of the pricing allow for the following;

- Factory inspection/Training of the system (SMS) to allow the Engineer and Client Staff familiarize themselves with the systems functions and installations procedures.
- Site inspection of at least two sites where the proposed systems has been installed.

In addition to ensure continued support of the proposed equipment from the manufacturer, the Tenderer must submit documentary evidence that they are indeed authorised and accredited distributor/reseller of the manufacturer.

1.3 Cable Management:

The necessary infrastructure i.e. cables, accessories, devices (excluding conduit work and raceways) for the Security System shall be done by the Security Sub-Contractor.

1.4 The Security Systems Requirements:

- CCTV Camera Installations.
- Access Control Systems Installations.

1.5 Commencement of Works:

The Tenderer in submitting his bid shall be deemed to have allowed for commencing the works on site immediately upon appointment.

1.6 Scope of the Contract Works:

The Contract Works shall comprise the supply, delivery, erection, testing, commissioning and setting to work of the complete **integrated security management system** as detailed in this Specification and accompanying Contract Drawings.

The Tenderer shall include for all apparatus and appliances not particularly called for in this Specification or on the Contract Drawings but which are necessary for the successful completion and satisfactory functioning of the Contract Works.

It is deemed that if, in the opinion of the Sub-Contractor at the time of tendering there exists a discrepancy in the Specification, Drawing or both, that the Contractor clarifies this difference with the Engineer before tendering.

The Tenderer shall provide as an integral part of his bid a statement of compliance in which he shall clearly declare any items of the Specifications to which his offer does not comply and an alternative which is included in the offer.

The Sub-Contractor shall be obliged to liaise with other parties involved in the project and to provide any necessary information as and when required.

No claims for extra payment shall be accepted from the Sub-Contractor due to his failure to adhere to the above requirements.

The work to be installed under the Contract shall comprise but not restricted to the supply and installation of the following complete as specified elsewhere in this Specification:

1. Access control zonal counter.
2. Access control readers.
3. Access control cards.
4. CCTV Camera Installations.
5. CCTV surveillance system integration.
6. Associated Structured Cabling.

All equipment as far as is practicable shall be designed and manufactured by a single preferred manufacturer. In any case equipment shall be of uniform standards compatible in operation and spare parts trained support and maintenance facilities being available. In this regard the Tenderer shall produce a letter of guarantee and commitment from the equipment manufacturer for production at tender opening. Any tender without such a commitment letter will be rejected.

1.7 Ordering of Materials:

The Sub-Contractor shall order materials from quantities taken from his own approved working drawings and not from the quantities shown on the Contract Drawings or in the Specification.

1.8 Builder's Work Requirements:

All chasing, cutting away and making good of walls and slabs will be by the Security Sub-Contractor to the satisfaction of the Interior Designer & Engineer.

1.9 Tender Return Items:

Drawings and publications illustrating the systems and equipment being offered against the schedules shall be returned with the Tender, together with a comprehensive description of the systems being offered to meet the requirements detailed elsewhere in the Specification.

1.10 Standards and Regulations:

The design, manufacture, selection, installation, testing, commissioning and subsequent maintenance of all equipment and materials described in this Specification shall comply with internationally recognised standards.

1.11 Documentation:

Record Drawings, operating instructions, logbook and certificates of installation and commissioning shall be provided adjacent to the control and indicating equipment at the end of the Contract.

Operating and Maintenance Instructions shall be provided before the system is accepted. The instructions shall describe the system operation, zoning, routine care and maintenance, fault finding procedures and the function and settings of all controls.

The instructions shall include a full set of drawings, other manufacturer's handbooks and proprietary items and a complete list of spare parts provided and which are available. Full details shall be provided of all manufacturers and suppliers.

1.12 Defects Liability and Spares:

The Sub-Contractor shall provide a comprehensive routine and emergency call out service for the defects liability period, and shall confirm the response time to be provided. This service shall include routine examination and any adjustments, cleaning, replacement of parts as required to keep the system in full working order.

All equipment shall have a minimum 1-year warranty period from the manufacturer.

The Tenderer shall include details of a proposed Maintenance Contract to provide regular maintenance from the start of the defects liability period, in accordance with this specification. The Client is not bound to accept the offer from the Sub-Contractor.

An appropriate set of spares shall be provided, including consumable and modular items, which can be replaced by on-site maintenance staff. A list of the proposed spare parts shall be provided with the Tender.

1.13 Inspection, Testing and Commissioning:

The Sub-Contractor shall inspect, test and commission the works in accordance with the equipment manufacturer's recommendations. The results of all tests shall be recorded on the standard test forms unless otherwise specified.

Before completion of the installation the Sub-Contractor shall submit to the Engineer for acceptance, a method statement of the procedure to be used for testing and commissioning, which has been agreed with the equipment manufacturers.

Before cables are terminated each cable shall be tested for continuity, insulation resistance, polarity and markings. Following satisfactory testing, cables shall be terminated in the equipment only by the manufacturer's appointed representative.

Power supplies shall be tested prior to making connections to the control equipment. The Sub-Contractor shall allow for all necessary attendance during the testing and commissioning of any ancillary systems interconnected with the security system.

PARTICULAR SPECIFICATIONS

2 PARTICULAR SPECIFICATIONS

2.1 Location of Site

The site of the proposed Sub-Contract works shall be at The Nairobi Hospital, along Argwings Kodhek Road.

2.2 Description of Project

The project comprises of the Fit-Outs and Reorganization for The Nairobi Hospital Labor Wards.

2.3 Integrated Security Management System

General

The System must be designed to perform a wide variety of feature rich functions as part of a Total Security Management Solution. These System functions are categorized into System modules which will be integrated with the overall platform. The various features and modules include:

A. Access Control
B. IP CCTV Camera Installations
C. CCTV Integration
D. Data Integration Services
E. Alarm & Event Monitoring
F. Time & Attendance
G. Third Party Integration
    a. Fire Detection System
    b. Building Management System
    c. Intercom Systems
    d. Wireless Locks
    e. Elevators
H. Licenses

2.3.1 Seamless Integration

All System application modules, features, and functions shall be generated from a single source code set. The access control, alarm monitoring, asset management, digital video management, intrusion detection, remote access level management, and visitor management, and credential management modules of the software shall be created from this single source code set.

One or All **systems** shall be from **ONE** manufacturer.

All System modules shall be seamlessly integrated to feature a single System, single code base, single graphical user interface, and single database.

The system shall allow for ease of maintenance and allow for the ease of future upgrades and enhancements. All System features and functionality listed in the specifications shall ship with each System. Features and functionality available to the client shall be determined through licensing and shall be controlled by a hardware/software license key – the license should be a onetime buy and should not.

All System data shall reside in a single database on the network and be instantly accessible from every/any client workstation connected to the network that is licensed to do so. This shall

provide automatic change propagation to all client workstations on the System as well as a common database to consolidate all information and allow for better disaster recovery. As such, any modifications made to cardholders, time zones, assets, or access levels shall be downloaded in real-time to all related Intelligent System Controllers.

2.4 IP CCTV Surveillance System

General

The Closed Circuit Television system shall cover the following areas:

- Entrance/Exit doors.
- Electrical and Server Rooms.
- Reception.
- Lobbies.
- Corridors.

All the systems shall be monitored and controlled at the Control Room.

CCTV System shall be integrated with other system like Access Control, Music System, Voice Evacuation, BMS etc.

2.4.1 Network Video Recorder (NVR):

- Optimized for Megapixel Video Recording
- Hardware RAID Subsystem
- Data Protection, RAID 5, 6
- Real-time network camera discovery
- Versatile views of various screen divisions
- HTML and image overlays
- Multiple views supported
- View patrolling for single or multiple views
- Real time video/event alarm display
- Instant playback
- Behaviours smart features like unattended items zoning
- Video clip bookmarking
- ANPR features
- Drag-n-drop camera manipulation
- Directional camera display
- Hierarchical map structure
- Real time event alert
- Instant live video of camera
- Multiple maps supported
- Pan, tilt, zoom operations (dependent of camera)
- Built-in, floating PTZ control panel
- Pre-set position (dependent of camera)
- Scheduled or continuous camera patrolling
- Event-driven camera patrolling
- On Screen PTZ control
- Up to 16 monitors
- Supports live view, playback, eMap functions
- Direct display to secondary monitor(s)
- Search by date, time, camera

- Search by pre-defined recent time
- Search by VI event combinations
- Search over multiple days
- Search over multiple cameras
- Video clip bookmarking and commenting
- Search via built-in VI analyser
- Customizable bookmark
- Intuitive, video thumbnail search results
- Cue-in, cue-out and repeat
- Quick playback by video thumbnail
- 1/8, 1/4, 1/2, 1x, 2x, 4x, 8x,16x play, pause, stop
- AVI-formatted video clip export
- 4-channel synchronized playback
- Supported in video alarm, event alarm, view functions
- Pre-defined playback durations
- Video clip bookmarking
- General motion detection
- Missing object detection
- Foreign object detection
- Intrusion detection
- Forbidden area detection
- Tampering detection
- Virtual fence
- Object counting

Full functional operation & management via standalone VMS Client should support web clients and storage

- Video codec: H.264, MPEG4, MJPEG
- Image enhancement
- Video privacy mask
- Digital zoom in, zoom out
- Log viewer
- Windows lockup
- Client auto login
- Digital I/O management
- Automatic storage recycling
- Client-server architecture
- Guaranteed performance of long period recording
- Customizable appearance of Surgeon logo
- Configurable video retention period
- Digital watermark proofing
- Support DDNS Function
- Support CH Products USB joystick
- Support Ethernet I/O device
- Support NTP Server synchronized

2.4.2 Cables:

All cables used for the installation shall be 4 – pair CAT 6 unshielded twisted pair (UTP) unless otherwise stated installed by other however, sub-contractor shall allow for all necessary accessories to make system functional.

2.4.3 Intelligent Camera and Lenses:

Cameras offered shall have an image sensor of 1/2.7" 3-megapixel progressive scan. All lenses used must be automatic iris with a variable local length of 3.3 – 12mm.

Min. Illumination - 0.01 Lux @ F1.2 (B/W) 0.1 Lux @ F1.2 (Colour)

Camera Angle Adjustment - Pan 0° ~340°, Tilt 30°~90°

Video Compression - H.264/MPEG-4/MJPEG

Resolution - Up to 2048 x 1536 Video Resolution

Video Stream - Dual stream at H.264, MPEG-4, and MJPEG simultaneously

Video Control- AGC (Auto Gain Control), AWB (Auto White Balance), AES (Auto Electronic Shutter), BLC (Back Light Compensation), image adjustment

Intelligent Video - Motion detection, tampering detection (blocked, redirected, defocused, or spray-painted)

Supported Protocols - IPv4, ARP, TCP, UDP, ICMP, DHCP, NTP, DDNS, SMTP, FTP, HTTP, CIFS, PPPoE, UPnP, RTP, RTSP, RTCP, 3GPP

Ethernet -10/100 Base-T / RJ45

Power Consumption - Max. 7.5W IP66 rated for indoor/outdoor use

2.4.4 Industrial Network Poe Switch-for IP Cameras

Features:

PoE Injectors, which complies with 802.3af

Embedded 200W AC power supply

10/100/1000TX support auto MDI/MDI-X function with 2 Gigabit combo interfaces

PD parametric information and power testing

QoS/CoS support

VLAN tagging (up to 4K)

802.3ad LACP

GVRP (256 groups)

Port mirroring / Port security

IGMP Snooping and Query mode

IGMP multicast groups

DHCP Client

802.1X RADIUS

SNTP support

Ingress / Egress packet filtering

User access authorization

Login IP source authorization

SNMP v1, v2

Remote upgrade support

2.4.5 Software Specification:

Monitors suitable for commercial applications shall be suitably installed in the areas as earlier mentioned. They shall have an impedance switch in the 75 ohms or in the 'High Impedance' position.

Management	SNMP/ Telnet/ web-browser/ CLI management
SNMP MIB	RFC 1157 SNMP, RFC 1213 MIB II, RFC 1643 Ethernet like, RFC 1493 Bridge MIB, RFC 2674 VLAN MIB, private MIB, RFC 1628 UPS MIB, RFC3621 Power Ethernet MIB
RFC standard	RFC 2030 SNTP, RFC 2821 SMTP (option), RFC 1215 Trap, RFC 1757 RMON 1
Type of Trap	Cold start, link down, link up, authorization fail, Trap station up to 3. Private trap for power supply device.
Software Upgrade	TFTP and console firmware upgradeable.
Port Trunk	Support IEEE802.3ad with LACP function. Up to 7 trunk groups and group member up to 4. The trunk port within 24-port 10/100TX and extension module.
Spanning Tree	Support IEEE802.1d spanning tree, IEEE802.1w RSTP
VLAN	Port based VLAN IEEE802.1Q Tag VLAN VLAN groups up to 256
Class of Service	Per system supports high and low queues. The priority service rule: first come first service, all High before Low, WRR for High or low weight.
Port-based Priority	Support 3 settings: "Disable, Low or High priority". When set to "Disable", the income packet will follow QOS policy; Otherwise, the packet will follow port priority setting to "High/Low" queue.
IGMP	It supports IGMP snooping for multimedia application and supports 256 groups.
Port Security	It supports ingress and egress MAC address filter and static source MAC address lock.
Port Mirror	Global system supports 3 mirroring types: "RX, TX and Both packet". The maximum of port mirror entries is up to 25.
Bandwidth Control	Per port supports bandwidth control. Per level 100Kbps.
802.1x Authentication	Supports IEEE802.1x User -Authentication and can report to RADIUS server. Reject / Accept / Authorize / Disable.
DHCP	DHCP client

Packet filter	Broadcast storm filter
Port configuration control	Port Disable / Enable. PD detect control (enable/disable), Classification detect control (enable/disable)
Fault status detect	Null: no PD present Overload: current support over 475mA @ DC 48V and over 50 milliseconds DR fail: PD discovery resistor is not in the limited range
Mode status	System detects status, it will show I –sample, V-sample and R-detect.
Parametric information	It will show current PD parameters, it includes Discover-resistor detected value, current, voltage, power consumption, classification current and determined class
SNTP	Supports RFC 2030 Simple Network Time Protocol
System log	System Log record up to 1000 entries.
Power monitor	Support power supply monitoring function for AC power, DC power, fan status Additional power supply can be installed with POE switch and POE-UPWM.
Power testing	Support test function to testing power supply.
PoE Management	PoE Enable/Disable, Power limit by Classification; Power limit by management, Power feeding priority Detect Legacy Signature

2.5 Access Control & Intruder Alarm System

General

The System must be designed to perform a wide variety of feature rich functions as part of a Total Security Management Solution. These System functions are categorized into System modules which shall include:

A. Access Control
B. Alarm Monitoring
C. Credential Management
D. Digital Video Management
E. Intrusion Detection Management
F. Asset Management
G. Visitor Management
H. Remote Access Level Management
I. Third Party Interfaces
J. System Administration
K. Mobile Enterprise Solutions
L. Badge Layout Creation
M. Screen/Forms Creation
N. Graphical Map Creation
O. Application Programming Interfaces
P. Data Import
Q. Bi-Directional Data Exchange
R. API Development Toolkit
S. Server Redundancy

2.5.1 Seamless Integration

All System application modules, features, and functions shall be generated from a single source code set. The access control, alarm monitoring, asset management, digital video management, intrusion detection, remote access level management, and visitor management, and credential management modules of the software shall be created from this single source code set.

All systems shall be from **ONE** manufacturer.

All System modules shall be seamlessly integrated to feature a single System, single code base, single graphical user interface, and single database.

The system shall allow for ease of maintenance and allow for the ease of future upgrades and enhancements. All System features and functionality listed in the specifications shall ship with each System. Features and functionality available to the client shall be determined through licensing and shall be controlled by a hardware/software license key.

All System data shall reside in a single database on the network and be instantly accessible from every/any client workstation connected to the network that is licensed to do so. This shall provide automatic change propagation to all client workstations on the System as well as a common database to consolidate all information and allow for better disaster recovery. As such, any modifications made to cardholders, time zones, assets, or access levels shall be downloaded in real-time to all related Intelligent System Controllers.

2.5.2 System Capacity

The System shall support an unlimited number of card readers, input points, video cameras, intrusion detection points, and relay outputs.

The System database server shall support an unlimited number of cardholders, visitors, and assets limited only by the memory located in the Intelligent System Controllers in which cardholder information shall be downloaded.

The database server shall also support an unlimited number of System events and System Operator transactions in the history file. The System shall support an unlimited number of client workstations.

A fully loaded System shall guarantee a one half-second response time for access granted/denied decisions from the time that a cardholder swipes his/her badge.

2.5.3 ID Management System

The System shall include a seamlessly integrated credential management module. The credential management functionality must allow the enrolment of cardholders into the database, capturing of images, biometric data, and signatures, as well as the import/export of employee data. This functionality shall also allow the System Operator to assign and/or modify the access rights of a cardholder.

The System shall include a seamlessly integrated state-of-the-art, 32-bit, credential creation and production System. This shall allow for the creation of different badge types based on a database field, the linking of that field to a badge type to automate the process of credential production, and the use of security colours, chromakey, and ghosting, to allow officers to quickly identify personnel access authority.

The System shall have capabilities for biometric verification. Through the enrolment and comparison of hand geometry (the size and shape of an individual's hand and fingers), or fingerprints, the identity of an individual shall be verified.

The System shall have the ability to crop and rotate an image automatically based on the orientation of the eyes found in the image. This shall include photographs captured from digital cameras, live cameras, scanned images and imported images.

2.5.4 Visitor Management Module

The System shall include a seamlessly integrated visitor management module. The visitor management module shall be a desktop-based application utilizing technology that allows the client to enrol and track visitors of the organization.

It shall allow the client to enrol visitors, sign them in or out, assign them to an employee, capture a photo, capture a signature, and track the visitors as they move throughout the facilities. It shall allow System Operators to enter and pre-schedule visits. It shall allow System Operators to print visitor badges and shall incorporate complete audit trail and reporting capabilities.

2.5.5 Browser-based Visit Host Application

The System shall provide a browser-based visit host application. The browser-based visit host application shall utilize n-tier architecture. The browser-based visit host application shall support single sign-on.

The browser-based visit host application shall allow for the registration of new visitors by the System User. The System User shall be able to create a new visitor and enter demographic information about the visitor, including first name, last name, address, and phone number. The System shall allow for the System User to add additional user defined fields to the list of demographics fields. The visitor and the visitor's information shall be saved on the System database and shall be able to be utilized by other components of the System.

2.5.6 Bi-Directional Data Exchange

The System shall support a real time, bi directional data interface to external databases such as Human Resources, Time and Attendance, Food Service Systems. The interface shall allow data to be imported into or exported out of the System in real time or in a batch mode basis. Data used for import shall be retrieved directly from an external database or through an import file. Data provided for export shall be applied directly to an external database or through an export file. Any data shall be imported or exported including image data. The file used for import or created by export shall have the ability to be structured in a wide variety of ways, but shall always be in ASCII text format.

The System shall also support a one-step download and distribution process of cardholder and security information from the external database to the System database, all the way down to the Intelligent Field Controller (ISC) database. This shall be a guaranteed process, even if the communication path between the System database server and the ISC is broken. If the communication path is broken, the data shall be stored in a temporary queue and shall be automatically downloaded once the communication path is restored.

2.5.7 Client/Server Relational Database Management Systems

The System shall support industry standard Open Database Connectivity (ODBC) compliant relational database management Systems. This shall include relational database management Systems such as Microsoft SQL Server 2005 and Microsoft SQL Server 2008 and Oracle Server 10g, and 11g.

These databases, through ODBC, shall be true client/server, high performance, and ANSI standard capable of handling high transaction rates and multiple users concurrently accessing and modifying the database.

2.5.8 Destination Assurance

The System shall provide an advanced destination assurance feature that reports instances of cardholders not going directly to their required locations after entering a specified card reader checkpoint. Once a cardholder passes through a checkpoint reader, that cardholder shall have a predefined amount of time to reach his or her destination card reader. Destination Assurance proves beneficial for entry and exit readers at hazardous locations, for example, where an alarm can be generated if a cardholder has not exited the hazardous location within a given length of time.

2.5.9 Network Account Management

The System shall support a Network Account Management module. The System's Network Account Management Module shall integrate System cardholders with external user network accounts. Through linked accounts, System Administrators shall be able to perform a set of administrative tasks in Windows domains from the System Administration Module. The Network Account Management functionality shall also enable System Administrators to create a link between physical access control and logical domains. The System shall additionally be combined with the management of cardholders' digital certificates stored on a smart card.

The integration shall provide a number of benefits, including the ability to do the following:

1. Perform administrative functions on Windows user accounts from within the System Administration Module.

2. Enable interaction between Physical Access Control Cardholders and Windows logical domains. For example, if badge is lost, a designated Windows account shall disable.

3. Control access to Computer Anti-Pass Back Areas

2.5.10 Access Control

2.5.10.1 Time Zones

The System must be capable of creating and storing up to two hundred fifty (250) time zones. Each time zone must have a minimum of six (6) intervals. Each interval shall be assignable to any day of the week and capable of being restricted on a minimum of eight (8) types of holidays.

2.5.10.2 Access Levels

All users shall have access based on facility, reader, time, and day. These time zones for each day are to be pre-defined by the client and must be able to be modified quickly by the System Administrator without vendor intervention.

2.5.10.3 Holidays

The System must allow the System Administrator to designate certain dates as holidays. As well, the dates for Daylight Saving Time shall be definable and shall automatically take effect without System Administrators/System Operators intervention.

2.5.10.4 First Card Unlock

The System shall support a First Card Unlock feature. When configuring the default attributes of a card reader in System Administration, a first card unlock setting shall be selectable. First Card Unlock requires that a valid access grant shall be received at a card reader (by an authorized cardholder) after the time zone change has occurred before placing the reader into an unsecured mode.

2.5.10.5 Database Segmentation

The System shall employ advanced database segmentation functionality. Each segment shall be allowed to have its own unique set of cardholders, hardware, and system parameters including access control field hardware, time zones, access levels, etc., which shall allow System Administrators to expand upon current hardware constraints. For example, each segment shall have its own 32,000 access levels, 250 time zones, and 250 holidays. As such, only credentials

that are assigned access levels to card readers in a segment need to be downloaded to the Intelligent System Controllers in that segment.

Cardholders shall be allowed to belong to one segment, many segments, or all segments.

2.5.10.6 Field Hardware Communications

The System shall communicate with the Intelligent System Controllers (ISC) by either RS-485 or RS-232 EIA standard. The System shall have the ability to communicate with ISCs by LAN/WAN connections utilizing TCP/IP communications protocol. The System shall also have the ability to communicate with the ISCs through remote dial up capabilities.

2.5.10.7 Dual Path Field Hardware Communications

The System shall support dual path communications between the database server and the Intelligent System Controllers. This shall allow for two paths of communication: a primary and secondary path. The primary path shall communicate between the database server and the Intelligent System Controllers (ISC) by either RS-485 or RS-232 EIA standard, LAN/WAN connections utilizing TCP/IP communications protocol, or through remote dial up capabilities using modems. The secondary path shall communicate via RS-485 or RS-232 EIA standard (dial-up shall not be the primary connection using this method), LAN/WAN connections utilizing TCP/IP communications protocol or remote dial up capabilities using modems.

Upon sensing a loss of communications via the primary communication path, the ISC shall automatically initiate the switching of communications to the secondary communications path. Once communications are switched from the primary path to the secondary path, the host shall periodically check and determine if the primary communications path has been restored. Upon restoration of the primary communications path, the host shall restore communications back to the primary communications path. Alarms shall be posted to alarm monitoring client workstations when the primary communications path is lost and/or restored. The currently active path shall be displayed with the Intelligent System Controller status in the System Hardware Status Tree.

2.5.10.8 Area Control

The System shall provide five (5) area control features: Global Hard Anti-pass back, Global Soft Anti-pass back, Timed Anti-pass back, Two Person Control, and Occupancy Limit. Area control shall be a security method of preventing a person from passing their badge to another person for dual entry into a single location utilizing one card.

2.5.10.9 Two Person Control

Two Person Rule shall be provided to restrict access to certain areas unless there are two (2) cardholders present. This restricts individuals from being alone in restricted or highly secure areas.

2.5.10.10 Designated One-Person Control

The System shall allow for a special One-Person Mode. This mode shall require that a designated cardholder is present before anyone else is allowed to access a certain area. This restricts individuals from accessing a restricted or highly secure area when not accompanied by the designated cardholder.

2.5.10.11 Occupancy Limit

Occupancy Limit shall restrict the number of cardholders that shall be present in an area at any given time. The Occupancy Limit area shall be able to be defined by the System Administrator to limit up to 65,000 users to be in that area at any given time. Once the occupancy limit has been reached, a cardholder must swipe out of the exit card reader before the next cardholder may enter. Each area for which Occupancy Limit is enabled shall be definable with up to 64 entry/exit card readers. Multiple Occupancy Limit Areas shall be definable.

2.5.10.12 Mustering

The System shall support advanced Mustering functionality. The Mustering function shall provide an automatic capability for registering cardholders that are on site during an incident. Designated exit and entry card readers shall be used to enter and leave hazardous locations and safe locations. When an incident occurs, a Muster Report shall be generated that consists of a listing of all personnel that are within the hazardous locations as well as all personnel that have registered in a safe location.

Safe Locations
A Safe Location shall be defined using entry and exit readers associated with the location. Safe Locations shall have both entry and exit card readers at all portals. Safe Locations shall require that a reader be used to enter and exit an area. Entry and exit readers shall be able to span across multiple ISCs.

ii) Muster Mode Operation
A Muster Mode shall mean that an incident has occurred and an evacuation is required of one or more Locations. A location shall enter into Muster Mode either automatically via an occurrence of a given hardware event transaction (such as an Alarm Input going active) or manually via a System Operator placing the Location into Muster Mode.

When a Location goes into Muster Mode, all associated Alarm Monitoring Workstations shall be notified with a breakthrough notification and Muster Reporting shall begin.

2.5.10.13 Global Input/output/Event Linkage

The System shall support a global linkage feature whereby any input/output/event shall be linked to any other input/output/event in the System. Input/output Linkages shall be able to span across Intelligent System Controllers.

System Administrators shall be able to create global I/O function lists, each consisting of a sequence of actions to be performed, such as changing card reader modes, activating outputs, and opening or closing anti-pass back areas. Each function list may include up to six actions.

System Administrators shall then be able to link events to the aforementioned global I/O function lists such that a particular device change will execute a function.

The System shall allow for the creation of correlation logic to execute a function only when two or more events occur within a specified time window. This correlation logic shall support both mandatory correlation of ALL members of a user specified a set of inputs (AND), and correlation of ANY members of a user specified set of inputs (OR). This correlation function must accommodate events that occur in close proximity but not necessarily overlapping. Simple Boolean logic does not satisfy this requirement.

2.5.10.14 Guard Tour

The System shall support advanced Guard Tour functionality. A tour shall consist of one or more checkpoints defined as card readers or alarm inputs that a guard shall check during a guard tour.

Security Clearance Levels

Security clearance levels shall optionally be created and assigned a name. Security clearance levels shall be assigned to one or more guard tours.

A Security Clearance Level is a means of limiting the number of 'tour guards' when a tour is launched. Particular Security Clearance Levels shall be assigned only to guards who will need access where the tour will take them. When a tour is launched, only those guards with the security clearance levels shall be listed.

2.5.10.15 Scheduling Utility

The System shall support an advanced Scheduling Utility. The Scheduling Utility shall allow System Administrators to schedule actions to occur on a one-time or a recurring basis. Recurring schedules shall be configured to begin immediately, last indefinitely, or have optional start and end dates.

2.5.10.16 Multiple Card Formats

The System shall support an unlimited number of card formats. Magnetic stripe and Wiegand card formats shall be supported. Each ISC shall support a minimum of eight (8) access control card formats and if applicable, eight (8) asset formats. As such, each card reader shall also be able to support a minimum of eight (8) access control card formats. If applicable, asset readers shall be able to support a minimum of eight (8) access control card formats and eight (8) asset management card formats. The System shall support any magnetic stripe format that uses card number, facility code, and issue code combinations with a maximum of a nine-digit card number and two-digit issue code. The System shall support any industry standard Wiegand card format.

2.5.11 Hardware Specifications

Biometric Reader
CPU: 400MHz DSP
Memory: 8MB flash + 16MB RAM
Fingerprint Sensor: Minimum 500 dpi optical sensor
Identification Speed: Minimum 2,000 matches in 1 second
Fingerprint Capacity: 5,000 fingerprints (10,000 templates)
Log Capacity: 50,000 events
RF Card Options: EM, Mifare / Desfire
Authentication: Finger / PIN / Card
Network Interface: TCP/IP
Wiegand: 1 channel (input/output switchable)
Environmental Rating: IP65
Credential Specification:
Dimensions: 2.127" x 3.375" x 0.033" max. (5.40 x 8.57 x 0.084 cm)
Weight: 0.20oz (5.7 g)
Card Construction: Thin, flexible polyvinyl chloride (PVC) laminate.
Operating Temperature: -40° to 158° F (-40° to 70° C)
Operating Humidity: 5-95% non-condensing
Operating Frequency: 13.56 MHz
Memory Type: EEPROM, read/write
Multi-application Memory: 2k bit (256 Byte) card

Endurance: Min. 100,000 cycles

2.5.12 System Controller Specifications

2.5.12.1 Communications:

On-board Ethernet 10/100Base-T. DHCP and fixed IP addressing supported. DNS device naming through DHCP extended commands additional RS-232 9600 to 115.2 Kbps async RS-485 (2-wire) 9600 to 38.4 Kbps a sync

2.5.12.2 Memory:

6 MB of available on-board, non-volatile flash memory. Battery-backed, non-volatile storage of 50,000 events.

2.5.12.3 Firmware Management:

Firmware stored in flash memory, background download of firmware updates supported.

Number of Simultaneous Card Formats Supported
Up to 16 different formats (8 card formats and 8 asset formats)
Access levels, Time zone and reader support
Up to 32,000 access level permissions
250 holidays with grouping
250 time zones, each with 6 intervals
Individual extended held open and strike times
Up to 9-digit user PIN codes

Other features:

. 2 dedicated inputs for tamper and power failure status
. . Advanced Encryption Standard (AES) 128-bit algorithm for communications

BILLS OF QUANTITIES

3 BILLS OF QUANTITIES

3.1 General Notes to Tenderers

1. The Bills of Quantities form part of the contract documents and are to be read in conjunction with the contract drawings and general specifications of materials and works.

2. The prices quoted shall be deemed to include for all obligations under the sub-contract including but not limited to supply of materials, labour, delivery to site, storage on site, installation, testing, commissioning (**excluding 14% VAT**).

3. All prices omitted from any item, section or part of the Bills of Quantities shall be deemed to have been included to another item, section or part thereof.

4. The brief description of the items given in the Bills of Quantities are for the purpose of establishing a standard to which the sub-contractor shall adhere. Otherwise alternative brands of **equal** and **approved** quality will be accepted.

5. Should the sub-contractor install any material not specified here in before receiving **written approva**l from the Project Manager, the sub-contractor shall remove the material in question and, **at his own cost**, install the proper material.

6. The grand total of prices in the price summary page must be carried forward to the **Form of Tender for the tender to be deemed valid**.

7. The Bills of Quantities are divided generally into three sections: -

a. Contractual Requirements – Bill 1

Sub-contractor's contractual requirements as called for the bill of quantities shall be priced and included in the tender. However, the Tenderer is free to include and price any other items he deems necessary taking into consideration conditions he is likely to encounter on site.

b. Installation Items – Other Bills

The brief description of the items in these Bills of Quantities should in no way modify or supersede the detailed descriptions in the contract Drawings, conditions of contract and specifications. The unit of measurements and observations are as indicated in the Bills of Quantities.

c. Summary

The summary contains tabulation of the separate parts of the Bills of Quantities carried forward with provisional sum, summary volume included. The sub-contract shall insert his totals and enter his grand total tender sum summary of prices.

3.2 Bills of Quantities

(Continue to next page)

SECTION D.W. 1.0 TITLE: PRELIMINARIES & CONTRACTUAL REQUIREMENTS

Item	Description	Unit	Qty	Rate	KShs.
D.W. 1	**CONTRACTUAL REQUIREMENTS**				
A.	Preparation of working drawings, printing and distribution.	Sum	1		-
B.	Preparation of 'As Installed Drawings", printing and distribution as specified. Drawings to include:				
	(a) Blue Prints - 4 sets of each.	Sum	1		-
	(b) AutoCAD on CD – 2 No.	Sum	1		-
	(c) Operational Instructions, manuals and test certificates	Sum	1		-
C	Allow for Necessary Insurances (WIBA, etc) for the Works execution	Sum	1		-
D	Provision of Performance Bond as stated under clause 5 of the published conditions of sub-contract.	Sum	1		-
E	Allow for removal of existing equipment/items and handing over to the client.				-
F	Any other item necessary to complete the installations in this section (please state)	Sum			
					-

SECTION D.W. 2.0 TITLE : IP CCTV SURVEILLANCE SYSTEM

Item	Description	Unit	Qty	Rate	KShs.
D.W. 2.0	**<u>IP CCTV Surveillance System</u>** For the supply and Installation of the following complete as specified. **(attach Catalogue)**				
A	3MP IP Indoor Bullet Fixed camera with advanced remote monitoring via POE, auto focus lens and IR mode for night time conditions as AXIS M2026-LE Mk II Network Camera or Approved Equivalent. **(attach Catalogue for other brand)**	No.	1		-
A	3MP IP Indoor Dome Fixed camera with advanced remote monitoring via POE, auto focus lens and IR mode for night time conditions as AXIS M2026-LE Mk II Network Camera or Approved Equivalent. **(attach Catalogue for other brand)**	No.	4		-
B	Allow use and configuration of the above system with Structured Cabling done by others (Cables by others)	Sum.	1		-
C	Allow for interconnection and programming of the the above System	Sum.	1		-
D	Allow for interfacing with other system like Public Address System, Master Clock System, Nurses Call System, CCTV System and Fire Detection & Alarm System as call for and approved by Engineer.	Sum.	1		-
E	Installation, testing & commissioning	Sum	1		-
F	Labeling, Documentation, 2 year Warranties, associated Training and certification. N.B; Provide comprehesive list of spare part and associated part numbers for above system	Sum	1		-
I.	Any other item necessary to complete installation in this section (Please state)	Sum.			
Total carried forward to Main Summary of Prices					-

SECTION D.W. 3.0 TITLE : IP BASED ACCESS CONTROL SYSTEM

Item	Description	Unit	Qty	Rate	KShs.
D.W. 3.0	**<u>IP Based Access Control System:</u>** For the supply and Installation of the following complete with wiring as specified.				
A.	IP Based Intelligent Dual Reader controllers, (5 yerar lithium battery or 3 months full run) 6 MB standard cardholder flash memory, 50,000 of Event memory, maximum of 32 devices, On-board Ethernet, on-board two door control, eight inputs, four outputs, cabinet tamper and power fault input monitors. RoHs, CE marked and UL 294.	No.	2		-
B	IP Based Open prox card reader complete with Biometric, PIN facility, magnetic door lock, door controllers (Dual Reader interface Module (series 2 - Supports OSDP Readers) - 12/24 VDC, 2 Reader interface, W/M, 8 inputs, 6 (%A) form C relays, RoHS, CE and UL294 certified and power supply unit with batteries).	No.	2		-
C	Allow for installation of IP Based Intercom station that support Remote unlocking via the client software as Hik Vision DS-DSKH8350complete with associated accessories to complete the installation	No.	1		-
D	Allow Supplying, Installing, Testing and Commissioning of Gate/Entry Video Call unit (vandal and Weather Proof) complete with any other associated accessories as HIK Vision DS-KB8112- IM or Equal and Approved.	No.	1		-
E	Proximity Cards printed and customised	No.	10		-
F	Break' glass sensor for emergency evacuation/override	No.	1		-
G	Allow use and configuration of the above system with Structured Cabling done by others (Cables by others)	Sum.	1		-

H	Allow for interconnection and programming of the the above System	Sum.	1		-
I	Allow for interfacing with other system like Public Address System, Master Clock System, Nurses Call System, CCTV System and Fire Detection & Alarm System as call for and approved by Engineer.	Sum.	1		-
J	Installation, testing & commissioning	Sum	1		-
K	Labeling, Documentation, 2 year Warranties, associated Training and certification. N.B; Provide comprehesive list of spare part and associated part numbers for above system	Sum			
L	Any other item necessary to complete installation in this section (Please state)	Sum.			

Total carried forward to Main Summary of Prices -

PROPOSED FIT OUTS AND RE-ORGANIZATIONS FOR THE LABOR WARDS IN NAIROBI HOSPITAL

DATA & VOICE SYSTEMS INSTALLATION
MAIN SUMMARY OF PRICES

Item	Description	Unit	Qty	Rate	KShs.
D.W.1	**SECTION 1** Preliminaries & Contractual Requirements				-
D.W.2	**SECTION 2** IP Based CCTV Surveillance System				-
D.W.3	**SECTION 3** IP Based Access Control System				-
	Sub - Total				
Total Carried Forward to Main Summary of Volume I					-

3.3 Schedule of Unit Rates

The tenderers shall provide a schedule of unit rates (under Tables (a) and (b) below) that shall be used to build up rates for variation items not specified in the bill of quantity.

This section, and the terms filled herein shall form part of the contract, and shall be considered locked for the duration of the project.

Rates filled herein shall be evaluated as part of the tender evaluation process. Attention is drawn to the tender evaluation criteria included in this tender package.

The sub-contractor shall disclose the cost of the material offered by the supplier, including or manufacturer or any other sources to the Engineer used to build up the rates in respect to schedule of table (a) and table (b) below. The engineer can reject the disclosed sources where the conflict of interest seems to prevail.

Table (a) and Table (b) shall be deemed to be exhaustive in capturing all cost components and the percentages filled herein shall be considered to be locked for the duration of the contract.

3.3.1 Locally Available Items

Unit rates for items that can be procured locally shall be generated according to table (a) below. Table (a) consists of the below items:

- Material cost – This is the supplier's unit cost for the item, i.e. the cost at the shop/supplier.
- Labor – This is to include all transportation, security, hoisting, installation, tools and consumables, testing, commissioning, costs, etc. The tenderer is to provide his/her labor cost as a percentage of material cost.
- Overheads and Profit – This is to capture all Sub-contractor's overheads, margins, profit, etc. The tenderer is to provide his/her overheads and profit as a percentage of material cost.
- Further to this, tenderers are expected to list all other cost carriers not deemed to have been captured in the table below, as a percentage of material cost.

3.3.1.1 Table (a): Locally Available Items.

Material Cost Kshs. (a)	Labour (as a percentage of material cost) (b)	Overheads and Profit (as a percentage of material cost) (c)	List any other component as necessary (as a percentage of material cost) (d)	Total Installed Cost of item shall Kshs. a + (axb%) + (axc%) + (axd%) (VAT exclusive)
	……..%	……..%	……..%	

3.3.2 Imported Items

Unit rates for items that will require importation shall be generated according to table (b) below. Table (b) consists of the below items:

- Material cost – This is the supplier's unit cost for the item as landed and cleared in Kenya. It includes FOB price, Carriage Insurance & Freight, Inspection Charges, Duty, Port Levies, Clearance Charges and VAT

- Labor – This is to include cost for transportation from port to site, security, hoisting, installation, tools and consumables, testing, commissioning and associated costs, etc. The tenderer is to provide his/her labor cost as a percentage of material cost.
- Overheads and Profit – This is to capture all Sub-contractor's overheads, margins, profit, etc. The tenderer is to provide his/her overheads and profit as a percentage of material cost.
- Further to this, tenderers are expected to list all other cost carriers not deemed to have been captured in the table below, as a percentage of material cost.

3.3.2.1 Table (b): Imported Items.

Material Cost Kshs. (a)	Labour (as a percentage of material cost) (b)	Overheads and Profit (as a percentage of material cost) (c)	List any other component as necessary (as a percentage of material cost) (d)	Total Installed Cost of item shall Kshs. a + (axb%) + (axc%) + (axd%) (VAT exclusive)
	……..%	……..%	……..%	

…….. **(Signed)**

…….. **(Date)**

…….. **(Official Stamp)**

3.4 Day Work Terms for Labour

(To Be Completed by Tenderer)

Description of Artisan	Cost Per Hour
Supervisor	……
Grade A Electrician	……
Grade B Electrician	……
Grade C Electrician	……
Labour	……
Apprentices	……

TECHNICAL SCHEDULE

4 TECHNICAL SCHEDULE

4.1 Documentation Requirements

Document	With Bid	Before Manufacture	During FAT	Upon Delivery
Preliminary general arrangement drawing (with dimensions)	YES			
QA / QC Plan in accordance with ISO 9001:2008		YES		
General arrangement drawing (with dimensions)		YES		
Schematics/Line diagrams for construction	N/A	YES	N/A	N/A
Recommended Spares List	N/A	N/A	N/A	YES
Routine Test Reports / Certificates			YES	
Type Test Reports / Certificates	N/A	N/A	YES	N/A
Commissioning Procedure	N/A	N/A	N/A	YES
As-built General arrangement drawing			YES	
As-built Schematics			YES	
Site Test Reports / Certificates				YES
Special Test Reports / Certificates	N/A	N/A	YES	NO

4.2 Technical Schedule

The tenderer **MUST SUBMIT** comprehensive manufacturer's technical brochures and performance details for all items listed in this schedule (fill forms attached).

ITEM No.	Description	Remarks
A	CCTV system	
B	Access Control System	
C	Work station	

APPENDICES

5 APPENDICES

5.1 Appendix I: Statement of Compliance

Technical Schedules shall be submitted by tenderers to facilitate and enable the Engineer to evaluate tenders but only when the fittings and accessories upon which the tenderer has based his tender sum differs in manufacture, type or performance from the description contained within this specification.

Tenderers shall submit separate leaflets and catalogues giving technical and physical details for all fittings and accessories described in the Technical Schedule at the time of tendering.

Completion of Technical Schedule shall not relieve the Sub-Contractor from complying with the requirements of the Specification except as may be approved by the Engineer.

…….. **(Signed)**

…….. **(Date)**

5.2 Appendix II; Exchange Rate Fluctuations

Adjustment will be made to the price of imported materials to compensate for variations in the foreign exchange rate. For this purpose, the tenderer is required to state the exchange rate in Kenya Shillings for the currency of the Country of origin of imported materials as applied to the actual remittance effecting payment to manufacturers of the materials.

Exchange Rate: ……..

Signed (as in Tender) ……..

Date ……

5.3 Appendix III; System Warranties

The tenderer shall outline the warranties for all systems installed on this site as specified elsewhere.

These shall include but not limited, to the following:

- CCTV system
- Access Control System
- Work station

5.4 Appendix IV; Technical Schedule

TECHNICAL SCHEDULE

The tenderer must complete in full the technical schedule. Apart from the information required in the technical schedule, the tenderer **MUST SUBMIT** comprehensive manufacturer's technical schedules details for all items listed in this schedule (fill forms attached).

Description	Manufacturer	Country of origin	Remarks (Catalogue No. etc.)
CCTV system Access Control System Work station			

GENERAL SPECIFICATION

1 PART A: GENERAL SPECIFICATION

1.1 General:

The site of the proposed Sub-Contract works shall be at The Nairobi Hospital, along Argwings Kodhek Road.

1.2 Reference Sites:

The offered equipment shall have been sold in Kenya in sufficient quantities to provide good proof of a Tenderer's capability of handling similar projects. Tenderers shall supply a detailed record of similar equipment that have been installed by them.

In addition to ensure continued support of the proposed equipment from the manufacturer, the Tenderer must submit documentary evidence that they are indeed authorised and accredited distributor/reseller of the manufacturer.

1.3 Cable Management:

The necessary infrastructure (excluding conduit work and cable raceways) for the Proposed Systems shall be done by the Electrical Sub - contractor, however should additional requirements be necessary the Sub - Contractor shall provide all the working drawings showing all the necessary conduit/trunking cable ways.

1.4 Systems Requirements:

The systems shall comprise but not limited to the following:

- Nurse Call System
- Public Address & Voice Evacuation System

1.5 Commencement of Works:

The Tenderer in submitting his bid shall be deemed to have allowed for commencing the works on site immediately upon appointment.

1.6 Scope of the Sub - contract Works:

The Sub - contract Works shall comprise the supply, delivery, erection, testing, commissioning and setting to work of the complete **systems** as detailed in this Specification and accompanying Sub - contract Drawings.

The Tenderer shall include for all apparatus and appliances not particularly called for in this Specification or on the Sub - contract Drawings but which are necessary for the successful completion and satisfactory functioning of the Sub - contract Works.

It is deemed that if, in the opinion of the Sub - contractor at the time of tendering there exists a discrepancy in the Specification, Drawing or both, that the Sub - contractor clarifies this difference with the Engineer before tendering.

The Tenderer shall provide as an integral part of his bid a statement of compliance in which he shall clearly declare any items of the Specifications to which his offer does not comply and an alternative which is included in the offer.

The Sub - contractor shall be obliged to liaise with other parties involved in the project and to provide any necessary information as and when required.

No claims for extra payment shall be accepted from the Sub - contractor due to his failure to adhere to the above requirements.

The work to be installed under the Sub - contract shall comprise but not restricted to the supply and installation of the following complete as specified elsewhere in this Specification:

1. Wall/ ceiling mounted Outlets.
2. Pull Cords
3. Door Indicators
4. Speakers
5. Etc.

All equipment as far as is practicable shall be designed and manufactured by a single preferred manufacturer. In any case equipment shall be of uniform standards compatible in operation and spare parts trained support and maintenance facilities being available. In this regard the Tenderer shall produce a letter of guarantee and commitment from the equipment manufacturer for production at tender opening. Any tender without such a commitment letter shall be rejected.

1.7 Ordering of Materials:

The Sub - contractor shall order materials from quantities taken from his own approved working drawings and not from the quantities shown on the Sub - contract Drawings or in the Specification.

1.8 Builder's Work Requirements:

All chasing, cutting away and making good of walls and slabs shall be by the Main contractor.

1.9 Tender Return Items:

Drawings and publications illustrating the systems and equipment being offered against the schedules shall be returned with the Tender, together with a comprehensive description of the systems being offered to meet the requirements detailed elsewhere in the Specification.

1.10 Standards and Regulations:

The design, manufacture, selection, installation, testing, commissioning and subsequent maintenance of all equipment and materials described in this Specification shall comply with internationally recognised standards.

1.11 Documentation:

Record Drawings, Operating instructions, log book and certificates of installation and commissioning shall be provided adjacent to the control and indicating equipment at the end of the Sub - contract .

Operating and Maintenance Instructions shall be provided before the system is accepted. The instructions shall describe the system operation, zoning, routine care and maintenance, fault finding procedures and the function and settings of all controls.

The instructions shall include a full set of drawings, other manufacturer's handbooks and proprietary items and a complete list of spare parts provided and which are available. Full details shall be provided of all manufacturers and suppliers.

1.12 Defects Liability and Spares:

The Sub - contract or shall provide a comprehensive routine and emergency call out service for the defects liability period, and shall confirm the response time to be provided. This service

shall include routine examination and any adjustments, cleaning, replacement of parts as required to keep the system in full working order.

All equipment shall have a minimum 1 year warranty period from the manufacturer.

The Tenderer shall include details of a proposed Maintenance Sub - contract to provide regular maintenance from the start of the defects liability period, in accordance with this specification. The Client is not bound to accept the offer from the Sub- contractor.

An appropriate set of spares shall be provided, including consumable and modular items, which can be replaced by on-site maintenance staff. A list of the proposed spare parts shall be provided with the Tender.

1.13 Inspection, Testing and Commissioning:

The Sub - contract or shall inspect, test and commission the works in accordance with the equipment manufacturer's recommendations. The results of all tests shall be recorded on the standard test forms unless otherwise specified.

Before completion of the installation the Sub - contract or shall submit to the Engineer for acceptance, a method statement of the procedure to be used for testing and commissioning, which has been agreed with the equipment manufacturers.

Before cables are terminated each cable shall be tested for continuity, insulation resistance, polarity and markings. Following satisfactory testing, cables shall be terminated in the equipment only by the manufacturer's appointed representative.

Power supplies shall be tested prior to making connections to the control equipment. The Sub - contractor shall allow for all necessary attendance during the testing and commissioning of any ancillary systems interconnected with the security system.

PARTICULAR SPECIFICATIONS

2 PARTICULAR SPECIFICATIONS - NURSE CALL SYSTEM

2.1 General

Equipment includes the following: all equipment listed and described in this document.

- Coordinate all work with other trades.

- Provide all incidental equipment and devices not mentioned herein that are required to provide a complete system and to realize a complete stable and safe operation thereof. All conduit, raceway, power, and grounding for these systems shall be installed or supplied by the Electrician.

- Provide a Renewable Annual Maintenance Agreement Proposal for all service work beyond the warranty period.

- After the system is completely installed and tested, provide the services of one technician to assist the User in adjusting the system and its terminations, connections and its programmed functionality. Provide a minimum of 16 hours unless otherwise specified.

- Drawings and conditions of the Sub - contract, including but not limited to General Conditions, and the Special Conditions listed below, apply to work of this section.

    1. Supplementary Instructions to Bidders
    2. Supplementary Conditions
    3. Summary of the Work
    4. Project Coordination
    5. Cutting and Patching
    6. Definitions and Standards
    7. Submittals
    8. Schedules and Reports
    9. Temporary Facilities
    10. Security Regulations
    11. Safety and Health
    12. Products
    13. Project Closeout

2.2 Project/Work Identification

Sub - contract documents indicate the scope of work of the Sub - contract, and related requirements and conditions that have an impact on the project. Related requirements and conditions that are indicated on the Sub - contract documents include, but are not necessarily limited to, the following:

1. site conditions and restrictions
2. Other work prior to work of Sub - contract
3. Alterations and coordination with existing work
4. Other work to be performed concurrently by User
5. Other work to be performed concurrently by separate Sub - contractors
6. Other work subsequent to work of Sub - contract
7. Requirements for occupancy by User prior to completion of work of Sub - contract

2.3 Project Objective

A. This performance specification provides the minimum requirements for a supervised audio-visual Voice over IP-based Nurse Call System. The System shall include, but not be limited to all equipment, materials, labour, documentation, and services necessary to

furnish and install a complete, operational Voice over IP-based Nurse Call System. The System shall have full duplex audio as well as "push to talk" control for high-noise areas. The System shall comply in all respects with all pertinent codes, rules, regulations, and laws of the hospital authority and local jurisdiction. The System shall comply in all respects with the requirements of the specifications, Manufacturer's recommendations and Underwriters Laboratories Inc. (UL) Listings.

B. Each System shall be capable of supporting in excess of 1,000 Patient Stations (>2,000 beds) and 5,000 Peripheral Stations. The System shall support networking of systems to a single integrated platform for:

1. Wireless communications system(s)
2. Reporting Database
3. ADT Integration
4. Wireless Locating
5. Electronic Whiteboard
6. PC Staff Console (List View and Floorplan view) applications
7. Patient/Staff Assignments
8. Automatic/Manual Messaging

C. It is further intended that upon completion of this work, the User be provided with complete information and drawings describing and depicting the entire System(s) as installed, including all information necessary for maintaining, troubleshooting, and/or expanding the System(s) at a future date, and complete documentation of System(s) testing.

2.4 Manufacturer

1. Acceptable Nurse Call System Manufacturers as Ascom Patient Systems US or any other approved equivalent manufacturer.

A. All equipment and components shall be the Manufacturer's current model. The materials, appliances, equipment, and devices shall be tested and listed by a nationally recognized approval agency for use as part of a Nurse Call System. The Manufacturer's representative shall be responsible for the satisfactory installation of the complete System.

B. The Sub - contract or shall provide, from the acceptable Manufacturer's current product lines, equipment and components, which comply, with the requirements of these specifications. Equipment or components, which do not provide the performance and features required by these specifications, are not acceptable, regardless of manufacturer.

C. The Manufacturer of the System equipment shall be regularly involved in the design, manufacture, and distribution of all products specified in this document. These processes shall be monitored under a quality assurance program that meets ISO requirements. The Manufacturer shall have the financial stability to provide project financing/lease options to the User if desired.

D. All System components shall be the catalogued products of a single Supplier. All products shall be listed by the Manufacturer for their intended purpose.

E. All connected field electronics shall be both designed and manufactured by the same company, and shall be tested to ensure that a fully functioning System is designed and installed. The VoIP-based Nurse Call System shall utilize Ethernet topology, switches, gateways, and devices. These devices shall make up a UL 1069 Listed nurse call LAN/WAN. The Nurse Call System shall be FDA Registered, Class II, 501 (k) exempt.

2.5 Alternates

A. Strict conformance to this specification is required to ensure that the installed and programmed System shall be function as designed, and shall be accommodate the future requirements and operations of the building User. All specified operational features shall be met without exception.

B. The authorized Representative of the Manufacturer of the equipment shall be responsible for the satisfactory installation of the complete System.

C. All equipment and components shall be the Manufacturer's current model. The materials, appliances, equipment and devices shall be tested and listed by a nationally recognized approval agency for use as part of an audio-visual Voice Over IP-based Nurse Call System. The authorized Representative of the Manufacturer shall be responsible for the satisfactory installation of the complete System.

D. All Annunciators, Staff Consoles, VoIP Staff Stations, IP Switches, Station Gateways, Telephone Gateways, IP Devices, Patient Stations, Dome Lights, and Peripheral Devices shall be provided by the same System Supplier, and shall be designed and tested to ensure that the System operates as specified. All equipment and components shall be installed in strict compliance with the Manufacturer's recommendations.

E. Alternates to the equipment specified shall be considered only if all sections of the performance specification are met. Any deviations from System performance as outlined in this specification shall be considered only when the following requirements have been met:

1. A complete description of proposed alternate System performance methods with three (3) copies of working drawings thereof shall be submitted to the User for approval not less than ten (10) calendar days prior to the scheduled date for submission of bids. The Supplier shall submit a point-by-point statement of compliance for all sections in this specification. The statement of compliance shall consist of a list of all paragraphs within these sections. Where the proposed System complies fully with the paragraph, as written, placing the word "comply" opposite the paragraph number shall indicate such. Where the proposed System does not comply with the paragraph as written, and the Supplier feels the proposed System shall be accomplish the intent of the paragraph, a full description of the function, as well as a full narrative description of how its proposal shall be meet its intent, shall be provided. Any submission that does not include a point-by-point statement of compliance as described herein shall be disqualified. Where a full description is not provided, it shall be assumed that the proposed System does not comply.

2. The acceptability of any alternate proposed System shall be the sole decision of the User or their authorized Representative.

2.6 References

General (References)

A. All work and materials shall conform to all applicable Federal, State, and local codes and regulations governing the installation. If there is a conflict between the referenced standards, federal, state, or local codes, and this specification, it is the Bidder's responsibility to immediately bring the conflict to the attention of the Engineer for resolution. National standards shall prevail unless local codes are more stringent. The Bidder shall not attempt to resolve conflicts directly with the local authorities unless specifically authorized by the Engineer.

B. System components proposed in this specification shall be listed by Underwriters Laboratories, Inc. (UL) to operate together as a System. The Supplier shall be responsible for filing all documents, paying all fees (including, but not limited to plan checking and permits), and securing all permits, inspections, and approvals. Upon receipt of approved drawings from the authority having jurisdiction, the Supplier shall immediately forward two sets of drawings to the User. These drawings shall either be stamped as approved or a copy of the letter stating approval shall be included.

2.7 Definitions

ADT: Admission Discharge Transfer System
AFF: Above Finished Floor
AHJ: Authority Having Jurisdiction
Approved: Unless otherwise stated, materials, equipment, or submittals approved by the Authority or AHJ
Circuit: Wire path from a group of devices or appliances to a control module
DL: Dome Light
ESM: Event Subscription Manager
FDA: Food and Drug Administration
HL7: Health Level 7 protocol
IP: Internet Protocol
IPN: IP Network
PD: Peripheral Device
PN: Peripheral Network
PSpkr: Pillow Speaker
RTLS: Real Time Locate System
SC: Staff Console (Master Station)
UL or ULI: Underwriters Laboratories, Inc.
UL Listed: Materials or equipment Listed and included in the most recent edition of the UL Equipment Directory

2.8 System Description

2.8.1 General

A. The System shall be network-based and incorporate decentralized, distributed intelligence architecture. This intelligent architecture shall be built on an IP (Internet Protocol) network. The System shall allow both data and voice to be distributed over a common network infrastructure, which is consistent with the communication industry. Communication devices on the network shall be utilize standards-based protocols. The System shall also provide a means of interoperability with 3rd party wired and wireless network devices within the facility, including PCs, PDA's, phones, databases, pagers, etc.

B. Each System shall be capable of supporting in excess of 1,000 Patient Stations (>2,000 beds) and 5,000 Peripheral Stations. The System shall support networking of up to three Systems of this size.

C. The System shall consist of (include):
   1. Staff Consoles and Annunciator Panels with colour touch screen LCD panels
   2. VoIP Staff Station with configurable colour touch screen for workflow & bed management operation
   3. Station Gateways
   4. Ethernet Switches/powered distribution hubs
   5. Single and Dual Patient Stations
   6. Configurable Single-Gang Push/Pull Type Peripheral Devices
   7. Single-Gang Dual Aux Input Stations with optional electrical isolation
   8. 1, 2, and 4-Section LED Corridor Lights

9. Network Bridge and Configuration Software
10. Telephone Gateway (Supporting Analog, T1 and/or SIP connectivity)

D. The System shall be capable of integrating to:
    1. Most brands of in-building wireless telephone systems
    2. Most brands of pocket paging systems
    3. Hospital data gathering and reporting software
    4. Staff locating systems, wireless call cords, IPTV system, Public Address System, CCTV switching controls, and door access controls
    5. Patient-to-staff assignments, wandering patient alarm systems, bed exit and/or fall prevention alarm systems, and patient equipment calls
    6. Marquee display panels, PC monitors, and large screen monitors such as Flat Panel LCD or Plasma displays
    7. Select Electronic Medical Record (EMR) system(s)

E. The System shall be capable of Hill-Rom and/or Stryker bed side-rail communication compatibility or any other approved equivalent including visual and audible annunciation of patient safety and fall prevention alarms generated by the bed and of disconnected bed.

F. It shall be possible to configure the System using a modular, flexible GUI application that provides the system administrator the ability to manage, (add, delete, modify) and diagnose information within the nurse call network. Systems not supporting administrative access remotely shall not be accepted.

G. The System shall not rely on any computer for operation. Systems requiring a PC to be connected for operation shall not be accepted.

H. The system architecture shall not require external power supplies. Systems requiring power supplies to be installed separately from the control equipment shall not be accepted.

2.8.2 Stations

2.8.2.1 Patient Stations

A. Patient Stations are a primary point of two-way communication between patients and staff. Equipped with three call buttons and a cancel button, they offer users an easy-to-operate means of placing calls on the patient-staff communications system. With a built-in speaker and microphone, these devices also provide patients with the means of opening a full-duplex channel of audio communications with attending staff, and vice versa. On-board LEDs provide operational feedback as well as status indication.

B. Smart Patient Stations provide separate 18-pin receptacles for the connection of pillow speakers. Each station also comes equipped with two ¼" (0.64 mm) receptacles that can be programmed to accept either an input from auxiliary hardware having an FDA approved or cleared nurse call connection, or a bed call cord. An optional Smart Patient Station with two ¼" (.64 mm) receptacles only (no pillow speaker receptacle) shall be available for locations where only call cords are used, eliminating the receptacle concerns of contaminates for infection control.

C. Patient Stations shall provide a durable 18-pin pillow speaker receptacle and two user-configurable ¼" jacks for use with call cords or as non-latching (auxiliary) inputs.

D. Stations shall provide four buttons that are field configurable allowing User to define call priorities without ordering custom stations. Configuration software shall allow the User to select from a list of button templates. The system shall include default templates and allow the User to create and define custom templates.

E. Patient Stations shall be available with an optional 37-pin bed interface receptacle on the front of the station, for use where bed interfaces are shown on plans, eliminating the need for separate devices.

F. Systems unable to provide Patient Stations that support pillow speaker(s), bed interface(s), and up to two auxiliary inputs from the Patient Station shall not be accepted.

G. Removal of the pillow speaker, bed interface or call cord/auxiliary alarm cable shall generate a cord out call.

H. Stations shall NOT require the use of "dummy" plugs for any receptacles including call cord/auxiliary device, pillow speaker, and bed interface connections. Systems requiring a dummy plug to be inserted to cancel cord out calls shall not be accepted.

I. Patient Stations must provide the ability to intentionally remove a device (call cord, pillow speaker, bed interface) without placing a call to the System. When this feature is activated, the removal of any of these items shall not send a cord out call.

J. Stations must provide a cleaning mode to allow housekeeping to clean station surfaces without generating false calls. Activating cleaning mode shall temporarily disable the front panel buttons for a defined period of time.

K. It shall be possible to cancel a call from any cancel button within a patient room by linking stations when configured to do so and code allows.

L. Patient Stations shall be configurable for custom call types without custom ordering devices from the Manufacturer or replacing devices.

M. Patient Stations shall have separate speaker and microphone to support full duplex audio. Systems using half-duplex audio (voice operated switch) shall not be accepted.

N. Patient Stations shall include two independent auxiliary inputs (1/4" jacks) capable of supporting either latching auxiliary hardware having an FDA approved or cleared nurse call connection and/or non-latching call cords. Staff members shall be able to configure these inputs for latching or non-latching inputs at the station via a button press on the face of the station. The Patient Stations shall provide a visual indication of the auxiliary input status being set.

O. Patient Stations shall have a status LED to indicate call and communication status.

P. Each Patient Station button shall have a dedicated LED to indicate that the button has been pressed or is actively indicating a call. Patient Stations using a single LED to indicate the pressing of any button shall be not be accepted.

Q. Patient Stations shall support a staff follow mode that, when activated, alerts staff to calls from other stations by an audible tone at the station in their current location. The staff follow tone shall match the tone of the incoming call priority.

R. Patient Stations shall NOT have DIP switches that require manual setting by field personnel. Each Patient Station shall have a preconfigured identification number that specifies the station type automatically. Stations utilizing manual DIP switches shall not be considered.

S. Patient Stations shall be hot swappable and not require system shutdown or removal of power prior to replacement.

T. Patient Stations shall support simultaneous input of pillow speaker and bed. If either connection is removed, audio must automatically transfer to the remaining device or to the on-board station speaker.

U. Volume levels for each Patient Station shall be adjustable on a station-by-station basis. Universal settings, or settings that affect an entire wing or floor, shall not be accepted.

V. All Patient Stations shall be supervised.

W. Each Patient Station shall connect to the System wiring via a single RJ-45 connector. All connections to television and light controllers shall be via removable lever connectors providing simple, hot swappable serviceability.

X. Patient Stations shall provide on-board lighting to provide visibility in dark rooms.

2.8.2.2 Staff, Duty Stations

A. Staff/Duty Station features shall be identical in operation to the Patient Station with the exception of the call cord, pillow speaker, and bed interface receptacles.

B. Annunciation tones at Staff/Duty Stations must be identical to the tones generated by the Staff Console for each priority to clearly identify call types. Systems having duty tones that are not identical to tones generated by the Staff Console shall not be accepted. Room graphical displays shall be provided

2.8.2.3 VoIP Staff Stations

A. The VoIP Staff Station is a dynamic communication device providing flexible operation via User defined menus and touch points utilizing factory provided templates. The VoIP Staff Station may provide communication needs including, but not limited to surgical communication, Patient room communication, room status signals, and nurse rounding timers, dispatch requests to supporting departments and speed dial operation to any device on the Telligence LAN or any other approved network. It operates as both a user interface and a communications device that sends and receives data and audio signals over the IP network. As an audio device, it provides audible signalling functions and facilitates two-way full-duplex staff patient and staff to staff communications.

B. The VoIP Staff Station shall be IP-based, utilizing Voice over IP technology.

C. The VoIP Staff Station shall have a 5.7" backlit colour touch LCD screen.

D. The touch screen shall provide all necessary touch point soft keys as opposed to mechanical switches. Systems having mechanical switches shall not be accepted.

E. The touch screen shall be configurable to support up to sixteen (16) menus. Each menu shall be capable of supporting up to sixteen (16) configurable touch points. Menus can be created via templates that can be applied to individual devices, or all devices in a given area, allowing simplified and efficient installation and ongoing management.

F. Intercom audio between the VoIP Staff Station to any device on the Telligence or any other approved network shall be full duplex, and provide the ability to switch to half duplex for environments with excessive ambient noise and privacy control. Systems unable to support user selectable full duplex and one-way (half-duplex) audio shall not be accepted.

G. The VoIP Staff Station shall connect to the nurse call LAN/WAN utilizing CAT. 6 cable and powered Ethernet. No separate power supply or wiring shall be used.

H. The VoIP Staff Station shall support room devices for a minimum of two beds, including dome light and up to five peripheral stations. Systems requiring separate cable plan to support the nurse call devices and workflow devices shall not be accepted.

I. The VoIP Staff Station shall provide a screen saver mode reducing ambient light in

patient rooms when staff is not present. The time elapse from last use to screen saver shall be user configurable. With integration of RTLS the screen saver shall give way to the home screen when staff is registered in the room in which the VoIP Staff Station resides.

2.8.2.4 Peripheral Stations

A. Peripheral Stations are addressable initiating devices that provide patient room call-for-assistance indication to the patient-staff communications system. When a Peripheral Station is activated, visual indication of the call displays at the dome light associated with the patient room, and an appropriate call indication registers on the staff console, as well as on any installed and covering annunciators.

B. Each room shall be capable of supporting more than nine Peripheral Stations. These stations shall be configurable to generate any level of call supported by the system configuration. Examples of Peripheral Stations are: Lavatory, Shower, Staff Emergency, Remote Cancel, Housekeeping, Code Blue, Code Pink, Urgent, Family Call, Staff Normal, Manual Presence, Auxiliary Inputs, etc.

C. Pushbutton/Pull Cord Stations shall be field configurable to allow one, two, or three pushbuttons, with or without a pull cord.

D. Call type/priority for each pushbutton or pull cord shall be programmable in system programming to annunciate the User-determined call type. The physical device button label shall be replaceable to match the specified call type/priority.

E. Peripheral Station buttons shall be configurable for 'Toggle On / Toggle Off", supporting bed management, patient flow, workflow and other non-clinical type events, as defined by the User. Check latest configuration options to clarify any limitations.

F. Peripheral Stations shall provide on-board lighting for visibility in dark rooms.

G. Peripheral Stations shall require only two wires for installation.

H. Each Peripheral Station button shall have a dedicated LED to indicate that the button has been pressed or is actively indicating a call.

I. All Peripheral Stations shall have the ability to be individually numbered to represent a separate and distinct location, even stations that are in the same daisy chain.

J. Peripheral Stations shall not require any screws to be removed for maintenance personnel to remove the station.

K. Peripheral Stations shall NOT have DIP switches that require manual setting by field personnel. Each station shall have a preconfigured identification number that specifies the station type automatically. Stations utilizing DIP switches shall not be considered.

L. Peripheral Stations shall be hot swappable and not require system shutdown or removal of power prior to replacement.

M. Peripheral Station pull cords shall be made of a non-contaminant material to reduce the spread of nosocomial infections. Pull cords made of cotton or other absorbent materials shall be not be accepted.

N. Peripheral Stations shall provide a cleaning mode to allow housekeeping to clean station surfaces without generating false calls. Activating cleaning mode shall temporarily disable front panel buttons for a configurable period of time.

O. All Peripheral Stations must be fully supervised.

2.8.3 Consoles, Annunciators and Lights

2.8.3.1 Corridor Lights

A. Corridor (dome) and zone lights provide bright, easy-to-see visual annunciation that speeds response time and increases caregiver efficiency. These devices are typically installed in corridors and outside patient rooms to provide staff with a visual cue as to the origin of a call placed on the system.

B. Corridor (dome) lights operate in a similar fashion to annunciator panels or staff consoles: the light colour and flash rate indicates the type and priority of the call. Models are available with one, two, or four sections.

C. Each Corridor Light shall utilize Light Emitting Diodes (LED) for displaying colours. Corridor Lights utilizing incandescent bulbs shall not be accepted.

D. Corridor and Zone Lights shall be available in one, two, or four sections.

E. To maintain aesthetics, reduce obstruction, and limit risk of damage to devices, the maximum size of each Corridor Light shall not be greater than 5 inches in length, nor shall it protrude more than 3.5" from the mounted surface.

F. Each Corridor Light section shall be capable of indicating in excess of eight User-selected configurable colours. Corridor Lights requiring more than four sections to provide this many colours shall not be acceptable.

G. To allow for maximum flexibility, the Corridor Light shall be configurable via programming to allow multiple sections of a single light to illuminate and/or flash the same colour for higher priority calls.

H. Corridor Lights shall be able to match most existing Corridor Light schemes via programming. Systems with corridor light schemes that are not able to match existing systems shall be not be accepted.

I. Any corridor lights requiring the replacement of filter caps or lenses to obtain facility-requested corridor light colours for any priority shall not be accepted.

J. Corridor Light shall provide a diagnostic indication of room status to prevent maintenance personnel from disrupting patients.

2.8.4 Staff Consoles

A. The Staff Console is a primary point of contact among users of the system. It operates as both a user interface and a communications device that sends and receives data and audio signals over the IP network.

B. As a user interface, the Staff Console alpha-numerically displays incoming calls from stations and connected healthcare equipment, and provides a means for the operator to prioritize and respond to selected events. As an audio device, it provides audible signalling functions and facilitates two-way full-duplex staff/patient and staff/staff communications.

C. The Staff Console shall provide visual identification of the calling station(s) by room number, bed identification, priority, station type or call type. Staff Console audible annunciation shall indicate priority level. Incoming calls shall be displayed on the colour display in the colours for their associated priority levels. Staff Console shall also display an elapsed time for each pending call.

D. The Staff Console shall be IP-based, utilizing Voice over IP technology.

E. The Staff Console shall have a 5.7" backlit colour touch LCD screen.

F. The touch screen shall utilize programmable soft keys as opposed to a mechanical dial/touchpad.

G. Staff Console display shall provide an adjustable tilt mechanism for viewing clarity.

H. Intercom audio between the Staff Console and any station in the System shall be full duplex. Systems providing only one-way (half-duplex) audio shall not be accepted.

I. The Staff Console shall connect to the nurse call LAN/WAN utilizing CAT 6 cable and powered Ethernet. No separate power supply or wiring shall be used.

J. The call pending screen on the Staff Console shall allow five calls to be visible at a time and provide a simple scrolling function to view additional calls when more than six pending calls are present. Pending calls shall be displayed in priority order regardless of the order in which they are received.

K. The Staff Console shall have the ability to "automatically select" incoming calls in order of priority, or to allow the user to select what call to answer from the pending calls list.

L. The user shall have the ability to adjust the volume of the Staff Console incoming call tones.

M. User shall be able to make available or remove selected functions/buttons from the Staff Console screens where selected functions are not to be used and to simplify operation. Functions/buttons that can be removed include Audio Page, Swing/Capture/Share and volume adjustments.

N. User shall be able to make available or password protect selected functions/buttons from the Staff Console where functions are to be restricted to approved users. Functions/buttons that can be restricted include Audio Page, Swing/Capture/Share, Reminder Clear and volume adjustments.

O. The Staff Console shall provide users the ability to go into half duplex mode to provide the ability to not transmit discussions at the nurse station into patient rooms.

P. The Staff Console shall be able to call other Staff Consoles, Annunciators and VoIP Staff Stations on the same network. Staff Console/Annunciator/ VoIP Staff Station to Staff Console/Annunciator/VoIP Staff Station audio shall be full VoIP, full duplex.

Q. Staff Consoles and Annunciators shall be programmable to receive and display selected call priorities from desired areas, or to delay selected calls for a programmable interval.

R. Staff Consoles shall have the ability to adjust independent talk and listen volume levels via easy-to-use touchscreen controls. These settings shall be adjustable on a room-by-room basis. Systems using group or zone-wide audio adjustments shall not be accepted.

2.8.5 Annunciator Panels

A. The Annunciator provides a primary call display for users of the system. It operates as both a user interface and a communications device that sends and receives data and audio signals over the IP network.

B. As a user interface, the Annunciator alpha-numerically displays incoming calls from stations and connected healthcare equipment, and provides a means for the operator to prioritize and respond to selected events. As an audio device, it provides audible

signalling functions and facilitates two-way full-duplex staff/patient and staff/staff communications.

C. The Annunciator shall provide visual identification of the calling station(s) by room number, bed identification, priority, station type or call type. The Annunciator shall indicate priority level. Incoming calls shall be displayed on the colour display in the colours for their associated priority levels. Annunciators shall also display an elapsed timer for each pending call.

D. The Annunciator Panel shall be IP-based, utilizing Voice over IP technology.

E. Annunciators shall have a 5.7" backlit colour touch LCD screen.

F. The touch screen shall utilize programmable soft keys as opposed to a mechanical dial/touchpad.

G. Annunciators shall provide intercom capability via panel speaker and microphone. Intercom audio between the Annunciators and any station in the System shall be full duplex. Systems utilizing one-way (half-duplex) audio shall not be accepted.

H. The Annunciator shall connect to the nurse call LAN/WAN utilizing CAT 6 cable and powered Ethernet. No separate power supply or wiring shall be used.

I. The Annunciator shall be able to call other Annunciators, Staff Consoles and VoIP Staff Stations on the same network. Staff Console/Annunciator/ VoIP Staff Station to Staff Console/Annunciator/VoIP Staff Station audio shall be full VoIP, full duplex.

J. Staff Consoles and Annunciators shall be programmable to receive and display selected call priorities from desired areas, or to delay selected calls for a programmable interval.

K. The call pending screen on the Annunciator shall allow five calls to be visible at a time and provide a simple scrolling function to view additional calls when more than six pending calls are present.

L. The Annunciator shall have the ability to "automatically select" incoming calls in order of priority, or to allow the user to select what call to answer from the pending calls list.

M. User shall be able to make available or remove selected functions/buttons from the Annunciator screens where selected functions are not to be used and to simplify operation. Functions/buttons that can be removed include Audio Page, Swing/Capture/Share and volume adjustments.

N. User shall be able to make available or password protect selected functions/buttons from the Annunciator where functions are to be restricted to approved users. Functions/buttons that can be restricted include Audio Page, Swing/Capture/Share, Reminder Clear and volume adjustments.

2.8.6 Network Equipment

2.8.6.1 Switches and Gateways

A. All control equipment shall be IP-based, utilizing IP Switches and gateways for connection to room devices. These devices shall make up a UL 1069 Listed Nurse Call LAN/WAN. The controller equipment shall mount in a standard rack to be shared with the facility's IT equipment or shall mount in an independent rack. The IP switches and gateways shall have power supplies to support all field devices internally. Systems using a proprietary enclosure/card cage for central equipment and/or requiring power supplies apart from

the control equipment shall not be accepted.

B. IP Switches shall be networked, allowing all units/floors of a facility to connect as a single System. Each nurse call system shall connect to the hospital's network via a software bridge that isolates the hospital network from the nurse call network to maintain UL requirements. This connection to provide connectivity to supplemental features such as display screens, an ADT system, wireless telephones, pocket pagers, wireless Voice over IP devices, and a reporting database.

2.8.7 Call Cords

2.8.7.1 Single Call Cords

A. Provide call cords as required. The call cord shall have a heavy duty, moulded, ¼" connector, a flexible PVC jacketed cable, and a moulded, flame retardant, ABS switch housing. The switch shall be the momentary contact type. The cord shall be <8'> in length, have an integrated sheet clip, and be suitable for ethylene oxide sterilization.

B. Call Cords shall be of a sealed design with a smooth shape and minimal crevices to allow for easy, comprehensive cleaning to assist in keeping infectious contaminants out of the pendant and reduce the potential for cross contamination.

C. An optional call cord shall be available providing a call assurance LED indicating to the patient a call has been placed.

2.8.7.2 Breath Call Cords

A. Provide rate only for Breath call cords where needed for use by patients who do not have adequate use of their hands to initiate a call. The Breath call cord shall have a heavy duty, moulded, ¼" connector, a flexible PVC jacketed cable, and a momentary contact switch that is sensitive to air pressure. The cord shall be 9' in length, feature an adjustable arm for clamping the call cord onto a headboard or bed frame, and be suitable for use in oxygen atmospheres. Each Breath call cord shall be furnished with twelve (12) replacement straws.

2.8.7.3 Air Bulb Call Cords

A. Provide rate only for air bulb call cords where needed for use by patients who must remain distant from electrical fixtures. The air bulb call cord shall have a heavy duty, moulded, combination ¼" connector/air pressure sensitive switch. The "cord" shall consist of <6'> <10'> of flexible tubing terminated with an air bulb, have an integrated sheet clip, be suitable for use in oxygen atmospheres, and be suitable for ethylene oxide sterilization.

2.8.7.4 Geriatric Call Cords

A. Provide rate only for geriatric call cords where for use by patients who have minimal use of their hands to initiate a call. The geriatric call cord shall have a heavy duty, moulded, ¼" connector, a flexible <white> <beige> <gray> PVC jacketed cable with a sensitive, momentary contact reed switch that requires only a gentle squeeze or tap to activate. The cord shall be 10' in length, have an integrated sheet clip, and be suitable for ethylene oxide sterilization.

2.8.7.5 Pillow Speakers

A. Provide one (1) pillow speaker for each Single Patient Station and two (2) pillow speakers for each Dual Patient Station. The pillow speakers shall have an 18-pin, durable plug that can withstand accidental removal from station plug without damage to pillow speaker or patient station. The housing shall contain the nurse call button, a speaker, and buttons for

TV volume control and channel control in a moulded, flame-retardant, ABS housing. The cord shall be 8' in length and have an integrated sheet clip.

B. Optional 37-pin pillow speakers may be used to plug into 37-pin receptacles, either on the patient stations or on a separate device.

2.8.7.6 To Set Priority

While the room and bed number of a patient are selected and appear in the display window of annunciator panel, the system program shall allow the attendant to set any one of three groups of priority types by pressing the priority button (PRIORITY).

Patient Call Group—for assignment of one of three levels (Normal, Priority (Code Red), Emergency (code Blue)) to be displayed at the staff console as a four-character priority name when a patient or staffs places a call from the peripheral devices.

Selecting the desired priority shall cause the new priority to replace the old one, and the system shall acknowledge the successful change. The next time a call is placed by the patient or automatically placed by the device, the new priority (device name) shall be displayed at the master station.

2.8.8 Integrations

2.8.8.1 Interface engine

A. Each nurse call UL 1069 Listed network shall connect to the hospital's network via a software bridge that isolates the hospital network from the nurse call network to maintain UL requirements. This connection to the hospital's network shall be allow the integration of supplemental systems such as:
    1. Wireless communication system(s)
    2. Reporting Database
    3. ADT Integration
    4. Wireless Locating
    5. Electronic Whiteboard
    6. PC Staff Console applications
    7. Patient/Staff Assignments
    8. Automatic/Manual Messaging
    9. This integration shall provide a single database for the entire facility, for ease of administrator maintenance.

B. The integration platform MUST be compatible with other Nurse Call Systems offered by the selected vendor to allow migration options to other Systems. A Manufacturer whose interface platform cannot be shared with their other Systems shall not be accepted. The browser-based Management Reporting is required

2.8.9 Management Reporting

A. A server computer running Microsoft SQL Server and a reporting application shall reside on the hospital's network to monitor all nurse call activity and log events into the SQL database. Reporting applications that do not utilize Microsoft SQL Server shall not be acceptable. The nurse call events shall be retrievable in the form of user-defined reports. The reporting database must provide flexibility to generate reports for facility wide efficiency studies, unit performance statistics, incident report/details, and system performance/device failures.

B. Staff members shall be able to generate and view reports from any networked PC with Internet Explorer 6.0. Systems requiring staff members to go to a dedicated PC to generate or review reports, or requiring special software applications such as pc Anywhere to be loaded on PCs to provide report access, shall not be accepted.

C. The reporting database shall allow up to 25 user logins, and be expandable to 125 logins for access to generate or view reports. Systems that only allow a single user to generate or view reports at a time shall be considered unacceptable.

D. Staff shall gain access to the reporting package via a login name and password. Each staff member's password shall determine which areas within the facility the staff member can include in his or her reports.

E. The reporting system shall include a wizard that provides step-by-step instructions to the user. Help menus shall also be available so that the user does not need to refer to a hardcopy user manual for assistance.

F. The reporting system must be capable of automatically generating scheduled reports. When the report is generated, a hyperlink shall be emailed to predetermined recipients. The recipient may click on the hyperlink and log in to view the report. This is applicable to PC's on the hospital intranet with appropriate access in order to secure the data.

G. The reporting system shall allow report templates to be defined and saved. A user shall be able to select a template for fast and simple report generation. The system shall allow a minimum of 125 report templates to be set up and saved. The Reporting system shall have the option to provide up to 625 templates shall be available.

H. Reports shall be organized by the user to include and sort data by any or all the following categories:

1. Time and Date-Range in days, hours, and minutes
2. Shift-Range in hours and minutes
3. Room/Bed Number-A range of bed numbers between four to six digits
4. Area Name-19 characters assigned to a group of rooms
5. Call Priority-Seven levels
6. Event-Any combination or all nine events
7. Staff Level-Any one or all three levels
8. Patient Name-Up to 25 characters

I. Dependent on the user's report selections, a generated report shall include a statistical summary of the maximum and average times for the following event pairs at each priority level:

1. Place/Answer-The interval between the time a call is placed to the Staff Console and the time the Staff Console answers the call.

2. Place/Clear-The interval between the time a call is placed to the Staff Console and the time a staff member makes the first response by answering from the Staff Console, pressing the presence set button at the originating station, or pressing the CANCEL button at the originating station.

3. Place/Cancel-The interval between the time a call is placed to the Staff Console and the time it takes for a staff member to disconnect the call at the Staff Console (unless the reminder feature is activated), press the CANCEL button at the originating station, or press the presence clear button at the originating station.

4. Connect/Disconnect-The interval between the time a Staff Console either originates or answers a call and the time the Staff Console ends the call.

5. Reminder Set/Reminder Clear-The interval between the time the reminder feature is activated for a particular room/bed number and the time the reminder feature is cancelled.

6. Presence Set/Presence Clear, the interval between the time the presence feature is activated

at a station and the time the presence feature is cancelled, with associated call/event.

J. The reporting system shall then take the Place/Answer, Place/Clear, Place/Cancel, and Reminder Set/Reminder Clear statistical summaries and display them in the report as a percentage in comparison to target rates determined by the administration. A percentage between 0 and 99 indicates that the staff's response time did not meet the standards set by the author of the report or the administrator of the system.

K. The reporting system shall allow each area of the facility to set target response times for each of the call priorities. Various types of exception reports shall be available to provide information about calls that were not handled within the department's target time. Systems with reporting packages that do not allow each area to set target times or to create exception reports shall not be accepted.

L. The reporting system shall record system failure signals, thereby allowing maintenance personnel to generate reports relating to system reliability and service response times.

M. Where supported, wireless phone integration (if present), shall provide the Nurse Call system an 'acknowledgement' of events sent to the wireless interface to be recorded in the reporting system providing historical data on the success of events being automatically routed to caregivers wireless devices. The client-based Shift Assignments are required

2.8.10 Patient, Staff Assignments

A. Staff assignment software to assign staff to wireless devices and staff to beds shall be available via client-based software. The staff assignment screens shall be password protected. The login password shall determine the staff, beds and wireless devices available to the operator.

B. The assignment screens shall allow the user to choose whether the patient name shall be displayed for each bed (requires an ADT interface), or whether each bed shall be simply indicate its current patient stations (occupied or empty).

C. The staff assignment software shall allow for shifts to be created ahead of time and saved so that they can be reused.

D. The staff assignment software shall provide active help to guide the user through the process (without opening a separate help screen). Help screens shall also be available for more detail instructions.

E. The staff assignment software shall provide the ability to manage float staff. The user shall be able to reassign Staff that work in various locations throughout the hospital from one unit to another without entering the staff names into multiple databases.

F. The staff assignment software must be client-based, allowing shift assignments to be completed from any networked computer in the facility. Systems requiring a dedicated PC for completion of staff assignments shall not be accepted.

2.8.11 Messaging

A. The System shall allow text messages to be sent to wireless devices from a messaging browser. Login to the browser shall be password protected.

B. The messaging software shall allow the user to send a message to a caregiver's wireless device by selecting either the caregiver's name, the caregiver's wireless device number, the number of the bed that requires assistance, or the name of the patient that requires assistance (requires ADT interface). Systems that require the

user to know who is assigned to a bed/patient in order to send a message shall not be accepted.

C. The messaging software shall provide feedback to indicate that the wireless system has received the message. Systems that do not provide acknowledgment of sent messages shall not be accepted.

D. The messaging software shall be browser-based, allowing users to send messages from any networked PC with Internet Explorer 6.0. Systems that require a dedicated PC or special software loaded onto individual PCs to provide messaging access shall not be accepted. The Wireless Telephone Integration is required.

2.8.12 Wireless Telephone Integration

A. The Nurse Call System shall allow connection to any brand of in-house wireless telephone system including wireless VoIP systems. This integration shall allow calls from patients to automatically ring the wireless device of the assigned caregiver(s). The wireless device must show the caregiver the bed number of the call, the call type/priority, and optionally either the unit name or the patient name (with presence of ADT interface).

B. The wireless telephone integration shall allow no less than three levels of staff, plus a charge nurse and a "group," to be assigned to each patient/bed or call priority. These assignments shall be performed via the client-based assignments software. The rollover time from the primary staff member to the secondary, tertiary, and charge nurse shall be definable by the facility.

C. A call escalation manager shall manage automatic messaging to wireless devices. The call escalation manager shall also provide group page functions that allow any defined group of devices to receive any selected call type(s). When a call is sent to a group, the call escalation manager shall also provide the ability to transmit a "call cancel" in the event of a call being attended to; remaining staff not yet on-site can be notified that the situation has been attended to.

D. System shall be capable of integrating to wireless devices without the need for additional third party software.

E. The wireless integration shall allow device failures in the Nurse Call System to generate an automatic call directly to a Biomed device.

F. The Wireless integration shall not require User to disable functions of the wireless phones including voice mail.

2.8.13 Pocket Pager Interface

A. The Nurse Call System shall allow connection to most brands of in-house pocket pager systems via TAP 1.8 protocol. This integration shall allow calls from patients to automatically send text messages to their assigned caregiver(s). The pager display must show the caregiver the bed number of the call, the call type/priority, and optionally the unit name or patient name (with presence of ADT interface).

B. The pocket pager integration shall allow no less than three levels of staff, plus a charge nurse and a "group," to be assigned to each patient/bed or call priority. These assignments shall be performed via the client-based assignments software. The rollover times between assigned caregivers shall be definable by the facility. Each Nursing Unit shall be have the ability to define rollover times independent of other department requirements.

C. A call escalation manager shall manage automatic messaging to the pocket pagers. The

call escalation manager shall also provide group page functions that allow any defined group of devices to receive any selected call type(s).

D. The call escalation manager shall also provide the ability to transmit a Call Cancel in the event of a call being attended to; remaining staff not yet on-site can be notified that the situation has been attended to.

The pocket pager integration shall allow device failures in the Nurse Call System to generate an automatic page to a Biomed pager(s).

E. The pocket pager integration shall allow housekeeping events to generate an automatic page to a Housekeeping device.

2.8.14 ADT Interface

A. The System shall allow automatic monitoring of the facility's HL7 (Version 2.2/2.3) Admit, Discharge & Transfer (ADT) transactions, and shall parse selected patient demographic fields into the Nurse Call System's database. This data shall be made available to assignments, messaging, electronic white board, and reporting applications.

2.8.15 Net Board Electronic Whiteboard

A. An electronic 'white board' shall provide automated, real-time patient and staff information. This software client shall display real-time data in a format configurable by the user. There shall be more than 40 fields of data available to display, selectable on a per unit or login basis. Twelve of these fields must allow for on-the-fly manual entry of notes pertaining to the bed/room that remain with the room, and an additional twelve fields for notes pertaining to the patient. Notes associated with the patient must transfer with the patient when moved to another bed/unit.

B. Patient information shall automatically populate (with interface to ADT system).

C. Staff information shall automatically update from the client-based assignments software.

D. The electronic white board must allow up to 125 simultaneous logins, each having the ability to customize their screen as needed.

2.8.16 Telephone Gateway

A. The nurse call network shall be equipped with an SIP compatible device that has SIP IP for connection to PBX extension ports.

B. The telephone gateway shall provide access to wired telephones that are connected to the hospital's telephone system. It shall allow wired or wireless telephones to communicate with Patient and Staff Stations. The call information shall include the room and bed identification, call type, and patient name (if available from ADT). The telephone gateway shall communicate using standard telephone protocols.

C. The telephone gateway shall be programmable via any PC that is connected to the network, either onsite or remotely. The gateway shall support up to 512 stations on the Nurse Call System. The gateway shall accept multiple inputs and outputs to connect to multiple Systems on site.

2.8.17 List View Client Software

A. List View Client Software shall be available to provide a list view of unit activity to supplement the Staff Console. This client shall provide information on:
   1. Pending calls
   2. Active reminders

3. Reminder reason
4. Staff Location (automated with presence of IR Locate)
5. Patient record data (manually or automatically with presence of ADT Interface)
6. Activity history per patient/bed including:
    a) Calls
    b) Audio connection to room
    c) Reminders
    d) Text messages (automatic and manual)
    e) Staff Arrivals
7. Nine levels of staff

B. The List View Client shall automatically expand to show room summary for the first call on the pending calls list.

C. Each List View login shall be capable of having a unique reminder reason and messaging list. Systems requiring all users to share the same remind and messaging list shall not be accepted.

D. The List View Clients shall be password protected. The login password shall determine the units visible and view preferences for each client.

E. List View Client's text colors shall be configurable to match Corridor Light settings.

F. The List View Client shall be capable of messaging a caregiver (one of three levels assigned plus charge or team) from the List View screen

G. Staff icons shall be configurable to match their staff type via one of nine available levels/colors. Systems limited to less than nine staff types shall not be acceptable.

H. The List View Client shall be capable of running on an existing PC at the nurse station or on a PC dedicated to Nurse Call System functions. Systems requiring a dedicated PC for the functions listed shall not be accepted.

I. List View Clients shall be capable of 'filtering' call activity based on call priority and/or what nursing unit the event was generated. Font size and color shall also be configurable. These features shall allow List View Clients to have the flexibility serve as system wide Supplemental Code Blue Display(s) and departmental status screens to allow LCD's or Plasmas to be used as an option to marquee displays.

2.8.18 Map View Client Software

A. Map View Client Software shall be available to provide a map view of each nursing unit via login to supplement the Staff Console. This client shall display the following information:

1. Staff list shall sort by level, name, device type (phone/pager), and device ID
2. 3D unit map
3. Staff location via multi-coloured icons
4. Call activity via room colour change
5. Reminder icons
6. Activity history per patient/bed including:
7. Calls
8. Audio connection to room
9. Reminders (with optional Reminder reason)
10. Text messages (automatic and manual)
11. Staff Arrivals
12. Location list shall be sortable by level, name, location or battery status
13. Patient census list shall be sortable by patient name, bed number
14. Unique icon for each device type (pager, phone, team)

15. Display bed-by-bed, three levels of assigned staff plus charge and active teams

B. Staff presence icons shall be configurable to match staff level/type. Up to nine colours/levels shall be available.

C. The Map View shall be configurable on site using a pick and place set up wizard. Systems requiring CAD files to be imported or graphical software for creation of unit maps shall not be accepted.

D. The Map View Client shall automatically show room summary for any selected room.

E. The Map View Clients shall be password protected. The login password shall determine the units visible and view preferences for each client.

F. The Map View Client shall be capable of running on an existing PC at the nurse station or on a PC dedicated to Nurse Call System functions. Systems requiring a dedicated PC for the functions listed shall not be accepted.

2.8.19 Real Time Locate System Integration

A. The Nurse Call System shall allow connection to a third party Real Time Locate System (RTLS). The Locate "network" shall be an optional infrastructure integrated to Nurse Call via a software connection.

B. The RTLS, when integrated to Nurse Call, shall be configurable to provide the following functionality when staff wearing a RTLS device enters a room:

1. A pending patient normal call shall be cancelled and all associated LED's and signals shall be extinguished, if a Staff Console or Wireless Phone had not previously answered the call.

2. A pending reminder shall be cancelled and all associated LED's and signals shall be extinguished if the appropriate level of staff has entered the room for the given reminder level.

3. The matching coloured section of the corridor light, as assigned to the RTLS device of the staff member entering the room, shall steadily illuminate to indicate staff presence.

4. The Status LED on the Patient Stations shall steadily illuminate while staff is in the room.

5. While staff is registered in a patient room a double press of the call button on the bed rail, pillow speaker or call cord shall generate a Staff Emergency call, providing staff and patients an additional level of safety.

6. MapView, and ListView and NetBoard Clients shall indicate staff locations

C. The Management Reporting software (if present) shall record all events of staff entering and exiting patient rooms. This data shall be available to draw reports showing identification of staff entering patient rooms; time stamped and indicates duration with the patient when associated to a call.

The Nurse Call System's software (i.e. – List View Clients) shall be capable of displaying low battery signals (provided the RTLS sends this data to the Nurse Call System).

D. The RTLS shall be capable of supporting Equipment Tracking. Equipment tags shall be configurable providing the nurse call system the option to display device locations on the corridor lights.

2.8.20 Submittals

2.8.20.1 Project Submittal

A. The Sub - contract or shall purchase no equipment for the System specified herein until the User has approved the project submittals in their entirety and has returned them to the Sub - contractor. It is the responsibility of the Sub - contract or to meet the entire intent and functional performance detailed in these specifications. Approved submittals shall only allow the Sub - contract or to proceed with the installation and shall not be construed to mean that the Sub - contract or has satisfied the requirements of these specifications. The Sub - contract or shall submit three (3) complete sets of documentation within 30 calendar days after a purchase order is awarded.

B. Each submittal shall include a cover letter providing a list of each variation that the submittal may have from the requirements in the Sub - contract documents. In addition, the Sub - contract or shall provide specific notation on each shop drawing, sample, catalogue sheet, installation manual, etc. submitted for review and approval, of each variation.

2.8.20.2 Closeout Submittal

A. Two (2) copies of the following documents shall be delivered to the building User's Representative at the time of System acceptance. The closeout submittals shall include:

1. Project-specific operating manuals covering the installed System.

2. As-built drawings consisting of: a scaled plan of each building showing the placement of each individual item of equipment, as well as raceway size and routing, junction boxes, and the conductor size, quantity, and colour in each raceway. All drawings must reflect point-to-point wiring, device addresses, and programmed characteristics.

3. The application program listing for the System as installed at the time of acceptance by the building User (disk, hard copy printout, and all required passwords).
4. The name, address, and telephone number of the authorized factory Representative.

2.8.21 Quality Assurance

2.8.21.1 Qualifications of Sub - contractor

A. The Sub - contract or shall have successfully installed similar Systems of comparable size and complexity. The User reserves the right to reject any control components for which evidence of a successful prior installation performed by the Sub - contract or cannot be provided.

B. The Sub - contract or shall have in-house engineering and project management capability consistent with the requirements of this project. Qualified and approved Representatives of the System Manufacturer shall perform the detailed engineering design of all control equipment. Qualified and approved Representatives of the System Manufacturer shall produce all drawings, submittals, and operating manuals. The Sub - contract or is responsible for retaining qualified and approved Representative(s) of those System Manufacturers specified for detailed System design and documentation, coordination of System installation requirements, and final System testing and commissioning in accordance with these specifications.

2.8.21.2 Pre-Installation Requirements

A. The provider shall submit a detailed project plan that shall be describe in detail how the provider shall be approach the project from inception to finalization. The plan must include at a minimum the following information:

1. Project Staging
2. Project Management
3. Equipment Schedules
4. Installation Time Lines
5. Other Trade Requirements
6. Final Acceptance Testing
7. Personnel Resumes
8. Progress Report Sample

B. All equipment and components shall be installed in strict compliance with each Manufacturer's recommendations. Consult the Manufacturer's installation manuals for all wiring diagrams, schematics, physical equipment sizes, etc. before beginning System installation. Refer to the Manufacturer's riser/connection diagrams and details for all specific System installation/termination/wiring data.

2.8.22 Delivery, Storage and Handling

2.8.22.1 Receiving and Handling

A. The Sub - contract or shall be responsible for all receiving, handling, and storage of his materials at the job site.

B. Use of loading docks, service driveways, and freight elevators shall be coordinated with the User.

2.8.22.2 Storage

A. The User shall be provide the Sub - contract or with a lockable storage space for the Sub - contractor's use during this project. The Sub - contract or shall be responsible for the security of this space.
B. Overnight storage of materials is limited to the assigned storage area. Materials brought to the work area shall be installed the same day or returned to the assigned storage area unless previously approved by the User.

2.8.22.3 Rubbish

A. The Sub - contract or shall remove rubbish and debris resulting from his work on a daily basis. Rubbish not removed by the Sub - contract or shall be removed by the User and back-charged to the Sub - contractor.

B. Removal of debris and rubbish from the premises shall be coordinated with the User.

2.8.23 Project Conditions

2.8.23.1 Conditions

A. It shall be the Sub - contractor's responsibility to inspect the job site and become familiar with the conditions under which the work shall be performed. Inspection of the building may be made by appointment with the User. Sub - contractors are requested to inspect the building prior to the pre-bid meeting.

B. A pre-bid meeting shall be held to familiarize the Sub - contractors with the project. Failure to attend the pre-bid meeting may be considered cause for rejection of the Sub -

contract or's bid. The minutes of this meeting shall be distributed to all attendees and shall constitute an addendum to these specifications.

C. All work, except for …… may be conducted during normal working hours, 8:00 a.m. to 5:00 p.m., Monday through Friday, by properly coordinating the work with the User. Noise restrictions do apply. The core drilling, testing of signals, and other work disruptive to occupants shall be prohibited between 6:00 a.m. and 6:00 p.m., Monday through Friday, and shall be explained at the pre-bid meeting. The Sub - contract or is to include, in his base bid, all overtime necessary to complete his work.

D. The Sub - contract or shall be responsible for prior coordination of all work and demolition with the User.

2.8.24 Warranties and Maintenance

2.8.24.1 Warranty

A. The Sub - contract or shall warranty all materials, installation, and workmanship for one (1) year from date of acceptance, unless otherwise specified. A copy of the Manufacturer's warranty shall be provided with closeout documentation and included with the operation and installation manuals.

B. The System Supplier shall maintain a service organization with adequate spare parts stock within 75 miles of the installation. Any defects that render the System inoperative shall be repaired within 24 hours of the User notifying the Sub - contractor.

2.8.25 Training

A. The System Supplier shall schedule and present a minimum of 8 hours of documented formalized instruction for the building User, detailing the proper operation of the installed System.

B. The instruction shall be presented in an organized and professional manner by a person who has been factory trained in the operation and maintenance of the equipment and who is also thoroughly familiar with the installation.

C. Optionally, in service training for clinical staff shall be conducted by clinical professionals. Vendors who cannot provide trainers with clinical background for in-service training shall not be accepted.

2.8.26 Installation

2.8.26.1 General

A. All equipment shall be attached to walls and ceiling/floor assemblies and shall be mounted firmly in place. Fasteners and supports shall be sized to support the required load.

2.8.26.2 Conductors

A. The requirements of this section apply to all System conductors, DC power, and grounding/shield drain circuits, and to any other wiring installed by the Sub - contract or pursuant to the requirements of these specifications.

B. All circuits shall be rated and power limited in accordance with the National Electrical Code (NEC), and installed in conduit or enclosed raceway. All System conductors shall be of the type(s) specified herein.

- Category 6

- 16 AWG Power (if applicable)

2.8.26.3 Conductors and Raceways

A. The entire System shall be installed in a skilful manner in accordance with approved Manufacturer's installation manuals, shop drawings, and wiring diagrams. The Sub - contract or shall furnish all conduit, wiring, outlet boxes, junction boxes, cabinets, and similar devices necessary for the complete installation. All wiring shall be of the type required by the NEC and approved for the purpose by local authorities having jurisdiction.

B. Any shorts, opens, or grounds found on new or existing wiring shall be corrected prior to the connection of these wires to any panel component or field device.

C. All penetration of floor slabs and firewalls shall be fire-stopped in accordance with all local fire codes.

2.8.27 Field Quality Control

2.8.27.1 Test & Inspection

A. All wiring shall be tested for continuity, shorts, and grounds before the System is activated.

B. All test equipment, instruments, tools, and labour required to conduct the tests shall be made available by the installing Sub - contractor.

C. The System, including all its sequence of operations, shall be demonstrated to the User or his Representative. In the event the System does not operate properly, the test shall be terminated. Corrections shall be made and the testing procedure shall be repeated until it is acceptable to the User, his Representatives, and the Fire Inspector.

D. At the final test and inspection, a factory-trained Representative of the System Manufacturer shall demonstrate that the System functions properly in accordance with these specifications. The Representative shall provide technical supervision, and shall participate during all of the testing for the System.

2.9 IP Based Public Address and Voice Evacuation System

2.9.1 General Requirements & Scope

The PA/VA system shall be integrated with the fire detection and alarm system to provide the specified cause and effect / alarm sequencing in the event of a fire being detected within the building. The necessary interface units required to achieve the specified cause and effect shall be built within the PA/VA control equipment / racks and pre-wired to clearly marked terminals.

No modification of the CIE is allowable on site and all interface requirements must be carried out as part of the rack build prior to shipping to site.

The PA/VA controllers / routers shall be fully IP configurable and the system must have the capability of allowing up to 250 controllers being connected on a single system. Each controller shall be capable of controlling 4 channels of audio with simultaneous announcements from different sources being operated across all 4 channels.

Connection locally within a rack shall be via a CAT. 6 screened cable, where multiple racks are deployed around the site connection between the racks shall be achieved using a fibre optic cable certified to BS8434-2 for 'enhanced' operation in the event of a fire. Each rack on a network using the fibre optic cable shall be fitted with a fibre switch to control and

manage the network connectivity, the fibre switch shall be EN54-16 certified.

The PA/VA equipment rack shall be supplied with a 4 way, duplex, fibre Patch panel and necessary supporting materials to allow the direct termination of the network fibre optic cable within the rack, external terminations of the network cable shall not be considered. The PA/VA network shall have a 100mbit bandwidth / capacity and be capable of transmitting ~200 concurrent messages.

The CIE shall be battery backed in the event of a failure of the mains supply for a period of 24 hours with the additional capacity of operating at full alarm load for a period of 30 minutes following this period. Standby batteries shall be provided in the form of sealed lead acid cells. The CIE shall be supported using an EN54-4 power supply unit. The racks supplied shall be IP31 rated with a glazed, lockable door. Please note that the PA/VA system indications must be visible with the door closed on the rack from a distance of 600mm.

Prior to the PA/VA racks being shipped to site a Factory Acceptance Test (FAT) shall be carried out at the manufacturer's premises; the FAT shall be confirm the system functionality (cause and effect) and fault free products prior to shipment of the CIE racks. The FAT tests being carried out shall be formally documented, copies of such being handed over as part of the overall O&M manuals on completion of the project.

The design of the loudspeakers required to provide the automatic and manual speech announcements in the building shall be in accordance with the requirements detailed in section 14 of BS5839-3: 2013.

The intelligibility level this project is to be designed to meet is 0.5STI. Where necessary the services of a specialist acoustic engineer shall be engaged and you shall provide a statement in your tender return confirming how you shall be achieve the audibility and intelligibility requirements of BS5839-8: 2013. Where necessary you shall be provide evidence in the form of an academic acoustic model.

The system supplied shall meet the following requirements with respect to audibility and intelligibility:

- 10dB greater than ambient background noise levels for speech messages
- The minimum audibility requirements of BS5839-1: 2013 for the attention grabbing tone preceding the emergency message

The spacing of loudspeakers shall be guided as per section 14 of BS5839-8:2013, particular attention shall be made in the design of loudspeaker layouts to the following:

Loudspeakers should be chosen primarily for their ability to produce an intelligible result rather than for aesthetic considerations such as size or appearance.

In a normal acoustic environment loudspeaker placement shall satisfy the following:

The distance between the centres of loudspeakers shall not greater than:

- 6m for unidirectional loudspeakers; and
- 12m for bi-directional loudspeakers

The unobstructed distance between the loudspeaker and any listener is not greater than:

- 6m for unidirectional loudspeakers; and
- 12m for bi-directional loudspeakers

The fire alarm evacuation zones associated with the PA/VA system specified are detailed within

The Public Address (PA) zones required are detailed in appendix 2.
The loudspeaker circuits to be installed shall be fully monitored and the system shall have the flexibility to be able to provide both impedance and/or end of line monitoring.

Impedance monitoring shall be employed in any circuit where there are 20 loudspeakers or less, where there are greater than 20 loud speakers on a given circuit end of line monitoring shall be employed. All loudspeaker zones shall be wired with a minimum of an A and B circuit with all loudspeakers being evenly distributed and interleaved across both circuits. In the event of a failure of a single circuit 50% of all loudspeakers shall remain in operation and evenly distributed.

The system supplied shall have the capability of having loudspeakers installed in the form of a loop within a single fire or PA zone. The loop shall be fitted with short circuit isolators between every 10 loudspeakers providing a high level of system integrity. A loudspeaker loop shall not exceed 1000M in length with a maximum load of 500 watts.

Paging and Fireman' Microphones shall be installed in accordance with appendix 3. The microphones shall be connected via the system data bus using a screened CAT. 6 cable (fire rated in the case of the Fireman's MIC's to BS8434-2) and wired in the form of a radial circuit back to the PA/VA rack/s.

The MIC's must be controlled and powered by the PA/VA CIE and supplementary PSU's local

to the MIC's shall be not be permissible.

The maximum cable distance using a CAT. 6 cable between the MIC's and the PA/VA CIE shall not exceed 300M, where distances exceed 300M the system shall have the capability of being able to supply the wiring of the MIC's utilizing fibre optic cabling. The units shall be certified to EN54-16.

All amplifiers to be supplied shall be class D and fully monitored and available in sizes of 4 x 125 watts, 4 x 250 watts, 2 x 250 watts, 2 x 400 watts and 2 x 500 watts. The units shall be certified to EN54-16.

Where possible the use of Direct Drive Amplifier (DDA) shall be employed where the 100v loudspeaker line is driven directly from the amplifier and a secondary transformer is not employed. This option shall be allow racks to be both smaller and lighter. Any DDA amplifier used as part of the rack build shall have an internal EN54-4 battery charger. Standby amplification is not required in line with BS5839-8: 2013 section 16.

The voice alarm system specified shall have the capability of being controlled and managed via a Graphical User Interface (GUI). The GUI shall be supplied in the form of a touch screen PC and monitor with graphics pages drawn and imported to provide a visual overview of the site. The GUI provided must be able to control PA/VA zones or groups of zones in order to route messages, control entertainment equipment and make schedule announcements.

The GUI shall be supported on a PC with the following minimum specification:

- 1 GB RAM or higher
- Free hard disk space min 200MB
- CD-ROM / USB
- Network card 100 Mbit or higher
- Microsoft Windows®2000 / XP
- Professional / Vista / 7 compatible
- Monitor with 1280 x 1024 pixel (ratio 4:3, 16:9 not supported)

With the addition of a System Communication Unit (SCU) detailed further within this specification the following functionality shall be achieved via the GUI:

- Recording, prior listening and discarding of announcements
- Simultaneous play back of pre-recorded audio messages
- Scheduler function for automatically controlled audio messages
- System status and indication logging
- Call 'stacking' functionality where two calls may be transmitted to a common area simultaneously but shall be played individually according to their system priority level

Before commencement of construction of the rack/s for this project a User Requirements Document (URD) shall be completed, signed and issued to the specialist supplier conforming that the product being built is in accordance with the design requirements of the project. The URD shall be confirm:

- VA Zones
- PA Zones
- Microphone's to be supplied (Paging and Fireman's)
- Standby battery requirements
- Special message requirements
- Entertainment system requirements

The following cable types shall be employed;

Voice Alarm Product;

Description	Cable type	Fire rated
Loud speaker	Cat 6	Yes
Fireman's microphone	Cat 6	Yes
Fire Interface	2 core	Yes
Network cable	Cat 6	Yes
Music interface	2 pair twisted	No

2.9.2 Technical Specification

Products to be supplied as part of this project shall meet the following technical specifications for each system component as detailed below. PA/VA Controller / Router for up to 24 loudspeaker zones (583362.22) System master control module with audio signal processing for connecting and controlling power amplifiers and associated control equipment with the following functionality:

- Four independent audio outputs for connecting power amplifiers (up to 500W per channel) and for simultaneous processing of up to four different audio channels per controller
- Connection of audio signal to one or up to six user-defined loudspeaker zones for each audio output to obtain up to twenty-four loudspeaker circuits per module (12No A&B Zones)
- Upgrade to a complex alarm/ public address system through integrated LAN interfaces
- Continuous monitoring of power amplifiers by means of a 22 kHz test tone. The defined loudness level is also taken into account for the backup amplifier (where employed)
- Continuous inaudible monitoring of loudspeaker circuits (earth faults, short / open circuits, and impedance deviations with specified tolerances for each loudspeaker circuit)
- Continuous monitoring of line and microphone of up to four connectable Microphones or universal input modules per control module
- Audio filters such as parametric equalizers, high and low-pass filters and delays per audio channel can be set
- Four sensor inputs for optional, continuous and automatic volume control in real time, independent of the ambient noise level
- Eight programmable, potential free contact outputs for controlling external components (e.g. priority relays) or for signalling various indicator states (collective fault messages)
- Four Ethernet 100 Mbit/s interface connections with switch function.
- Integrated TWI bus for optional connection of an additional module (e.g. time synchronization using TCM-GPS)
- Display for indicating operation status, errors, circuit connection, and active power-saving mode via multi-coloured LEDs
- Emergency control operation (Power Save) during a power failure to preserve battery capacity – this means not activating background music or low-priority announcements when there is a failure in the primary power supply. The connected amplifiers are switched to standby mode
- Non-volatile audio memory for up to 1 hour, freely scalable, for user specific canned audio

2.9.3 System communication unit (SCU)

The system communication unit (SCU) shall act as a digital audio memory for the PAVA system. The unit shall be provide a minimum of 50 channels of audio data to be recorded and played back at the same time – regardless of the available bandwidth from the PA/VA network.

The connection to a PA/VA system network shall be established via Ethernet and is monitored continuously, the SCU shall be housed within one of the equipment racks to be supplied as part of this project. As per EN54-16, the audio data for critical alarms and evacuation messages shall be stored on non-volatile flash memory. The memory capacity within the SCU shall be a minimum of 2 hours.

Additional messages, such as announcements, signals, music files or advertising texts, shall be stored on a hard drive within the SCU. The memory capacity shall be a minimum of 1,000 hours.

2.9.4 VCM display/control module

The View control module for clear and easy display of collective messages and for operation of the voice alarm system in accordance with the EN 54-16 standard with the following:

Each rack or system must have control and display indications to ensure compliance with EN54-16. In a networked system confirmation prior to the building of the control racks shall be sought to confirm which rack shall house the VCM module.

- 5 keys for operating the voice alarm system
- Integrated buzzer for acoustic signals

2.9.5 Power Amplifier

Power amplifier 4 x 125W; class D, 24 V DC (580242) highly efficient class D power amplifier having the following characteristics: Certified to EN54-16

- 4 x 125 watt channel Direct-Drive amplifier for voice alarm application that utilize industry standard 100V speakers (no step up secondary transformers on loudspeaker output) High efficiency (80% typical) Class D Amplifiers Delivers maximum possible power under any overload or overdrive condition to maintain intelligibility of voice messages
- Integrated temperature compensated battery charger certified to EN54 Part 4, capable of charging up to 65Ah battery pack
- Compliant with IEC BS EN 60268-3, 55013 55020 norms
- Microcontroller based extensive self-monitoring and control
- Protection against overload and wiring short
- Protection against overheating
- Temperature management with variable speed fan assisted cooling
- LED status display per audio channel for POWER, SIGNAL,
- CLIP, and FAULT
- LED status display for MAINS POWER; BATT POWER, CPU
- STATUS, SYSTEM FAULT
- Symmetrical audio inputs and control via CAT 5 cable with RJ45
- connector
- 100 V outputs via pre-assembled system cable, lockable

2.9.6 Fully digital paging microphone (MIC)

Fully digital paging microphone (MIC) with electret microphone (cardioid characteristic) on a flexible 300 mm long gooseneck with the following functionality:

- Integrated broadband loudspeaker for monitoring and previewing purposes as well as intercom functions
- Continuous acoustic monitoring of microphone capsule. Acoustic monitoring is not only used to check the functioning of the voice
- coil but also of the capsule
- 12 freely programmable buttons, which can be individually labeled
- 13 integrated and 12 freely programmable LED display elements

including a combined operation and error display
- Digital transmission of control signals and all four audio signals to and from the digital paging MIC and the supply voltage via DAL link
- The paging MIC shall be connected to the PAVA system controller via CAT 6 cable (screened) and RJ45 socket (up to 300 meters distance)
- Optional fiber optic connection for distances up to 2,000 meters
- RJ12 socket for connection with up to 6 expansion modules via
- daisy chain
- An audio input with 2 cinch sockets at the back of the digital call station for connecting an auxiliary device allows audio playback outside of the central control unit

2.9.7 Fireman's Microphone

Fully digital Fireman's microphone with handheld microphone and built in loudspeaker for monitoring and previewing purposes and intercom functions in surface-mounted or flush-mounted housing with the following functionality:

- Continuous acoustic monitoring of microphone capsule. Acoustic monitoring is not only used to check the functioning of the voice coil but also of the capsule
- Five freely programmable buttons for the alarm
- One button for the all-clear signal
- One button for reset/acoustic
- Three integrated LED display elements (in operation, fault, busy)
- Digital transmission of control signals and all audio signals to and from the digital call station and the supply voltage via DAL link
- The Fireman's MIC shall be connected to the PAVA system in star-shaped topology via CAT 5 cable and RJ45 socket (up to 300 meters distance)
- Optional fiber optic connection for distances up to 2,000 meters
- Display window and locking mechanism in accordance with EN 54-11
- Enclosure to be coloured Red

2.9.8 GPS time synchronization module

Module to all the PA/VA system to be time synchronization by means of GPS signals. This will allows accurately timed, automated announcements time-controlled volume adjustments or simply precise time-logging of announcements or trouble alarms.

The module shall be connected to the VA/PA system directly using a standard CAT. 6 cable (max. 10m) and shall be contained within one of the PA/VA racks to be supplied as part of this project.
A fault in the module or satellite reception is entered in the message list.
The GPS signal is transmitted to the receiver via the antenna and coaxial cable.

2.9.9 Graphical User Interface (GUI)

The Graphical User Interface is used to easily address zones, transmit and preview and voice announcements, and input and display text messages.

It shall be operated by means of a graphical user interface which displays the individual object with the loudspeaker or display zones. The application can also be used by means of a touch screen, so it has a simple and clear design and saves on space. The GUI shall be have the following functionality:

The graphics shall be created simply and conveniently using a bitmap of the building. A paging microphone shall be required local to the GUI for voice announcements.

- Full-screen application, suitable for use via touch screen
- Graphical view (e.g. building layout) for zone selection and status display
- Zone display in table form with selection and status display
- LIVE announcements via PTT (press to talk) button on screen or paging microphone
- Record, preview and transmit announcements.
- Input text messages for display view
- Text display in conjunction with voice announcements
- Time-controlled text display, in intervals or loops
- Status display for each zone – assigned or error
- Several PC call stations on one TCP/IP LAN
- Project-specific Help function

2.9.10 Loudspeakers

Loudspeakers shall be supplied for this project meeting the specifications detailed below as a minimum. All loudspeakers supplied shall be EN54-24 certified.

2.9.11 5" Ceiling Loudspeaker

EN54-24 certified voice alarm ceiling loudspeaker designed for flush fixing into suspended ceiling c/w fire dome.

Note maximum spacing between ceilings loudspeakers shall not exceed 6M.

Technical Specification:

Max power Rated	9w
Power Rated	6w
SPL AT 1W/1M (100 HZ - 10 KHZ)	91dB
FREQUENCY RANGE (-10DB)	180 Hz - 20 KHz
RATED IMPEDANCE	1.7k Ω / 3.3k Ω / 6.7k Ω / 13k Ω
POE enabled	Yes

2.9.12 Network Equipment

2.9.12.1 Switches and Gateways

A. All control equipment shall be IP-based, utilizing IP Switches and gateways for connection to room devices. These devices shall make up a UL 1069 Listed PA/VA system LAN/WAN. The controller equipment shall mount in a standard rack to be shared with the facility's IT equipment or shall mount in an independent rack. The IP switches and gateways shall have power supplies to support all field devices internally. Systems using a proprietary enclosure/card cage for central equipment and/or requiring power supplies apart from the control equipment shall not be accepted.

B. IP Switches shall be networked, allowing all units/floors of a facility to connect as a single System. Each PA/VA system shall connect to the hospital's network via a software bridge that isolates the hospital network from the nurse call network to maintain UL requirements. This connection to provide connectivity to supplemental features such as display screens, an ADT system, wireless telephones, pocket pagers, Nurse Call, wireless Voice over IP devices, and a reporting database.

2.9.13 Examination

A. Examine conditions, with the Installer present, for compliance with requirements and other conditions affecting the performance of the wireless clock system.

B. Do not proceed until unsatisfactory conditions have been corrected.

2.9.14 Installation

2.9.14.1 General:

Install system in accordance with applicable codes. Install equipment in accordance with manufacturer's written instructions.

A. Wiring Methods:

1. Conceal wiring except in unfinished spaces.

2. All new wiring on this project must be properly rated for the application.

3. Cable to the new devices at new locations shall be installed in a neat and professional manner, following the standard procedures used in the electrical Sub - contract ing trade.

4. Exposed wiring shall not be permitted under any circumstances on this project.

5. Any wiring, which is considered sloppy by the Engineer, shall be strictly unacceptable.

6. Upon installation completion, a room-by-room test shall be conducted for every device in the system. A technician shall perform the test after school hours, and repairs shall be performed as needed at no cost to the Engineer to any devices, which do not function correctly, including cable. A written room-by-room report following testing and repairs shall be prepared and submitted to the Engineer.

2.9.14.2 Field Quality Control

A. Sub - contract or Field Service:

1. Provide services of a service representative for this project location to supervise the field assembly and connection of components and the pre-testing, testing, and adjustment of the system.

B. Inspection

1. Make observations to verify that units and controls are properly labelled.

C. Testing:

1. Rectify deficiencies indicated by tests and completely re-test work affected by such deficiencies at the Sub - contractor's expense. Verify by the system test that the total system meets the specifications and complies with applicable standards.

2.9.15 Commissioning

Train Engineer's maintenance personnel in the procedures and schedules involved in operating, troubleshooting, servicing, and preventative maintenance of the system. Operator Manuals and User Guides shall be provided at the time of this training.

Schedule training with Engineer through the Architect, with at least seven (7) days advance notice.

2.9.16 Cleaning and Protection

Prior to final acceptance, clean system components and protect from damage and deterioration.

PRICE SCHEDULES

3 PRICE SCHEDULES

3.1 General Notes to Tenderers

1. The Bills of Quantities form part of the Sub - contract documents and are to be read in conjunction with the Sub - contract drawings and general specifications of materials and works.

2. The prices quoted shall be deemed to include for all obligations under the Sub - contract including but not limited to supply of materials, labour, delivery to site, storage on site, installation, testing, commissioning (**excluding 16% VAT**).

3. All prices omitted from any item, section or part of the Bills of Quantities shall be deemed to have been included to another item, section or part thereof.

4. The brief description of the items given in the Bills of Quantities are for the purpose of establishing a standard to which the Sub - contractor shall adhere. Otherwise alternative brands of **equal** and **approved** quality shall be accepted.

5. Should the Sub - contractor install any material not specified here in before receiving **written approva**l from the Project Manager, the Sub - contractor shall remove the material in question and, **at his own cost**, install the proper material.

6. The grand total of prices in the price summary page must be carried forward to the **Form of Tender for the tender to be deemed valid**.

7. The Bills of Quantities are divided generally into three sections:-

a. Sub - contractual Requirements – Bill 1

Sub - contractors Sub - contractual requirements as called for the bill of quantities shall be priced and included in the tender. However the Tenderer is free to include and price any other items he deems necessary taking into consideration conditions he is likely to encounter on site.

b. Installation Items – Other Bills

The brief description of the items in these Bills of Quantities should in no way modify or supersede the detailed descriptions in the Sub - contract Drawings, conditions of Sub – contract and specifications. The unit of measurements and observations are as per Volume 1 or as indicated in the Bills of Quantities.

c. Summary

The summary contains tabulation of the separate parts of the Bills of Quantities carried forward with provisional sum, summary volume included. The Sub - Contractor shall insert his totals and enter his grand total tender sum in the summary of prices of Volume 1.

3.2 Bills of Quantities

(Continue to next page)

PROPOSED FIT OUTS AND RE-ORGANIZATIONS FOR THE LABOR WARDS IN NAIROBI HOSPITAL					
NURSE CALL SYSTEM INSTALLATIONS					
A	**Section DW 1: Preliminaries and Contractual Requirements**				
S/N	**Contractual Power Requirements**	**Unit**	**QTY**	**Rate (Kshs)**	**Total (Kshs)**
1	Preparation of working drawings, printing and distribution.	Sum	1		-
2	Preparation of 'As Installed Drawings", printing and distribution as specified.Drawings to include:				
	(a) Blue Prints - 4 sets of each.	Sum	1		-
	(b) AutoCAD on CD – 2 No.	Sum	1		-
	(c) Operational Instructions, manuals and test certificates	Sum	1		-
3	Allow for Necessary Insurances (WIBA, etc) for the Works execution	Sum	1		-
4	Provision of Performance Bond as stated under clause 5 of the published conditions of sub-contract.	Sum	1		-
5	Allow for removal of existing equipment/items and handing over to the client.				-
6	Any other item necessary to complete the installations in this section (please state)	*Sum*	*1*		-
	Sub - Total Carried Forward to the Main Summary Page				-

E	Section DW 5: Nurse Call System Installations

S/N	Nurse Call System Installations	Unit	QTY	Rate (Kshs)	Total (Kshs)
	Server Supply and installation of rack mounted server unit configured Visio Call by Shrack Seconet or ZKR or equal and approved complete with Dual redundant modular power supplies and associated accessories, licences and a programming work station to management softwares, complete the installation.	No.	1	ON - SITE	
A					-
	Network Switch 24 Port Data POE switch as SWI-9 Series configured per Shrack Seconet or equal and approved to support Nurses Call System complete with links, 24 Port patch panels,				
B	cables organizers, Dual redundant modular Power supplies and associated accessories.	No.	1		-
	Staff Terminal; IP Based Answering unit for staff as centralized communication and information terminal of a ward. Speech connections and telephone calls are possible via the integrated hands-free facility or the receiver as Seconet Schrack (ST-TOUCH)				
B.		No.	1		-
C.	Connection module as Shrack Seconet SM-S	No.	9		-
D	Room Communication Terminal Unit (KMT)	No.	9		-
	Patient Terminal Unit	No.	8		-
E	Washroom Call - Pull Cord	No.	16		-
	Power Supply Unit (REDIN240-24)	No.	9		-
F	Call and Cancel button	No.	9		-
	Light Module Complete with Relay as (LM-IO)	No.	15		-
H.	Allow for Connecting of the above system with UTP Cabling done by others	Lot	1	-	-
	Sub - Total Carried Forward to the Main Summary Page				-

IP BASED PUBLIC ADDRESS AND PIPED MUSIC SYSTEM

Item	Description	Unit	Qty	Rate	KShs.
4.1	**<u>IP Based Public Address and Piped Music System</u>** For the supply, Installation, testing & commisioning of the following complete with associated accessories as specified and shown on the drawings.				
A.	IP Based 91dB, 9W RMS, 5" ceiling/ surface mounted speakers as Honeywell or approved equivalent complete with associated accessories as follows;	No.	4		-
B.	IP Based microphone as Honeywell or approved to be installed at the announcement station/ remote paging complete with associated accessories	No.	1		-
C.	Supply and installation of rack mounted IP Based Public Address controller Server complete with Back Ground Music Player and associated accessories, management softwares, licences to complete the installation.	No.	1	AT THE SITE	
D.	Allow use and configuration of the above system with Structured Cabling done by others (Cables by others)	Sum.	1		-
E.	Allow for interconnection and programming of the the above System	Sum.	1		-
F	Installation, testing & commissioning	Sum	1		-
G	Labeling, Documentation, 2 year Warranties, associated Training and certification. N.B; Provide comprehesive list of spare part and associated part numbers for above system	Sum	1	Included	
H	Any other item necessary to complete installation in this section (Please state)	Sum.			
Total carried forward to Main Summary of Prices					-

	Summary of Costs				
S/N	**Description**	**Unit**	**QTY**	**Rate (Kshs)**	**Total (Kshs)**
	MAIN SUMMARY OF PRICES				
A	SECTION 1 Preliminaries & Contractual Requirements	Lot	1		-
B	SECTION 2 Nurse Call System	lot	1		-
C	SECTION 3 IP Based P.A System	lot	1		-
	Figures are Inlcusive of 16% VAT				
	Sub Total for Nurse Call System				-
	Sub - Total Carried Out to Main Summary				-

4 TECHNICAL SCHEDULE

4.1 Documentation Requirements

Document	With Bid	Before Manufacture	During FAT	Upon Delivery
Preliminary general arrangement drawing (with dimensions)	YES			
QA / QC Plan in accordance with ISO 9001:2008		YES		
General arrangement drawing (with dimensions)		YES		
Schematics/Line diagrams for construction	N/A	YES	N/A	N/A
Recommended Spares List	N/A	N/A	N/A	YES
Routine Test Reports / Certificates			YES	
Type Test Reports / Certificates	N/A	N/A	YES	N/A
Commissioning Procedure	N/A	N/A	N/A	YES
As-built General arrangement drawing			YES	
As-built Schematics			YES	
Site Test Reports / Certificates				YES
Special Test Reports / Certificates	N/A	N/A	YES	NO

4.2 Technical Schedule

The tenderer **MUST SUBMIT** comprehensive manufacturer's technical brochures and performance details for all items listed in this schedule (fill forms attached).

ITEM No.	Description	Remarks
	Nurse Call system Public Address system	

APPENDICES

5 APPENDICES

5.1 Appendix I; Statement of Compliance

Technical Schedules shall be submitted by tenderers to facilitate and enable the Engineer to evaluate tenders but only when the fittings and accessories upon which the tenderer has based his tender sum differs in manufacture, type or performance from the description contained within this specification.

Tenderers shall submit separate leaflets and catalogues giving technical and physical details for all fittings and accessories described in the Technical Schedule at the time of tendering.

Completion of Technical Schedule shall not relieve the Contractor from complying with the requirements of the Specification except as may be approved by the Engineer.

…….. **(Signed)**

…….. **(Date)**

5.2 Appendix II; Exchange Rate Fluctuations

Adjustment will be made to the price of imported materials to compensate for variations in the foreign exchange rate. For this purpose, the tenderer is required to state the exchange rate in Kenya Shillings for the currency of the Country of origin of imported materials as applied to the actual remittance effecting payment to manufacturers of the materials.

Exchange Rate: ……

Signed (as in Tender) ……..

Date ……

5.3 Appendix III; System Warranties

The tenderer shall outline the warranties for all systems installed on this site as specified elsewhere.

These shall include but not limited, to the following:

- Nurse Call system
- Public Address system

5.4 Appendix IV; Schedule of Unit Rates

The tenderers shall provide a schedule of unit rates (under Tables (a) and (b) below) that shall be used to build up rates for variation items not specified in the bill of quantity.

This section, and the terms filled herein shall form part of the contract, and shall be considered locked for the duration of the project.

Rates filled herein shall be evaluated as part of the tender evaluation process. Attention is drawn to the tender evaluation criteria included in this tender package.

The sub-contractor shall disclose the cost of the material offered by the supplier, including or manufacturer or any other sources to the Engineer used to build up the rates in respect to schedule of table (a) and table (b) below. The engineer can reject the disclosed sources where the conflict of interest seems to prevail.

Table (a) and Table (b) shall be deemed to be exhaustive in capturing all cost components and the percentages filled herein shall be considered to be locked for the duration of the contract.

Locally Available Items

Unit rates for items that can be procured locally shall be generated according to table (a) below. Table (a) consists of the below items:

- Material cost – This is the supplier's unit cost for the item, i.e. the cost at the shop/supplier.
- Labor – This is to include all transportation, security, hoisting, installation, tools and consumables, testing, commissioning, costs, etc. The tenderer is to provide his/her labor cost as a percentage of material cost.
- Overheads and Profit – This is to capture all contractor's overheads, margins, profit, etc. The tenderer is to provide his/her overheads and profit as a percentage of material cost.
- Further to this, tenderers are expected to list all other cost carriers not deemed to have been captured in the table below, as a percentage of material cost.

1.1.1.1 Table (a): Locally Available Items.

Material Cost Kshs. (a)	Labour (as a percentage of material cost) (b)	Overheads and Profit (as a percentage of material cost) (c)	List any other component as necessary (as a percentage of material cost) (d)	Total Installed Cost of item Kshs. (VAT exclusive) (a+b+c+d)

Imported Items

Unit rates for items that will require importation shall be generated according to table (b) below. Table (b) consists of the below items:

- Material cost – This is the supplier's unit cost for the item as landed and cleared in Kenya. It includes FOB price, Carriage Insurance & Freight, Inspection Charges, Duty, Port Levies, Clearance Charges and VAT

- Labor – This is to include cost for transportation from port to site, security, hoisting, installation, tools and consumables, testing, commissioning and associated costs, etc. The tenderer is to provide his/her labor cost as a percentage of material cost.
- Overheads and Profit – This is to capture all contractor's overheads, margins, profit, etc. The tenderer is to provide his/her overheads and profit as a percentage of material cost.
- Further to this, tenderers are expected to list all other cost carriers not deemed to have been captured in the table below, as a percentage of material cost.

1.1.1.2 Table (b): Imported Items.

Material Cost Kshs. (a)	Labour (as a percentage of material cost) (b)	Overheads and Profit (as a percentage of material cost) (c)	List any other component as necessary (as a percentage of material cost) (d)	Total Installed Cost of item Kshs. (VAT exclusive) (a+b+c+d)

…….. **(Signed)**

…….. **(Date)**

…….. **(Official Stamp)**

5.5 Appendix V; Day Work Terms for Labour

(To Be Completed By Tenderer)

Description of Artisan	**Cost Per Hour**
Supervisor	……..
Grade A Plumber	……..
Grade B Plumber	……..
Grade C Plumber	……..
Labour	……..
Apprentices	……..

…….. **(Signed)**

…….. **(Date)**

…….. **(Official Stamp)**

5.6 Appendix VI; Technical Schedule

TECHNICAL SCHEDULE

The tenderer must complete in full the technical schedule. Apart from the information required in the technical schedule, the tenderer **MUST SUBMIT** comprehensive manufacturer's technical schedules details for all items listed in this schedule (fill forms attached).

Description	Manufacturer	Country of origin	Remarks (Catalogue No. etc.)
• Nurse Call system • Public Address system			

PART A

GENERAL MECHANICAL SPECIFICATION

1 PART A - GENERAL MECHANICAL SPECIFICATION

1.1 General

This section specifies the general requirements for plant, equipment and materials forming part of the Contract Works and shall apply except where specifically stated elsewhere in the Specification or on the Contract Drawings.

1.2 Quality of Materials

All plant, equipment and materials supplied as part of the Contract Works shall be new and of first-class commercial quality, shall be free from defects and imperfections and where indicated shall be of grades and classifications designated herein.

All products or materials not manufactured by the Contractor shall be the products of reputable manufacturers and so far as if they had been manufactured by the Contractor.

Materials and apparatus required for the complete installation as called for by the Specification and Contract Drawings shall be supplied by the Contractor unless mention is made otherwise.

Materials and apparatus supplied by others for installation and connection by the Contractor shall be carefully examined on receipt and stored. Should any defects be noted, the Contractor shall immediately notify the Engineer.

Defective equipment or that damaged in the course of installation or tests shall be replaced or repaired to the approval of the Engineer.

1.3 Regulations and Standards

The Contract Works shall comply with the current editions of the following:-

(a) The Kenya Government Regulations.

(b) The United Kingdom Institution of Electrical Engineering Regulations for the electrical equipment of buildings.

(c) The United Kingdom Chartered Institution of Building Services' Engineers Guides.

(d) The Kenya Bureau of Standards Specifications.

(e) European Standards/Codes of Practice published by British Standards Institution.

The Local Council By-laws.

The electricity Supply Authority By-laws.

The Kenya Building Regulations.

Other International Standards.

1.4 Electrical Requirements

Plant and equipment supplied under this Contract shall be complete with all necessary motor starters, control boards, and other control apparatus. Where control panels incorporating several starters are supplied they shall be complete with a main isolator.

The supply power up to and including local isolators will be provided and installed by the Electrical Contractor, all other wiring shall be as described in the Particular Specification.

The Contractor shall supply three copies of all schematic, cabling and wiring diagrams for the Engineer's approval.

The starting current of all electric motors and equipment shall not exceed the maximum permissible starting currents described in the Kenya Power and Lighting Company Ltd's By-laws.

All electrical plant and equipment supplied by the Contractor shall be rated for the supply voltage and frequency obtained in Kenya, that is 415 volts, 50HZ, 3-phase or 240 volts, 50HZ, 1-phase as specified in the particular specification.

Any equipment that is not rated for the above voltage and frequencies may be rejected by the Engineer.

1.5 Transport and Storage

All plant and equipment shall, during transportation be suitably packed, crated and protected to minimise the possibility of damage, and to prevent corrosion or other deterioration.
On arrival at site all plant and equipment shall be examined and any damage to parts and protective priming coats made good before storage or installation or replaced.

Adequate measures shall be taken by the Contractor to ensure that plant and equipment do not suffer any deterioration during storage.

Prior to installation all piping, plant and equipment shall be thoroughly cleaned.

If, in the opinion of the Engineer any equipment has deteriorated or been damaged to such an extent that it is not suitable for installation, the Contractor shall replace this equipment at his own cost.

1.6 Site Supervision

The Contractor shall ensure that there is an English-speaking supervisor on the site at all times during normal working hours.

1.7 Installation

Installation of all special plant and equipment shall be carried out by the Contractor under adequate supervision form skilled staff provided by the plant and equipment manufacturer or his appointed agent, in accordance with the best standards of modern practice to the relevant regulations and standards described under clause 1.3 of this section.

1.8 Testing

1.8.1 General

All testing shall be carried out to the entire satisfaction of the Engineer.

The following sub-clause are intended to define the Contractor's responsibilities with respect to testing and inspection.

1.8.2 Materials Tests

All materials for plant and equipment to be installed under this Contract shall be tested, unless otherwise directed, in accordance with the relevant B.S. Specification.

For materials where no B.S Specification exists tests are to be made in accordance with the best modern commercial methods to the approval of the Engineer having regard to the particular type and application of materials concerned.

The Contractor shall prepare specimens and performance tests and analysis to demonstrate conformance of the various materials with the applicable standards.

If stock material, which has not been specifically manufactured for the plant and equipment specified is used, then the Contractor shall submit satisfactory evidence to the Engineer that such materials conform to the requirements stated herein in which case test of material may be partially or completely waived. Certified mill test reports of plates, piping and other materials shall be deemed acceptable.

1.8.3 Manufactured Plant and Equipment - Works Tests

The rights of the Engineer relating to the inspection, examination and testing of plant and equipment during manufacture shall be applicable to the Insurance Companies or Inspection Authorities so nominated by the Engineer.

The Contractor shall give two weeks' notice to the Engineer of the manufacturer's intention to carry out work tests and inspection.

The Engineer or his representative shall be entitled to witness such tests and inspections. The costs of such tests and inspections shall be borne by the Contractor.

Six copies of all test and inspection certificates and performance graphs shall be submitted to the Engineer for his approval as soon as possible after the completion of such tests and inspections.

Plant and equipment which is shipped before the relevant test certificate has been approved by the Engineer shall be shipped at the Contractor's own risk and should the test and inspection certificate not be approved, new tests may be ordered by the Engineer at the Contractor's expense.

1.8.4 Pressure testing

All pipework installation shall be pressure tested in accordance with the requirements of the various sections of this Specification. The installation may be tested in sections to suit the progress of the works but all tests must be carried out before the work is buried or concealed behind building finishes. All tests must be witnessed by the Engineer or his representative, and the Contractor shall give 48 hours' notice to the Engineer of his intention to carry out such tests.

Any pipework that is buried or concealed before witnessed pressure tests have been carried out shall be exposed at the expense of the Contractor and the specified tests shall then be applied.

The Contractor shall prepare test certificates for signature by the Engineer and shall keep a progressive and up-to-date record of the sections of the work that have been tested.

1.9 Colour Coding

Unless stated otherwise in the Particular Specification all pipework shall be colour coded in accordance with the latest edition of B.S.1710: 1984.

1.10 Welding

1.10.1 Preparation

Joints to be made by welding shall be accurately cut to size with edges sheared, flame cut or machined to suit and the required type of joint. The prepared surfaces shall be free from all visible defects such as laminations, surface imperfections due to shearing or flame cutting operation, etc., and shall be free from rust scale, grease and other foreign matter.

1.10.2 Method

All welding shall be carried out by the electric arc process using covered electrodes in accordance with B.S. EN ISO 1071:2003

Gas welding may be employed in certain circumstances providing that prior approval is obtained from the Engineer.

1.10.3 Welding Codes and Construction

All welded joints shall be carried out in accordance with the following specification:-

a) Pipe Welding

All pipe welds shall be carried out in accordance with the requirements of B.S. 2633:1987

b) General Welding

All welding of mild steel components other than pipework shall comply with the general requirements of B.S.5135:1984.

1.10.4 Welder's Qualifications

Any welder employed on this Contract shall have passed the trade test as laid down by the Government of Kenya.

The Engineer may require to see the appropriate certificate obtained by any welder and should it be proved that the welder does not have the necessary qualifications the Engineer may instruct the Contractor to replace him by a qualified welder.

PART B

GENERAL PLUMBING & DRAINAGE SPECIFICATION

2 PART B - GENERAL PLUMBING AND DRAINAGE SPECIFICATION

2.1 General

This section specifies the general requirements for plant, equipment and materials.

2.2 Authoritative Standards and Codes of Practice

The authoritative standard referred to in this Specification are European and other International Standards Codes of practice. Should the contractor wish to substitute any other authoritative standard or code of practice for any referred to in the specification, he must submit details of any such standard or code of practice with two copies of the document for approval by the Engineer. Approval will only be given to use an alternative standard or code of practice if the Engineer considers the proposed standard or code of practice will produce work of a standard equal or better than that of the specified standard or code of practice.

The whole of the plumbing works is to be executed by a registered plumber and drain layer in strict accordance with the Regulations of the Local Authorities and to the satisfaction of the Architect.

2.2.1 Materials

1.2.1 Pipework and Fittings

(a) Black Steel Pipework

All black steel pipework up to 65mm nominal bore shall be manufactured in accordance with European and other International standards medium Grade, with tapered pipe threads in accordance with B.S. EN 10226 – 1: 2004. All fittings shall be malleable iron and manufactured in accordance with B.S. 143 AND 1256:2000

Pipe joints shall be screwed and socketed and sufficient couplings unions shall be allowed so that fittings can be disconnected without cutting the pipe. Running nipples and long screws shall not be permitted unless exceptionally approved by the Engineer.

All black steel pipework, 80mm nominal bore up to 150mm nominal bore, shall be manufactured to comply in all respects with the specification for 65mm pipe, except that screwed and bolted flanges shall replace unions and couplings for the jointing of pipes to valves and other items of plant. All flanges shall comply with the requirements of B.S. 10, to the relevant classifications contained hereinafter under section C of the Specification.

(b) Galvanised Steel Pipework

Galvanised steel pipework shall be manufactured to comply in all respects with the standards described for black steel pipework in paragraph (a) above.

Galvanising shall be carried out in accordance with the requirements of B.S. EN 10255:2004 and B.S 143 respectively.

(c) Copper Tubing

All copper tubing shall be manufactured in accordance with B.S.EN 13349:2002 from C.160 'Phosphorus De-oxidized Non-arsenical Copper' in accordance with B.S. 1172.

Pipe joints shall be made with soldered capillary fittings and connections to equipment shall be with compression fittings manufactured in accordance with B.S.864.

Short copper connections tubes between galvanised pipework and sanitary fitments shall not be used because of the risk of galvanic action.

If, as may occur in certain circumstances, it is not possible to make the connections in any other way than by the use of copper tubing, then a brass straight connector shall be positioned between the galvanised pipe and the copper tube in order to prevent direct contact.

(d) Galvanised iron Pipework

i) Internal Services

Internal iron pipework and fittings for use above ground in connection with internal buildings services, shall be manufactured with spigot and socket joints of the weight required by the Local Authority and shall comply fully with the requirements of B.S. 416.

All joints on galvanised iron spigot and socket pipes shall be made with an approved cold caulking compound and contraction which may take place.

All galvanised iron pipework, branches, tees, bends and other fittings shall be supplied complete with inspection covers for cleaning purposes. These inspection covers shall be included as part of the fittings and shall comply with the requirement of B.S. 416.

ii) External Services

Galvanised iron pipework which is used in connection with buried external services, shall be manufactured, coated and tested in accordance with the requirements of B.S. 1211:1958

All buried galvanised iron bends, elbows swept tees and other fittings, shall comply with the requirements of B.S EN 10242:1995

Jointing on external galvanised iron pipes shall be carried out in accordance with one of the methods described in B.S. Code of Practice 301, Clause 505c (v) to the approval of the Engineer.

(e) Fibre Cement Pipes and fittings for Sewers

Fibre Cement Pipework and fittings for use in connection with external drainage services shall be manufactured in accordance with the requirements of dn 19850-1 Part 1. Pipes shall be connected by means of purpose made tapered joints manufactured in accordance with DN 19850-1. Part 1.

(f) Concrete Pipes

Where concrete pipe and fittings are used in connection with the conveyance of surface water or sewage under atmospheric pressure, they shall be manufactured in accordance with the requirements of B.S. 5911-1:2002 Class 1 except where otherwise stated.

The joints of concrete pipe and fittings may be one of the following depending upon application and conditions:

1. Flexible spigot and socket type
2. Flexible rebated type (Stormwater drainage only)
3. Ordinary spigot and socket type
4. Ordinary rebated type (Stormwater drainage only).

Joints (1) and (2) shall be sealed with suitable rubber gaskets manufactured in accordance with B.S. 2494 except where they are likely to be contaminated by oil products in which case the gaskets shall be manufactured in accordance with B.S. 3514.

Joints (3) and (4) shall be made with an approved cement mortar mix.

(g) P.V.C. (Head) Pressure Pipes and Fittings

All PVC pipes and fittings shall be manufactured in accordance with B.S. EN 1452:2000.

i) Jointing

The method of jointing to be employed shall be that of Solvent Welding, using the pipe and manufacturers approved cement. Seal ring joints shall be introduced where it is necessary to accommodate thermal expansion.

ii) Anchoring

All bends, valves and hydrant tees etc., in the line of the water main shall be adequately anchored to resist thrust due to internal water pressure. A concrete block shall be cast under and around the pipe and between it and sides of the trench. Well rammed material shall be used to support the pipe and either side of the concrete.

iii) Pipe Bed

Pipe shall be uniformly laid on a 75mm thick bed, (the full width of trench) of fine grained material (sand or red soil) and must not be allowed to rest on the joint or on stones etc.

iv) Supports to Fittings

In underground installations care shall be taken to ensure that heavy components such as valves are fully supported so that no weight is carried by the pipeline.

v) Backfilling

For the protection of the pipe initial backfilling shall be carried out as soon as possible after laying. The initial backfill shall be fine grained material thoroughly compacted around the pipe and consolidated to a depth of 6" above the crown of the pipe at no time shall heavy rocks, stones or other objects be included in the balance of the backfill that might protrude through the initial backfill layer and come into contract with the pipe.

vi) Testing

Pipelines shall be tested in sections under the internal water pressure- normally one and half times the maximum allowable working pressure for the class of pipe used. Testing shall be carried out as soon as practicable after laying and when the pipeline is adequately anchored. Precautions shall be taken to eliminate all air form the test section and to fill the pipeline slowly to avoid risk of damage due to surge.

(h) PVC Soil system

The Contractor shall supply and fix PVC soil pipe and fittings as indicated on the drawings and schedules.

Pipes and fittings shall be in accordance with relevant B.S. including B.S. 4514:2001, and fixed to the manufacturer's instructions, and B.S. 12056-2:2000

The soil system shall incorporate synthetic rubber gaskets as provided by the manufacturers whose fixing instructions shall be strictly adhered to.

Connections to W.C. and pans shall be effected by the use of a W.C. connector, gasket and cover, sized to suit pan outlet.

Suitable supporting brackets and pipe clips shall be provided at maximum of one metre centres.

The Contractor shall be responsible for the joint into the Gully Trap on Drain as indicated on the drawings.

2.2.2 VALVES

(a) Draw-off Taps and Stop Valves (up to 50mm Nominal Bore)

Draw off taps and valves up to 50mm nominal bore, unless otherwise stated or specified, for attachment or connection to sanitary fitments shall be manufactured in accordance with the requirements of B.S. 1010.

(b) Gate Valves

All gate valves 80mm nominal bore and above, other than those required for fitting to buried water mains shall be of galvanised iron construction, in accordance with the requirement of B.S. EN 12288:2003, BS 5163-1;2004 AND DIN 3546-1. All gate valves required for fitting to buried water mains shall be of galvanised iron construction in accordance with the requirements of B.S. 1218.

All gate valves up to and including 65mm nominal bore shall be of bronze construction in accordance with the requirements of B.S. 5163-1:2004.

The pressure classification of all gate valves shall depend upon the pressure conditions pertaining to the Site of Works.

(c) Globe Valves

All globe valves up to and including 65mm nominal bore shall be of bronze construction in accordance with the requirements of B.S. 13709:2002.

The pressure classification of all globe valves shall depend upon the pressure conditions pertaining to the Site of Works.

(d) Check or Non-Return Valves

All check or non-return valves 800mm nominal bore and above shall be of the swing check type of galvanised iron construction in accordance with the requirements of B.S. EN 12288:2003.

The pressure classification of all check or non-return valve shall depend upon the pressure conditions pertaining to Site of the Works.

(e) Ball Valves

All ball valves for use in connection with hot and cold water services shall be of the ports mount type in accordance with the requirements of B.S. EN 1983:2006 constructed from bronze or other corrosion resistant materials. These valves fall into three pressure classifications as follows:-

(i)	Low Pressure	-	3.58 b maximum
(ii)	Medium Pressure	-	7.72 b maximum
(iii)	High Pressure	-	12.62b maximum

The pressure classification required for each ball valve will be designated in the description of its associated equipment.

(f) Manually Operated Mixing Valves

Mixing valves for shower fittings and other appliances being provided under the Contract Works shall be manufactured in accordance with the requirements of B.S. EN 1286:1999 from bronze or other corrosion resistant materials.

2.2.3 WASTE FITMENT TRAPS

(a) Standard and Deep Seal P & S Traps

Where standard or deep traps are specified they shall be manufactured in suitable non-ferrous materials in accordance with the full requirements of B.S. 1184:1976

In certain circumstances, galvanised iron traps may be required for galvanised iron baths and in these instances bath traps shall be provided which are manufactured in accordance with the full requirements of B.S. 1291.

(b) Anti-Syphon Traps

Where anti-syphon traps are specified, these shall be similar or equal to the range of Antisyphon Traps.

2.2.4 PIPE SUPPORTS

(a) General

This Sub-Clause deals with pipe supports securing pipes to the structure of buildings for above ground application.

The variety and type of supports shall be kept to a minimum and their design shall as such as to facilitate quick and secure fixing to metal, concrete, masonry or wood.

Consideration shall be given when designing supports, to the maintenance of desired pipe falls and the restraining or pipe movement to a longitudinal axial direction only.

The Contractor shall supply and install all steelwork forming part of the pipe support assemblies and shall be responsible for making good any damage to builders work associated with the pipe support installation.

The Contractor shall submit all his proposals for pipe supports to the Engineer for approval before any erection work commences.

(b) Steel and Copper Pipes and Tubes

Pipe runs shall be secured by pipe clips connected to pipe hangers, wall brackets, or trapeze type supports. 'U' bolts shall not be used as a substitute for pipe clips without the prior approval of the Engineer. An approximate guide to the maximum permissible supports spacing's in metres for steel and copper pipe and tube is given in the following table for horizontal runs.

Size Minimal Bores	**Copper Tube to B.S. 659**	**Steel Tube to B.S. 1237**
15mm	1.25	2.0m
20mm	2.0m	2.5m
25mm	2.0m	3.0m
40mm	2.5m	3.0m
50mm	2.5m	3.5m
65mm	3.0m	3.5m
80mm	3.0m	3.5m
100mm	3.0m	4.0m
125mm	3.0m	4.5m
150mm	3.5m	4.5m

The support spacing for vertical runs shall not exceed one and a half times the distances given for horizontal runs.

(c) Concrete and Pitch Fibre Pipes

These pipes shall not be used for above ground application.

(d) Expansion Joints and Anchors

Where practicable, cold pipework systems shall be arranged with sufficient bends and changes of direction to absorb pipe expansion providing that the pipe stresses are contained within the limits prescribed in the relevant B.S. Specification.

The Contractor shall pay particular care when supporting galvanised iron in order to ensure that settlement and building movement do not break the pipe joints.

Where piping anchors are supplied, they shall be fixed to the main structure only. Details of all anchor design proposals shall be submitted to the Engineer for approval before erection commences.

The Contractor when arranging his piping shall ensure that no expansion movements are being transmitted from pumps to piping systems or vice versa.

(e) Jointing Pipes

Joints shall be made strictly in accordance with the manufacturer's instructions. The Contractor shall make use of the technical advisory services offered by manufacturers for instructing pipe jointers in the methods of assembling joints.

Where manufacturers recommend the use of special jointing tackles, the contractor shall use these for the assembly of all joints to pipes. Sockets shall be laid looking uphill unless otherwise approved.

Before making any joints, all jointing surfaces shall be thoroughly cleaned and dried and maintained in such condition until the joints have been completely made or assembled. Notwithstanding any flexibility provided in the pipe joints, pipes must be securely positioned to prevent avoidable movement during and after the making of the joint.

The space between the ends of the spigot shall be as recommended by the manufacturer or ordered by the Engineer.

After flexibly jointed pipes, other than PVC pipes have been jointed the gaps between the barrel of the pipes and the internal face of the socket shall be sealed with puddle clay, inculcate rope yarn or other approved material. The rope yarn or other material must have treated so as not to support bacterial growth.

Where loose collars are used to join the pipes cut for closers, special tools shall be employed to keep the inside of the pipes flush and the collar concentric with the pipe while the joint is being made.

Pipes provided with spigot and socket joints of the self-centering, instantaneous joint type, such as the rubber ring push fit joint, shall be laid and jointed strictly in accordance with the maker’s instructions. Generally the joint ring shall be cleaned

and inspected for cuts and defects, and socket and spigot examined to ensure freedom from oil, grease, tar and grit. The makers recommended lubricant will be used.

(f) Galvanised iron Joint Fittings

Galvanised iron detachable joint collars and flanges shall be tested by striking lightly with a spanner immediately before they are placed and if they fail to ring true shall be set aside and not incorporated in the work until proven sound.

The flanges shall be correctly positioned and the component parts including any insertion ring cleaned and dried.

Insertion rings shall be fitted smoothly to the flange without folds or wrinkles. The face and bolt holes shall be brought fairly together and the joints shall be made by gradually and evenly tightening bolts in diametrically opposed positions. Only standard length spanners shall be used to tighten the bolts. The protective coating if any, of the flange shall be made good when the joint is completed.

Bolt threads shall be wrapped with PTFE tape where directed before use.

No washers shall be used on flanged pipework to be laid below ground. Bolts shall be as specified and shall be of the correct length, leaving a maximum of two threads exposed.

(g) **Solvent Welded Joints**

Only the solvent cement recommended by the manufacturer for his pipe joint system shall be used and his instructions on the making of the joint shall be closely followed.

Excess solvent cement shall not be applied to the inside of the pipe socket and all surplus solvent shall be removed from the joint and the pipe. Any solvent falling on the trench formation shall be removed by excavating the contaminated soil.

Solvent welded pipes jointed outside the trench shall not be lowered into the place until the elapse of time recommended by the manufacturer. The time allowed for curing shall be increased with lower temperatures.

2.2.5 Connection of Tubing to Cold Storage Tanks, Hot Water Cylinders and Sanitary Fittings

Each connection of tubing to cold water storage tanks shall be made by drilling a hole in the tank side and using a long screw, union and two backnuts all well screwed up in red lead. Joints of tubing to flanged and bossed connections of hot water cylinders shall be made with a boiler screw, union and backnut screwed up in red lead.

Connections to sanitary fittings shall be made with 450mm lengths of copper tubing bent to shape as required with copper to iron couplings at each end, and red lead joint to joint union of fittings and tubing.

All sanitary-ware fittings shall be left in a clean and good condition to the satisfaction of the Engineer.

All fittings shall be fixed in accordance with the manufacturer's instructions and shall comply with the general requirements of B.S. Code of Practice 305 and the Particular requirements of the latest applicable B.S. Specification.

Lavatory basin brackets shall be cut and pinned to walls in cement mortar including making good rendering, tiling or plastering etc.

2.2.6 Pipe Sleeves

Main runs of pipework are to be fitted with sleeves where they pass through walls and floors. Generally the sleeves shall be of P.V.C. except where they pass through the structure, where they shall be mild steel. The sleeves shall have 6mm - 12mm clearance all around the pipe, or for insulated pipework all around the insulation. The sleeve will then be packed with slag wool or similar.

2.2.7 Cutting Pipes

Iron pipes shall be cut by a method and with apparatus which provides a clean square cut of the pipe and of the lining, if any, without damage to pipe or lining.

All cut or trimmed ends, and the parts of any pipe on which the coating may have suffered damage shall be recoated with bitumen before the pipes are laid. The external area at cut spigot ends of ductile iron pipes shall be ground for a distance of at least 125mm.

Pitch-impregnated fibre pipes shall be cut by saw and where necessary the end shall be filled or machined to the required 2 degrees taper.

Concrete pipes shall be cut to a square and even finish without splitting or fracturing the wall of the pipe. Reinforcement shall be cut back flush with the concrete and bare metal protected with bituminous paint or cement grout as directed.

Only steel pipes supplied rounded throughout their length shall be used as cut pipes to form closures. The cutting shall be done by an approved method and apparatus which provides a clean square cut, without separation of the lining from the pipe wall. Minor damage to the lining may, if permitted be repaired on site in accordance with the manufacturer's instructions. Where in the opinion of the Engineer the damage is serious the pipe or special shall be returned to the manufacturer for reconditioning.

2.2.8 Pipes Built into Structures

The outside surface of all pipes and special castings to be built into structures shall be thoroughly cleaned immediately before installation. Where ordered protective coatings to metal pipes shall be removed from the sections to be built in, while the external surfaces of fireclay and concrete pipes shall be roughened to form a key for concrete or mortar. Sheathing to steel pipes shall be cut away from the sections to be built-in and after erection the protection shall be completed by applying approved bituminous material around the barrels of pipes at the junctions with structures.

Pipes passing through water retaining walls and floors shall, where possible, be built into the structure in-situ. Shuttering shall be formed closely to the outside of the pipes, and concrete shall be placed and compacted thoroughly round pipe and puddle flange, if any.

Where fixing in the course of construction is not possible, temporary opening in structures, formed to the dimensions shown by the Engineer shall be left where indicated or directed to accommodate the subsequent erection of pipes and special castings. In water

retaining structures, they shall taper to a smaller dimension towards the external faces of structures and shall include where indicated a waterstop. In basements, dry chambers at pumping stations etc., temporary openings shall taper to a smaller dimensions towards the internal faces of structures and shall also include, where indicated a waterstop.

Prior to in-filling, all surfaces against which fresh concrete is to be placed shall be prepared as specified, while the external surfaces of pipework shall be prepared as described in this clause.

2.2.9 Setting Valves

Care must be taken to prevent damage to all valves, fire hydrants and the like, and their ancillary equipment. Valves etc., and ancillary apparatus shall be stored in clean conditions and in a manner that excludes all water. Where directed, head-stock, motors, gearing or indicators shall be removed, adequately labelled for identification, stored carefully in weather-proof premises and be reconnected after erection of the valves. Electrical equipment shall be protected from damp and the damp-proofing seals shall remain intact until the electrician is ready to connect up the equipment.

The gunmetal faces and seats of all valves must be kept clean. No valve shall be closed without first wiping the faces with a clean cloth. The cavity beneath the valve door shall be thoroughly cleaned by hand. In the event of accident, fouling matter shall be either dissolved or carefully removed by methods that do not involve scraping or gunmetal faces.

All valves shall be set so that operating spindles are truly vertical unless otherwise detailed or directed.

Every stuffing box shall be examined when the main is charged with water and leaking boxes shall be adjusted or replaced with square plaited lubricated hemp packing or approved manufacture. The stuffing box shall not be so tightly packed as to materially affect the friction of the packing on the spindle.

No air valve shall be stored before erection in the open in sunlight, or upside down to expose the balls and air cavities. Air valves shall be checked before the main is charged to ensure that the balls and faces are not scored or split and that there is no direct or other deleterious materials in the cavities of the body. All air nozzles shall be probed to see that they are clean.

Fire hydrants and similar fittings shall be checked before being incorporated in the line and before the main is charged to ensure that all passageways are clean.

The installation of special types of valve and metering equipment must be strictly in accordance with the manufacturer's instructions.

The direction of opening of the valve shall be indicated on the headstock and on the underside of hydrant covers.

2.2.10 Pressed Steel Plate Storage Tanks

The water capacity of the tanks and the diameter of all pipes and pipe connections therewith will be as detailed on the Drawings and Bills of Quantities. Unless otherwise detailed the proportions of a tank will be such that the height is not less than three quarters of the length and not less than the width. All dimensions must be approved by the Engineer.

Elevated Pressed Steel Plate storage tanks will comply with B.S. 1564 and will be constructed of 4.76mm (top row only) and 6.35mm thick galvanised pressed steel tank plates, 1.22m or 1.00m square nominal size, embossed and with external flanges bolted together. Where detailed in the Contract the tank will be partitioned centrally, the division wall to be adequately stayed to permit emptying of either half of the tank whilst maintaining full water depth in the other half.

The tank will be complete with a pitched or vaulted cover and gable ends of 3mm thick steel plates, lap jointed and supported on bearers with hinged insect proof cover; 1 No. float operate water level indicator; and will be provided with internal and external ladders as follows. Where the tank is constructed to operate in two halves 2 No. access manholes and internal ladders will be provided.

The external ladder will have 40mm x 6mm mild steel flat stringers with 12mm diameter mild steel rungs and will be cleated to the tank at 1.2m intervals. The stringers will be taken 750mm above the tank cover and bent to return to the cover a distance of 450m from the edge. This ladder will be complete with 40mm x 3mm mild steel flat safety hoops of 600mm diameter, spaced at 1.2m vertical centres, truly bent and welded to the stringers. The safety hoops will be jointed by 3 No. 40mm x 3mm mild steel flat vertical guard strips, evenly spaced and flat fillet welded to the hoops.

The internal ladders will have 65mm x 12mm steel flat stringers with 20mm diameter mild steel rings and will be cleated to the tank at 1.2m intervals.

The tank bottom plates will be provided with a single pipe pad for the washout pipe connections and double pipe pads for all other pipes which pass through the bottom of the tank.

The tank will be provided and erected complete with all bolts, nuts, washers, internal braces and approved non-toxic jointing materials (fibre-glass or bitumen impregnated filler strip or approved equal).

The whole of the tank steelwork and plates will be galvanised as specified before dispatch and after erection, painted with an approved etching primer and two coats of a bitumen based aluminium paint externally and two coats of non-toxic black bitumen paint internally, both as specified.

The tank after final erection on its permanent foundation will be filled with water to overflow level for a period of 24 hours. Any leaks which become apparent will be made good to the satisfaction of the Engineer before acceptance of the work. Both halves of the tank will be tested separately.

2.2.11 Pipework for Pressed Steel Tank

All pipework associated with the tank and stand will be mild steel pipe to B.S. 534 with flanged joints. The pipework will comprise one ball mounted standing inlet pipe at designed top water level, one outlet pipe with ball mounted and approved strainer to take water from the level as detailed on the Drawings. Where not detailed the outlet pipe will take water from not less than 75mm above the tank bottom. One ball mounted standing overflow pipe with its lip 50mm above designed top water level, and one washout pipe which will be capable of completely draining the tank will be provided. Where the tank is constructed to operate in two halves the inlet, outlet, overflow and washout pipes will be duplicated in each half of the tank.

2.3 INSTALLATION

2.3.1 General

Installation of all pipework, valves, fittings and equipment shall be carried out under adequate supervision from skilled staff to the relevant codes and standards as specified herein. The Contractor shall be responsible for ensuring that all builders work associated with his piping installation is carried out in a satisfactory manner to the approval of the Engineer.

2.3.2 Above Ground Installation

(a) **Water Services**

Before any joint is made, the pipes shall be hung in their supports and adjusted to ensure that the joining faces are parallel and any falls which shall be required are achieved without springing the pipe.

Where falls are not shown on the Contract Drawings or stated elsewhere in the specification, pipework shall be installed parallel to the lines of the buildings and as close to the walls, ceilings, columns, etc., as is practicable.

All water systems shall be provided with sufficient drain points and automatic air vents to enable them to function correctly. Valves and other user equipment shall be installed with adequate access for operation and maintenance where valves and other operational equipment are unavoidably installed beyond normal reach or in such position as to be difficult to reach from a short step ladder, extension spindles with floor or wall pedestals shall be provided.

Screwed piping shall be installed with a sufficient number of unions to facilitate easy removal of valves and fittings, without the need to cut the pipe.

Full allowance shall be made for the expansion and contraction of pipework precautions being taken to ensure that any force produced by pipe movements are not transmitted to valves, equipment or plant.

All screwed joints to piping and fittings shall be made with Polytetra Flouroethylene (P.T.F.E.) Resin Skived Tape in accordance with ASTM D3308-06

The test pressure shall be maintained by the pump for about one hour and if there is any leakage, it shall be measured by the quantity of water pumped into the main in that time. A general leakage of one gallon per 25mm of diameter, per 1.6 kilometre per 24 hours per 30 metres head, may be considered reasonable but any visible individual leak shall be repaired.

(b) **Sanitary Services**

Soil, waste and vent pipe systems shall be installed in accordance with the best standards of modern practice as described in B.S. 5572 now replaced with BS EN 12056-2:2000 to the approval of the Engineer.

The Contractor shall be responsible for ensuring that all ground floor waste fittings are discharged to a gulley trap before passing to the sewer via a manhole.

The Contractor shall provide all necessary roding and inspection facilities within the draining system in position where easy accessibility is available.

Where a branch requires roding facilities in a position to which normal access is unobtainable, then that branch shall be extended so as to provide a suitable purpose made roding eye in the nearest adjacent wall or floor to which easy access in available.

The vent stacks shall terminate above roof level and where stack passes through roof, a weather skirt shall be provided. The Contractor shall be responsible for sealing the roof after installation of the stacks.

The open end of each stack shall be fitted with a plastic coated, or galvanised steel, wire guard.

Access for roding and testing shall be provided at the foot of each stack.

(c) **Sanitary Appliances**

All sanitary appliances associated with the Contract Works shall be installed in accordance with the best standard of modern practice as described in BS 6465-3:1996 to the approval of the Engineer.

2.3.3 Underground Installation

(i) **General**

All underground water and drainage service installation shall be installed in accordance with the best standard of modern practice as described in BS EN 13566-1:2002.

(ii) **Bedding**

(a) **Granular Bedding Material - Type A**

Granular bedding Type A shall comprise broken stone or gravel, crushed brick or concrete to pass a 25mm sieve and be retained on 5mm sieve thoroughly mixed with free draining coarse sand in the ratio of one part sand to two parts stone or gravel; or aggregate to B.S. 882 Table 3 or other material which in the opinion of the Engineer has similar characteristics.

Particles shall be rounded or angular but not flaky or elongated and of adequate crushing strength to produce when tested in accordance with B.S. 812 a 10 percent fines value, greater than 5 tonnes.

(b) **Selected Fill - Type B**

Type B selected fill shall be uniform readily compatible material from tree roots, vegetable matter and building rubbish. All clay lumps retained on a 75mm sieve and all stones retained on a 25mm sieve shall be excluded.

(c) **Granular Bedding Material - Type C**

Granular bedding Type C shall be as type A bedding material but with all material passing a 10mm sieve. In addition, where used to be flexible not exceeding 0.1. The compaction factor test shall be carried out as follows:-

Equipment

1. An open ended cylinder 225mm long and 150mm internal diameter, (a pitch fibre or PVC pipe is suitable)

2. A metal rammer with a skirting face 40mm diameter weighing 0.9 to 1.1 kg

3. A measuring ruler.

Method

A representative sample more than sufficient to fill the cylinder is obtained, (about 12 kg). It is important that the moisture content of the sample should not differ significantly from that of the material from which the sample was obtained at the time of the use of the trench.

The cylinder is placed on a firm surface and the material sample poured into it loosely and without tamping. The top surface of the material is struck off level with the top of the cylinder and all surplus material removed. The cylinder is then lifted clear of its contents and placed on a clean area of the flat surface.

About one quarter of the material is then placed back in the cylinder and tamped thoroughly until no further compaction can be obtained. This procedure is repeated until with the second, third and final quarter tamping each successive surface as level as possible.

The height from the material surface to the top of the cylinder is then measured with the ruler and this distance divided by the height of the cylinder, (225mm), is referred to as the Compaction Factor.

For each batch of material three (3) Compaction Factor Tests will be made and if the average value is greater than 0.1 then the batch of material will be deemed to be unsuitable for use as Type C bedding material. Material sufficient for the bed and surround of 200 linear metres of pipe will be considered to comprise a batch.

(d) **Bedding and Surround for Concrete Pipes**

The material to be used for bedding and surround for concrete pipes shall not contain more than 0.3 per cent sulphate expressed as sulphur trioxide nor shall it be obtained from a site where the ground water contains more than 0.1 per cent sulphate.

(iii) **Field or French Drains**

Pipes for French drains shall be either British Standard Surface pipes glazed or unglazed manufactured to B.S. 65 and 540, with Type 2 sockets or plain ended supplied with sleeve couplings or type 1 perforated socketed and sleeve coupled pipes porous concrete pipes to B.S. 1194.

(iv) **Definitions**

For the purpose of underground piped services the following definitions shall apply:-

(a) Top soil shall mean the top layer of soil that can support vegetation.

(b) Suitable material shall mean all material capable of being compacted, forming a stable fill and approved as such by the Engineer.

(c) Unsuitable material shall mean material other than suitable material and shall include material from swamps, marshes or bogs, peat, logs, stumps, or other perishable material, clay of liquid limit exceeding 80 and/or plasticity index exceeding 55, or materials having greater moisture content than approved for use.

(d) Rock in excavation shall mean such material which cannot be excavated by hand methods and individual solid boulders exceeding 0.2 cu.m.

(e) `Rigid pipes' shall mean pipes of cast or spun iron, concrete cement, clay or similar materials.

(f) `Flexible pipes' shall mean pipes of steel, PVC or other plastic, ductile iron or similar materials.

(g) `Rigid joints' shall mean joints made of bolting together flanges integral with the barrels of the pipes, by welding together the barrels of the pipes, by caulking sockets with non-deformable material, such as cement mortar, run lead or by similar techniques.

(h) `Flexible joints' shall mean joints made with factory-made jointing materials, loose collars, rubber rings etc., and which allow some degree of flexing, however small, between adjacent pipes.

(v) **Types of Pipe**

The Contractor shall construct the pipelines using the designs of pipe, bed, haunch and surround detailed on the Drawings.

Where the Contractor wishes to use a type of pipe not manufactured in the minimum internal diameter indicated in the Contract, he may substitute the next larger diameter manufactured, subject to compliance with the design requirements, clearance and cover. The Contractor shall not use pipes and fittings supplied by more than one manufacturer without approval.

(vi) **Setting Out**

The Contractor shall set out the underground services to the lines shown on the Drawings. Where the service is required laid to falls these shall be set by means of proper sight rails and boning rods.

Sight rails shall be of the following minimum standard. They shall be adjustable sight rails of 150mm x 30mm wrought softwood of length 1m painted black and white as directed secured to strong uprights embedded in the ground at distances not exceeding 60 metres.

Care shall be taken to ensure that these sight rails are not obscured by spoil from the excavation.

(vii) **Excavation**

The Contractor shall carry out the excavation in accordance with the Drawings and shall comply with the slopes, levels, depths and heights shown thereon.

Unless otherwise directed top soil shall be stripped, laid aside and kept separate from other excavated materials for reuse. Road bottoming and surfacing material which is approved as suitable for re-use shall be laid aside and kept separate from other excavated materials.

Where shown in the Contract or directed top soil shall be stripped over the full width of the working area before any other operation is carried out and soil deposited in dumps. On completion of the other operations the soil shall be evenly spread over the stripped surface.

Excavation shall be carried out the dry and both trenches and general areas shall be kept free from water by pumping, provision of temporary drains, sumps and the like.

Excavations shall be taken out to the least dimensions required to accommodate the service and the working space necessary for its installation subject to the following restrictions. All excavations shall be carried so that the soil beneath receives the maximum amount of disturbance.

Unless otherwise directed the overall width of pipe trench excavation from the trench bottom to a level 300mm above crown of the pipe shall be in accordance with the following table:

Table 40.1 - Pipe Trench Widths

Nominal Internal Diameter (mm)	Minimum Overall Trench Width (mm)	Maximum Overall Trench Width (mm)
100	430	630
150	500	700
200	550	750
225	580	780

300	680	880
375	950	1150
400	1000	1200
450	1330	1230
525	1120	1320
600	1240	1440
675	1330	1530
750	1400	1600
825	1490	1690
900	1920	2120
1050	2100	2300
1200	2290	2490
Above 1200	Outside diameter of pipe plus 800mm	Outside diameter of pipe plus 1000mm

Battering or stepping of the sides of trenches, if approved, will only be permitted from 300mm above the crown of the pipe to the original ground level.

The maximum trench width given above shall be measured to the earth face of any sheeting or trench supports.

Excavation shall be taken to the depth required for the class of bedding shown on the drawings. Any excavation greater than this depth shall be filled with the same material as required for bedding to the Engineer's satisfaction and at the Contractor's expense.

When concrete is directed to be cast directly against existing soil the excavation shall be neatly executed to the shape required.

Excavation shall be timbered, sheet piled or otherwise supported to ensure the stability of the surrounding ground, the Works and adjacent structures and to ensure the safety of all persons. The sides of excavation will be battered only where approved or directed. All over-excavation due to slips, overbreak and the like shall be remedied at the Contractor's expense, by infilling with suitable material as directed by the Engineer.

Should the Engineer regard the Contractor's support of any excavations as inadequate then the Contractor shall comply with any instruction by the Engineer to alter or increase the support. Any instruction so given by the Engineer will in no way relieve the Contractor of his responsibilities under the Contract.

Material from excavations other than unsuitable material shall be set aside clear of the sides of excavation for reuse. Unsuitable material shall be removed to the Contractor's tip.

When the final level of the foundation, as shown on the Drawing or directed by the Engineer, has been reached the Engineer will inspect and approve the foundation prior to the commencement of concreting or other work thereon. The bottoms of all excavations shall be carefully shaped for slop as shown or directed. Any pockets of soft or loose material shall be removed and any cavities or fixtures filled as directed.

The Contractor shall at his own expense make good with mass concrete or as directed exaction greater than required for the complete work. Material which the Contractor has

allowed to become unsuitable shall be removed and replaced with mass concrete or as directed, at the Contractor's expense.

The Contractor shall provide whatever additional pipe protection is directed specified maximum width be exceeded due to his method of working.

Where rock or boulders are present in pipe trenches specified to have Class C or FD bedding the sides of the trenches shall be so trimmed that when the pipe is laid to the correct level and alignment no projection of the rock comes within 100mm of the outside of the pipe barrel at any point.

Where rock is found in the bottom of trenches for pipes specified to have Class C or FD bedding, the trenches shall be excavated to the additional depth necessary to allow for Class B or FC bedding respectively.

The Contractor shall avoid unduly disturbing the finished trench formation and shall make good disturbed areas and excavate any wet or puddled material which might result from his failure to do so.

Where directed trenches close to existing structures shall be opened in short lengths and refilled or partly filled with mass concrete or other approved material.

Trenches for pipes carrying water under pressure, except where otherwise required by the Contract, shall be excavated to a sufficient depth to ensure, after consolidation of the refilling, a normal minimum depth of cover of 1800mm from the ground surface to the top of the pipe. Under roads a normal minimum depth of cover of 900mm shall be provided. Where the pipeline is required to be laid to a depth which does not permit this condition to be fulfilled the ground surface shall be made up locally with banking as directed.

(viii) **Pipe laying General**

On arrival at the Site, pipes shall be carefully inspected for damaged ends, cracks or other defects and any found to be faulty shall be marked and set aside for a decision from the Engineer as to their acceptability.

Pipes with damaged ends may be either completely replaced or have the ends cut off and trimmed as directed by the Engineer.

The Contractor shall ensure that all pipes are properly handled both by his staff and by any cartage Contractor employed by him. During transport, pipes shall not be allowed to rest on narrow cross-members of vehicles or anything else that might give concentrated loads due to the weight of the pipe or bumping of the vehicle but shall be properly supported on soft material. Sufficient labour and equipment shall be on hand before loading and unloading is commenced and under no circumstances shall any pipes be dropped or thrown from a vehicle.

The Engineer will have the right to reject consignments or stocks of piping from which failed pipes have been drawn, or order them to be pressure tested to works pressures outside the pipelines at the Contractor's expense even though no defects are apparent, if there is reason to believe that mishandling has taken place.

Flat braided wire slings shall be used for slinging all pipes except externally coated pipes and plastic pipes for which only special band slings not less than

300mm wide shall be used. Chain or rope slings, hooks, or other devices working on scissor or grab principles shall not be used.

Subject to the requirements of inspection before acceptance, protective bolster, caps or discs on the ends of flanges of pipes, specials or fittings shall not be removed until the pipes, specials, or fittings are about to be lowered into the trench.

Before a pipe is lowered into the trench, it shall be thoroughly examined to ensure that the internal coating or lining and the outer coating or sheathing are undamaged.

Where necessary the interiors of pipes, specials and fittings shall be carefully brushed clean.

Any damaged parts of the coatings or lining shall, before a pipe is used, be made good as directed.

Pipeclaying shall not commence until the bottom of the trench and the pipe bed have been approved. Pipes shall be brought to the correct alignment and inclination concentric with the pipes already laid.

(ix) **Bedding and Protecting Pipes Generally**

Pipe bedding refers to all bedding haunching and surrounding of pipes and shall be carried out to the types arrangements and dimensions shown on the Drawings.

During the placing of pipe bedding temporary side supports and sheeting shall be removed except where directed to be left in and the full width of the trench shall be infilled with bedding, haunching, surrounding or anchoring materials.

A cavity of adequate size shall be excavated in the sides and bottom of the trench or left in the pipe bed at each joint and at each sling position.

The bottom of the trench or surface of the bed shall be finished to a smooth even surface at the correct levels to permit the barrel of the pipe to be solidly and evenly bedded throughout its whole length between joint and sling holes.

For water pipes the preparation of the trench bottom or surface of the bed shall be completed for at least one full pipe length in advance of the pipe laying, except where in exceptional circumstances another arrangement is approved.

For sewer pipes the trench bottom or surface of the bed shall be completed between adjacent manholes for inspection by the Engineer prior to laying the pipes.

No pipe bedding material shall be placed in trenches containing water.

Where granular bedding is to be used, stones, bricks or similar materials shall not be used below or against the pipe to locate them in position in the trench or to level the pipes.

Where directed, puddle clay dams 500mm thick shall be constructed around the pipe and across the trench as haunching proceeds. The dams shall be at

intervals not exceeding 30 metres or as directed and their height shall be determined by the Engineer.

Where directed by the requirements for testing pipelines the method of haunching and surrounding pipes shall be modified to leave pipe joints exposed.

Where there is high ground water table all pipes shall be surrounded in an approved free draining bedding material as specified.

(x) **Laying of Pipes**

Every pipeline shall be accurately laid to correct line and level perfectly true from joint to joint.

Whenever work is suspended, the open ends of all pipes and junctions shall be adequately plugged to prevent the ingress of any coil or rubbish etc. Care shall be taken at all joints to prevent ingress of any material.

Immediately after laying, the open end of a pipe shall be sealed with a wooden plug or approved stopper of appropriate size to prevent the entry of material which might contaminate the pipeline, damage the linings, obstruct the waterway or affect the working of valves, meters etc. Plugs shall be unperforated and shall be shaped to fit exactly so that water from the trench excavations cannot gain access to the pipeline.

Water pipes and fittings 150mm and under in diameter shall have a brush equal in diameter to the internal bore of the pipe drawn through them as the work proceeds. The brush shall not be removed from the pipeline from commencement until completion.

The plugs in sewers may, with the Engineer's approval, be provided with small holes for drainage purposes, but water from the trench excavation which is heavily charged with silt shall not be allowed to gain access to the pipe.

Where work is interrupted for a period, the plugs left in position shall be regularly inspected for their fixing to ensure that there has been no tampering by unauthorised persons. Whenever any plug is removed, the immediate length of pipe shall be examined for dirt or obstructions and shall be cleaned as required.

Adequate precautions shall be taken by way of backfilling or other means to anchor each pipe securely to prevent floatation of the pipeline in the event of trench being flooded.

No equipment, clothing or apparel shall be left or stored inside pipeline.

If the normal continuity of construction would otherwise be interrupted pending the delivery of valves or specials, the exact extent of the temporary gaps to be left shall be pre-determined after reference to the Engineer. The Contractor shall submit dimensioned sketches, to the Engineer for approval, showing details of the pipes and jointing arrangements to be adopted to effect ultimate closures. Care shall be taken to preserve the accurate alignment of the pipeline across all such temporary gaps.

(xi) **Laying to Curves**

Where flexibly jointed rigid pipes are to be laid to curve, the outside of spigots in the joints shall not butt hard against the inside of the socket. An angle of pull shall not exceed that laid down by the pipe manufacturer.

Where curves are to be negotiated with straight steel piping with welded joints, no joint shall be flexed more than one degree. Up to two degrees will be permitted with Couplings.

Where curves are to be negotiated with straight prestressed concrete pipes no joint shall be flexed more than half a degree. For sharper curves purpose made level pipes, level pipes, level adaptors and standard bends shall be provided.

(xii) **Manholes**

(1) **General**

All manholes provided under the Contract Works shall be constructed of approved materials and in an approved manner.

All manholes shall be water-tight and if constructed of brickwork, solid blockwork or stonework, they shall be rendered internally with a cement mortar of at least 12mm thickness and finished with a smooth surface.
The sides of all channels in every manhole shall be brought up vertically to a height of not less than the diameter of the drain and shall be benched in good concrete from the top of the channels at an angle of 30^0 to the horizontal and floated to a smooth hard surface with a coat of 1:1 cement mortar.

In all other respects, manholes shall be constructed in accordance with B.S. Code of Practice 301.

(2) **Rectangular and Square Manholes**

Rectangular and square straight through manholes shall be constructed from brickwork, solid blockwork, stonework or concrete to comply with the following minimum internal dimensions (millimetres).

Depth Below Ground of Outgoing Invert	Internal Access Shaft Dimensions L X W	Size of Main Channel Diameter	Internal Chamber Dimensions L X W	Height of Chamber above Benching	Wall Thickness
Up to 740	-	100 to 150	610 x 450	-	150
Up to 740	-	230 to 460	760 x 760	-	150
Up to 1200	-	100 to 150	760 x 760	-	150
160 to 1200	-	230 to 460	910 x 910	-	150
1220 to 1800	-	100 to 150	910 x 910	-	150
1220 to 1800	-	230 to 460	1070 x 910	-	150
1830 to 4550	760 x 760	100 to 150	1370 x 910	1370	230
1830 to 4550	760 x 760	230 to 460	1370 x 1070	1370	230
4570 and Over	760 x 760	100 to 150	1370 x 1140	1680	230
4570 and Over	760 x 760	230 to 460	1370 x 1140	1680	230

When branches are connected into the manhole, the length and width dimensions of the chamber shall be increased as follows:-

Length

Branch Diameter

100mm 300mm/branch on the side with most branches.

150mm 380mm/branch on the side with most branches.

230 and 300mm 460mm/branch on the side with most branches.

460mm 610mm/branch on the side with most branches.

Width

Branch Diameter

100mm to 300mm for each side with branches plus 160mm 460mm or the diameter of the main drain whichever is the greater.

3. **Precast Concrete Circular Manholes**

Where specified straight through precast concrete manholes shall be manufactured and constructed to comply with B.S. 556 and the following dimensional requirements, (Dimensions in millimetres).

Ground Depth of Outgoing Invert	Internal Access Shaft Diameter	Size Main Channel Diameter	Height Chamber Diameter	Chamber Above Benching
Up to 740	-	100 to 460	910	-
760 to 2410	-	100 to 460	1070	-
2440 to 4550	760	100 to 460	1200	1370
4570 and Over	760	100 to 460	1370	2680

When branches are connected into manholes the internal diameter of the chamber shall be increased as necessary, up to a maximum chamber diameter 1830mm.

4. **Step Irons and Covers**

Access shaft to manholes of depths greater than 760mm shall be provided with approved step irons at suitable intervals.

Every manhole or manhole access shaft shall be fitted with a removable air-tight galvanised iron cover to adequate size and strength, fixed in a manner which prevents surface water gaining access into the drainage system.

Cast manhole covers and frames shall be manufactured in accordance with the requirements of B.S. 497 and shall generally fall into the following categories:-

Heavy Duty	:	1For Carriageways
Medium Duty	:	For Footpaths

5. **Back Drop Connections**

Where the level of the branch drain entering the manhole is higher than can be suitably accommodated by the normal type benching, then the branch drain shall be connected to the manhole by means of a back drop connection.

Back drop connections shall be made in accordance with the details shown on the relevant Contract Drawings and the requirements of B.S. Code of Practice 301.

6. **Channels**

Where the branch channel connects to the main channel in the manhole, the invert of the branch channel shall be a minimum of 38mm higher than the main channel.

(xiii) **Testing of Pipelines**

After pipelines are connected up and joints have been sealed, the pipeline shall be tested before pipes are, if required, haunched or surrounded in concrete.

Methods of testing and inspection shall be in accordance with Clause 4 of the Specification.

xiv) **Concrete Bedding, Haunching and Surround**

Concrete bedding, haunching and surround shall be provided as necessary or where called for by the Engineer in accordance with the requirements laid down in B.S. Code of Practice 301, Clause 310.

xv) **Backfilling**

Backfilling of trenches, headings and around manholes shall be carried out in accordance with the methods described in B.S. Code of Practice 301, Clause 508.

xvi) **Reinstatement of Surfaces**

Following the final backfilling of all trenches, headings and manhole surrounds, the surface of the excavated areas shall be fully reinstated to the approval of the Engineer.

Where excavations have been carried out in public highways or other areas not forming part of the site, the Contractor shall be deemed to have allowed in his price for all charges associated with the temporary and final reinstatement requirements of the Local of Highway Authority, whether this is carried out by the Contractor or by the Authority concerned.

No claims for extras in this respect will be accepted.

2.4 Testing and inspection

2.4.1 Site tests - pipework systems

(a) **Underground Water Mains**

After laying, jointing and anchoring, the main shall be slowly and carefully charged with water, so that all air is expelled and allowed to stand full for three days before testing under pressure.

A long main shall be tested in sections as the work of laying proceeds and all joints shall be exposed for inspection during the testing.

The open end of the main may be temporarily closed for testing under moderate pressure by fitting a water pipe expanding plug, of which several types are available. The end of the main and the plug should be secured by struts or otherwise, the resist the end thrust of the water pressure in the main.

If the section of main terminates with a sluice valve, the wedge of the valve shall not be used to retain the water, instead the valve shall be fitted temporarily with a blank flange, or if a socket valve with a plug and the wedge shall be placed in the open position while testing. The Contractor shall provide suitable end supports to withstand the end thrust of the water pressure in the main.

(b) **Above Ground Internal Water Service Installation**

All water service pipe system installed above ground shall be tested hydraulically for a period of one hour to not less than one and a half times the design working pressure.

If preferred, the Contractor may test the pipelines in sections. Any such section found to be satisfactory need not be the subject of a further test when the system has been completed, unless specifically requested by the Engineer.

During the test, each branch and joint shall be examined carefully for leaks and any defects revealed shall be made good by the Contractor and the section re-tested.

The Contractor shall take all necessary precautions to prevent damage occurring to special valves and fittings during the tests. Any item damaged shall be repaired or replaced at the Contractor's expense.

(c) **Underground Drainage System**

A site test shall be carried out on all drainage pipes before concrete haunching or surrounds are applied. These tests shall be carried out preferably from manhole to manhole.

Short branch drains connected to a main drain between manholes shall be tested as one system with the main drain. In long branches a testing junction shall be inserted next to the junction with the main drain and the

branch tested separately. After the test has been passed, the testing junction shall be effectively sealed.

All tests on underground drains shall be permitted on galvanised iron drains at the discretion and to the approval of the Engineer.

Water tests shall be carried out in accordance with the methods described under B.S. Code of Practice 301, Clause 601 (b) and (c) and the test pressure shall not be less than 1,520mm head at the highest point in the pipe section and not more than 10,360mm head at any point in the section.

The test pressure shall be maintained for a period of one hour during which time the pipe and joints shall be inspected for sweating and leakage. Any leak discovered during the tests shall be made good by the Contractor and the section re-tested.

In addition to pressure tests, drain pipe runs shall also be tested for straightness where applicable. This test shall be carried out in accordance with one of the two methods described in B.S. Code of Practice 301, Clause 601 (e).

Testing of manholes shall be carried out in accordance with the methods described under B.S. Code of Practice 301, Clause 601 (f).

(d) **Above Ground Soil Waste and Ventilation Pipe System**

All soil, waste and ventilating pipe system forming part of the above ground installation, shall be given a smoke test to a pressure of 38mm of water gauge and this pressure shall remain constant for a period of not less than three minutes.

Water tests on above ground soil, waste and ventilating pipe systems shall not be permitted.

Pressure tests shall be carried out before any work which is to be concealed is finally enclosed.

Any defects revealed by the tests shall be made good by the Contractor and the test repeated to the approval of the Engineer.

In all other respects, tests shall comply with the requirement for B.S. EN 12056-2:2000

2.4.2 Site test - performance

Following satisfactory pressure tests on the pipework systems, operational tests shall be carried out in accordance with the relevant B.S. Code of Practice on the systems as a whole to establish that special valves, gauges, controls, fittings, equipment and plant are functioning correctly to the satisfaction of the Engineer.

All hot water pipework shall be insulated with performed fibre glass sectional lagging to a thickness of 25mm.

Cold water pipework shall be installed with preformed fibre glass lagging to a thickness of 25mm where the pipe runs above a false ceiling or in areas where the ambient temperature is higher than normal with the result that pipe "sweating", due to condensation will cause nuisance.

All lagged pipes which run in a visible position after erection shall be given a cover and prepared for painting as follows:-

i) Apply a coating of a suitable filler until the canvas weave disappears and allow to dry.

(ii) Apply two undercoats of an approved paint and finish in suitable gloss enamel to colours approved by the Engineer.

All laggings for cold and hot water pipes erected in crawlways, ducts and above false ceiling which, after erection are not visible from the corridors or rooms, shall be covered with a reinforced aluminium foil finish and banded in colours to be approved by the Engineer.

In all respects, unless otherwise stated, the hot and cold water installation shall be carried out in accordance with the best standards of modern practice as described in C.P. 342 and C.P. 310 respectively, to the approval of the Engineer.

The test pressure shall be applied by means of a manually operated test pump or, in the case of long main or mains or larger diameter, by a power driven test pump which shall not be left unattended. In either case precautions shall be taken to ensure that the required pressure is not exceeded. Pressure gauges should be recalibrated before the tests.

The Contractor shall be deemed to have included in his price for all test pumps, and other equipment required under this Clause of the Specification.

The test pressure shall be one and a half times the maximum working pressure except where a pipe is manufactured from a material for which the relevant B.S. Specification designates a maximum test pressure as in the case of cast or spun iron pipes, where the test pressures should not exceed 120, 180 and 240 metre/head of Clause B, C, or D pipes.

2.4.3 Sterilization of Hot and Cold Water Systems

All underground water mains and above ground water distribution systems, cisterns, tanks, calorifiers, pumps, etc., shall be thoroughly sterilized and flushed out after the completion of all tests and before being fully commissioned for handover.

The sterilization procedures shall be carried out by the Contractor or specialist employed by the Contractor in accordance with the requirements of B.S. Code of Practice 310, Clause 409, to the approval of the Engineer.

PART C

GENERAL TECHNICAL SPECIFICATION

3 PART D - GENERAL TECHNICAL SPECIFICATION

3.1 Materials and Workmanship

All materials shall be of adequate quality for the duty specified and the workmanship shall be in accordance with the best accepted modern practice. Unless otherwise stated the Contractor shall be obliged to comply with the requirements of the latest edition of the relevant Kenya Bureau of Standards Specification where applicable. Failing this, the latest edition of the relevant Britain Standard Specification shall provide the required standard. If the Contractor desires to use any other standard specification or code of practice, it shall be referred to the Engineer for approval.

3.2 Structural Steelwork

The structural steel used in the Mechanical Contract shall be mild steel to B.S. 15. Black bolts and nuts shall be in accordance with B.S. 916. Black metal washers shall be in accordance with B.S. 916.

High Strength friction grips, bolts, nuts and washers shall be in accordance with B.S. 3139, Part 1, and their application shall conform to B.S. 3139, Part 1, and their application shall conform to B.S. 3294, Part 1 torque wrenches or impact tools where used be recalibrated before each shift.

All fabrication and erection procedures shall be in accordance with B.S. 449 as amended, Part 5. Before commencing the fixing of the steelwork the erector shall check the seating for line, level and bolt setting, and any errors which cannot be accommodated by the steelwork erector shall be reported to the Engineer.

3.3 Steel Fabrication and Baseplates

The manufacture of all fabricated items of plant shall be generally in accordance with B.S. 449 as amended, Part 5.

The fabrication and manufacture of the plant and equipment shall be completed in the Mechanical Contractor's workshops before delivery to site. No fabrication of complete units shall take place on site, site work shall be confined to only such minor alterations and adjustments as are found to be necessary during erection. If major alterations are found necessary the items of plant covered shall be returned to the Mechanical Contractor's workshop for modification on replacement and shall be tested and checked before re-delivery to site.

Drive baseplates shall be robustly constructed and adequately stiffened to prevent twisting and distortion. The ration of the base length to its height shall not be more than 10:1.

All surfaces shall be free from recesses and cavities to prevent the accumulation of dirt and/or waste material, and shall be designed to facilitate ease of cleaning and maintenance.

Where driving units are directly coupled to the driven component all mounting surfaces shall be accurately machined to ensure alignment. After final assembly and testing, the individual items of plant shall be accurately dowelled in position on the baseplate to prevent misalignment during installation or during operation.

The Mechanical Contractor shall include in the design for any measures required to counter the effects of vibration which might be caused by operation of equipment.

3.4 Stainless Steel

All items fabricated in stainless steel shall be in the grade specified and detailed designs shall be compatible with fabrication techniques. The designs of articles to be pressed or welded shall be discussed with the fabricator before manufacture. All stainless steel items shall have a 'half-moon' finish to the satisfaction of the Engineer. Edges shall be finished by either welding on 12mm stainless steel round bar in the same grade as the article or by turning down to an acceptable radius.

3.5 Welding

3.5.1 WELDING

Welding shall be carried out in accordance with the BC Code of Practice for welding No.044 Parts 1, 2, 3, & 4.

3.5.2 Freedom from Surface Defects

All welded fillets or butt joints shall be ground smooth and shall be free from porosity, cavities and entrapped slag. All welds shall conform to the requirements of B.S. 1856.

Welds which are to be hot dip zinc coated shall be neatly formed and the surfaces shall be acceptable and free from cracks in the welds or heat affected zone, from overlap undercuts, porosity, entrapped slag and spatter in or associated with the welds. The welds shall seal completely the edges of all overlapping or contacting surfaces.

3.5.3 Smoothness of joints where Weld is re-commenced or terminated

The joints in the weld run where welding has been recommenced or terminated shall be smooth and shall show no pronounced hump or crater in the weld surface.

3.5.4 Shape of Profile

The profile of the weld shall be uniform, of appropriately equal leg length and free form overlap at the toes of the weld. Unless otherwise specified the surface shall be either flat or slightly convex in the case of welds and with a reinforcement of not more than 3 mm in the case of butt welds.

3.5.5 Uniformity of Surface

The weld face shall be uniform in appearance through its length.

3.5.6 Electrodes

Electrodes shall be of an approved type for the material being used and shall be kept in a dry condition. All electrodes shall conform to the latest issue of B.S. 693 'Electrodes for Manual Metal Arch Welding of Mild Steel and Medium High Tensiles Steel'.

3.5.7 Qualification of Welders

Welding on or off the site shall be carried out only by welders qualified to the approval of the Engineer. Each welder to be used on the Mechanical Contract Works will be required to carry to test welds to the approval of the Engineer and in the presence of the Engineer's Representative. Only welders whose test welds have been passed by the Engineer shall be employed on the Mechanical Contract Works and then only for the class of welding for which they have been tested. Initial testing of welders and such periodical tests as may be required by the Engineer shall be carried out at the Mechanical Contractor's expense using materials supplied by the Mechanical Contractor.

3.6 HOT DIP (Galvanised Zinc Coatings)

3.6.1 General

All hot dip zinc coatings shall conform to the requirements of the latest issue of specification 'Hot-Dip (Galvanised Zinc coatings' with particular reference to the following.

Tubular constructions shall be provided vent holes in appropriate locations to prevent internal pressure build-up during the hot zinc bath shall be referred to the galvaniser who shall state his requirements for the vent holes desired. Welding flux shall be chipped away, all welds shall be wire brushed, ground or grit or shot blasted if necessary before hot zinc coating.

The surfaces to be hot-dip coated shall be free from paint, oil, grease, and similar impurities. Identification numbers of individual pieces shall be clearly stamped on surfaces of members prior to hot-zinc coating, numbers painted or welded on the surfaces of these members shall be unacceptable.

Exposed surfaces, except welds when necessary, need not be grit or shot blasted, but the engineer shall decide to call for grit or shot-blasting in cases of unsuitable surface finish on material for hot-dip zinc coating. The Engineer shall have the right to inspect all steel components before galvanising, and shall have the right to reject or ask for remedial treatment of any material which is considered unsuitable. This applies particularly to welds, burrs, and surfaces having visible surface defects.

Globular extra heavy deposits for zinc which interfere with the intended use of the material shall not be acceptable. Excessively protuberant lumps and nodules shall be removed by hot wiping or skilful application of mechanical means provided that a sufficient minimum thickness of unbroken zinc coating remains after such treatment. Flows on small parts and working surfaces shall be repaired only by stripping, dressing and re-dipping.

3.6.2 Threads

The galvanising on threads or bolts shall be such as to fit a gauge made by overtapping a nut to the following increased limits of size to 7H tolerances:

		Bolt Sizes	M6	M8	M10		M12	M16	M24
Overcut,mm	To be	To be	0,33	0,33	0,38	0,38	0,38		

For threaded articles less than 10mm diameter mechanical plating will be acceptable instead of hot dip zinc coating (galvanising).

Nuts shall be capable of being spun over the full length of the thread by hand ungalvanised internal threads shall be coated immediately after cutting, before they are allowed to rust, with preventive compound of type agreed between the supplier and the Engineer.

3.6.3 Bolts

Bolts to be galvanised shall be standard black bolts manufactured according to B.S 916 (and having threads produced to medium class tolerances G8). Any bolt which has been subjected to cold forming (heading) operation during manufacture shall be stree-relieved at a temperature between 600^0C for a minimum period of 20 minutes and subsequently cooled in air.

3.6.4 Protection of Coating (Passivation)

Immediately after withdrawal from the bath of molten zinc, galvanised material shall be quenched in water containing approximately 1% of sodium dichromat slightly acidified with sulphuric acid. Other bath compositions may be used provided that they contain recognised passivating agents unless otherwise specified.

Alternatively by agreement between the galvaniser and the Engineer, protection may be applied by other means, such as, for instance, a lacquer containing chromate salts.

3.6.5 White Rust (White Storage Stain)

All galvanised material shall be free from gross deposits of white rust. If material has been affected by white rust, the deposit may be removed, by means of non-metallic brushes and provided that the thickness of zinc coating in the affected area meets the requirements of the specification the material can be accepted.

No galvanised material shall be used for erection unless such material:-

a) Has been zinc coated under the Kenya Bureau of Standards certification scheme, and this is indicated by the diamond standardisation mark, which should appear on all labels, delivery notes, and other similar documents relating to such material. Such documents should also indicate the name of the galvaniser concerned.

Structural material should also bear a paint mark applied by the galvaniser to indicate standardisation mark quality. The Engineer may call for certificates from the galvaniser indicating that each consignment of material complies with the specification and was galvanised under the certification mark scheme: or

b) The galvanised material has been inspected, and each consignment is accompanied by an inspector's certificate indicating that the material is acceptable and complies with the requirements. Structural material should also bear a paint mark applied by the inspector to indicate that the material has been inspected and accepted. Bolts,

nuts and other material of small size should be in a bag or container containing a label bearing the inspector's stamp.

3.7 CASTINGS

Because of the corrosion-inducing conditions, and in order to obtain satisfactory mechanical properties of tensile, shear and yield strengths, resistance to impact and transverse loads and hardness properties, all ferrous castings other than those included in the proprietary 'bought out' items of equipment shall comply with the specification hereunder. If the Contractor wishes to offer alternative materials, he shall submit comprehensive details of such alternatives and obtain the prior written approval of the Engineer before proceeding with manufacture.

Material:	Pearlitic Nodular Structure.
Mechanical Properties:	Ultimate Tensile Strength - 725 mpa Elongation - 2% Hardness - 240 to 300 brinell (after normalizing)
Inoculation:	All castings shall be inoculated with 3% copper.
Heat Treatment:	To provide the optimum physical properties consistent with the pearlitic nodular structure of the material, and to provide a hardness within the range 207 to 235 brinell.
Test Certificates:	The contractor shall submit to the Engineer all test certificates of analysis including all relevant details of the micro-structure and mechanical properties. The number of tests to be performed and for which certificates of analysis are required shall depend on the respective casting and shall be a greed in writing with the Engineer.

3.8 VEE-BELT DRIVES

All vee-belt drives shall conform to B.S. 1440: 1962 - "Endless V-belt drives" and shall be as specified below:

a) Application

Unless otherwise specified or agreed to by the Engineer, Vee-Belt drives shall only be used in applications of constant and slightly varying load conditions. Belt speeds shall not exceed 900 metres per minute, unless otherwise agreed. For reasons of spares interchangeability and maintenance, standard stock vee-belts shall be used.

b) Pulleys

The belt pulleys shall be manufactured from a close-grained galvanised iron and shall be accurately balanced. The belt grooves shall be properly machined to the correct groove angle and depth.

All sharp corners at the top of the groove shall be removed and the groove sides shall be polished smooth to avoid excessive belt wear. The grooves of mating pulleys shall accurately match each other, particularly regarding width, angle and alignment.

c) Adjustment

Adjustment inward, i.e. towards the driven pulley, shall be provided to ensure sufficient movement of the driving pulley to enable the vee-belts to be fitted by hand, without the use of a lever of any king to force the belts over the pulleys.

The outward adjustment shall provide for correct belt tensioning to ensure that slipping does not occur. All belt tensions shall be re-checked within 24hours and again within a week to start-up to ensure that the initial slack, if any, is taken up.

d) Speed Ratio

Speed ratios greater than 7:1 shall not be acceptable unless otherwise agreed by the Engineer.

3.9 BEARINGS

1.9.1 Anti-Friction

Anti-friction bearings shall include all bearings which provide rolling contact between one or more sets of hardened steel balls or rollers located between hardened steel rings or raceways. Anti-friction bearings shall be of approved manufacture.

To facilitate maintenance, spares interchangeability and standardisation, anti-friction bearings of standard designs and manufacture shall be employed. All anti-friction bearings shall be provided with greasing facilities in accordance with the manufacturer's requirements.

1.9.2 Bushed Bearings

Only where specifically stated and in cases of low velocities and light loads in moisture-free conditions will bushed bearings be accepted. All bushed bearing shall be made of an approved friction quality and shall be capable of withstanding severe usage.

All bushed bearings shall be provided with lubrication facilities to ensure adequate lubrication and shall be properly grooved to distribute the lubricant uniformly over the bearing surface. Grooves shall not be cut into the journal, but always into the surrounding bush. The edges of all chamfers and grooves shall be rounded to avoid sharp corners and to facilitate the introduction of the oil or grease.

1.9.3 Self Lubricating or Oil-less Bearings

Self-lubricating or oil-less bearings shall only be used on application of light loads and low velocities in moisture-free and low humidity conditions and where bearings are of difficult access and likely to be neglected during servicing. The types of bearing metal composition used shall have frictional and wear resistant properties akin to those of grease lubricated bushed bearings.

3.10 KEYS AND KEY WAYS

All keys and Keyways and taper pins shall conform to B.S. 46: Part 1, 1958.

3.11 LIMITS AND FITS

Limits and tolerances for shafts and hoes shall conform to B.S.3614.

3.12 GENERAL MACHINERY PROTECTION

3.12.1 Coupling and Shaft Guards

All high speed couplings, projecting shaft ends and every dangerous moving part of machinery shall be protected by a guard manufactured from not less than 1.6mm mild steel plate. The guards shall be neatly formed and securely fixed in position.

3.12.2 Belt Guards

All belt or rope drives shall be adequately protected by a belt guard.

The guard shall be manufactured from wire mesh or open type expanded metal, securely braced and stiffened with suitable rolled steel sections and bolted in position. Guard supports shall not short-circuit vibration isolators on form. Provision must be made for test openings to permit RPM reading of fan and motor without the removal of the belt guard.

3.12.3 Painting

All guards shall be finished in a light orange colour to B.S. 381C in accordance with Clause 2.8.4 Class 'C'.

3.12.4 EQUIPMENT BASES

Unless stated elsewhere in this specification, inertia base formers for machinery shall be provided to the Main Contractor for casting, by the Contractor for casting, by the Contractor. The bases shall consist of reinforced concrete cast into sheet metal formers at least 150mm deep.

The formers shall comply with the standard set by Mason Industries, for both size and construction. Bases shall be mounted on properly selected spring isolators incorporating noise isolation pads.

Either free-standing stable steel spring or caged spring with snubber may be used. Spring isolators shall be provided with levelling bolts. Noise isolation pads shall be large enough to prevent excessive rocking of equipment during start up and normal operation. Bases and supports shall be arranged to give a clearance of approximately 25mm between the underside of the bases and the floor. Bases shall be large enough to accommodate motors and the equipment they drive.

3.13 IDENTIFICATION AND LABELLING

All plant and equipment items, including items such as dampers, pumps, etc, shall be labelled in a clearly visible position with the item name and, in the case of duplicate items, a number. Plant labels shall correspond with labels on starters, isolators, etc.

Labels shall be of sandwich thermosetting plastic with black lettering on a white background. Lettering shall be at least 6mm high and labels shall be in keeping with the size of equipment and legibility with regard to position.

3.14 PAINTING

3.14.1 Painting Materials

All paint, driers and the like, and other materials shall conform with the requirements of the relevant British Standard Specification. All paints shall be of the best quality and of approved brand and manufacture. All materials shall be used in strict accordance with the manufacturer's instructions and otherwise in strict accordance with the best standard practice. Undercoats of paintwork and primers shall be as supplied by the manufacturer of the paint begin used for the finishing coat. If necessary, paint shall be strained free from skins and similar impurities immediately before application. Priming coats shall be applied over the whole surface and well brushed in order to obtain the maximum penetration. All materials shall be delivered to the job in their original unopened containers with the manufacturer's name and description of contents thereon and no adulteration will be allowed.

3.14.2 Colours

Samples of the final colours required shall be submitted for approval before painting the work in hand and the work shall then be finished to the colour or colours as approved. Each coat of paint shall be a distinctive colour working up to the finished colour as approved.

3.14.3 External Painting

External painting shall not be undertaken during rainy, damp, frosty or other inclement weather or where such weather is reasonably to be expected within the next 24 hours.

3.14.4 Internal Painting

Before internal painter's work is commenced all floors shall be swept clean, and dirt and rubbish removed, and the rooms left practically free from dust; dust-free conditions being maintained during the progress of the work. No sweeping or dusting shall be done whilst the painting is in progress.

Unless otherwise stated, no paint shall be applied within 50mm of areas which are to be welded. Welds and adjacent parent metal shall be de-slagged, inspected and approved and area shall be abrasive-blasted or ground, and all contaminants shall be removed prior to painting. Wire brushing of the weld shall only be allowed if the paint specification calls for wire-brushing. The weld area shall then be flushed with fresh water and allowed to dry before receiving the full paint system.

Areas where the paint coating has been damaged during transportation erection or by any means whatever, shall be repaired as follows:

Damaged areas or rust spots shall be removed by means of a wire brush or emery paper and the surrounding paint which is still intact shall be feathered for a distance of 20mm beyond the damaged area. Spot priming shall consist of all the coats previously applied and shall overlap the undamaged area by 20mm. Surfaces which are to rest on concrete or other floors or which will be inaccessible after erection shall receive full specified paint system before erection or assembly. Unless otherwise specified, steel embedded with concrete shall not be painted except to within 50mm below the concrete/air interface.

Mating or contact surfaces shall be protected from corrosion by ensuring that the two surfaces brought into contact with each other shall be prepared and primed in accordance with the specification. The primed surfaces shall be brought together while the paint is still wet. Surfaces which are to be friction-bolted shall be prepared in accordance with the specification (i.e. blast-cleaned or wire-brushed) but shall receive no paint coating. All sharp edges shall receive the specified dry film thickness of paint.

Where the shop coat has been allowed to age for a few months before painting, it shall be lightly sanded or rubbed with steel wool and scrubbed with clean water suing a bristle brush.

Before painting galvanised iron surfaces, they shall be treated with galvanised Iron Cleaner" or equal and approved cleaner, used in strict accordance with the manufacturer's instructions. Where a temporary protective coating has been applied to prevent wet storage stain, the surface shall be thoroughly scrubbed down by means of a bristle brush and the approved cleaner until all the temporary protection has been removed. The treated surfaces shall then be thoroughly washed down with clean water and the surfaces allowed to dry before painting.

All galvanised sheeting shall be painted on the ground before erection. This will also ensure that overlaps are well protected. Where it is impracticable to apply the coating system before erection, prior consent to paint after erection shall be obtained form the Engineer.

Paint dry-film thickness shall be measured using a non-destructive thickness gauge such as the MIKROTEST or equivalent.

3.14.5 Inspection of Surfaces

All surfaces to be painted shall be carefully inspected by the Contractor who shall satisfy himself that the surfaces are in a perfect state to take the paintwork specified. No claim will be entertained arising form defective work due to not strictly insisting on receiving from defective work due to not strictly insisting on receiving from other trades, surfaces in a proper condition, fit to receive the type of paint specified. All surfaces shall be perfectly clean, free from dust, dirt, grease, blotches, and other blemishes before painting, staining or application of any coat.

All surfaces shall be properly prepared before painting or staining. Each coat of paint, except the last, shall be rubbed down with a fine glass paper before the next coat is applied.

Unless otherwise directed, the last coat of paint or finishing shall be done when all other work in the Contract is completed and the premises free from all rubbish and dirt. On completion, all painter's work shall be touched up where necessary and any defects made good. All paint and stain spots shall be removed and all surfaces left in a perfect condition.

3.14.6 Iron and Steel Surfaces

The contractor shall ensure that primed steelwork which is to be delivered to site is stacked on bearers and is clear of the ground. Wherever possible channels, angles, and other equipment and material shall be stacked so that water cannot collect on the steel.

Iron and steel surfaces shall be scrapped or shot blasted to produce a clean surface before painting. Paint shall not be applied over any surface containing traces of grit, grease, oil and the like, loose rust, loose millscale or corrosion products and foreign matter of any kind.

All air used for blast-cleaning or spraying shall be free from all traces of water and oil. When blast-cleaned, a satisfactory blast profile (i.e. anchor pattern) shall be achieved.

If the abrasive used for blast-cleaning is sand, it shall be free of clay. All metal surfaces to which paint is to be applied shall be moisture dry paint surfaces which are to be over-coated shall be hard-dry before over-coating, unless otherwise specified.

3.14.7 Painting of Steel Surfaces with Polyurethane System

This system is based on a polyurethane which is cured with an Aliphatic Di-Isocyanate. No polyurethane products which are cured with Aromatic Di-Isocyanate curing agents will be acceptable. This system shall be used as specified in highly corrosive conditions and where a high quality finish is required.

a) In Fabricator's Premises

i) Surface Preparation. All steel surfaces shall be abrasive blast-cleaned to a near-white finish and shall be free from oil and grease and any corrosive contaminants.

ii) Priming. Within 4 hours of blast-cleaning, one coat of an approved zinc chromate epoxy primer shall be applied to give a minimum dry film thickness of 38 micrometers.

iii) Undercoat. One coat of an approved undercoat compatible with both the primer and the finishing coat to give a minimum dry film thickness of 50 micrometers

b) On Site Painting

After erection the following procedures shall be adopted:-

i) Damaged areas shall be repaired as per clause 15.4 above, and spot priming shall comprise all the shop coats.

ii) Undercoat. Unless the undercoat has already been applied it shall be applied before erection as described in Sub-Clause (a) iii) above.

iii) Finishing. Two finishing coats of approved polyurethane enamel in the specified colour shall be applied to give a minimum dry film thickness of 25 micrometers per coat. The two coats shall be distributable in colour and the second coat shall be applied within 24 hours of the first. The total Minimum dry film thickness for the complete paint system shall be 138 micrometers.

3.14.8 Painting of Steel Surfaces with Alkyd System

This system shall be used as specified on columns, roof trusses, steel window frames and door jambs, pipes, pumps and equipment in areas where corrosion is mild and a decorative appearance is required.

i) Surface.

Where a decorative rather than corrosive resistant finish is required, steel surfaces may be specified to be mechanically or hand wirebrushed to remove loose rust millscale.

Where a more corrosive resistant finish than the above is specified, all steel surfaces shall be abrasive blast-cleaned to a near white finish. The abrasive shall be free form oil and grease and corrosive contaminants such as chlorides and the like.

ii) Etch Priming. (Applicable to abravise-blasted surfaces only).

Within 24 hours of cleaning, apply one coat of an approved single pact within 4 hours of cleaning, apply one coat of an approved single pack zinc chromate etch primer to give a dry film thickness of not less than 20 micrometers.

iii) Priming. (For abrasive - blasted surfaces).

Apply one coat of an approved zinc chromate primer (green) to give a dry film thickness of not less than 38 micrometers.

For wire brushed surfaces to the clean steel apply one coat, by rush or roller, of an approved red lead primer to give a dry film thickness of not less than 38 micrometers.

b) On-Site Painting of Steelwork

i) Damaged Areas

Before and after erection damaged areas shall be repainted as for Clause 14.4 above, and spot priming shall comprise all the shop coats.

ii) Undercoat

Apply one coat of an approved undercoat to give a minimum dry film thickness of 38 micrometers. The undercoat may be tinted to a shade just lighter than the finishing colour using approved stainers.

iii) Finishing

Apply at least one coat of an approved high gloss enamel in the specified colour, to give a minimum dry film thickness of 25 micrometers.

The total dry film thickness for the complete system shall not be less than 100 micrometers for wire-brushed surfaces, and 120 micrometers. The total dry film thickness for the complete system shall not be less than 100 micrometers for wire-brush surfaces and 120 micrometers for abrasive-blasted surfaces.

Note: Where window frames, door jambs and the like have been painted in the fabricator's yard with red oxide primer, this shall be rubbed down and primed in accordance with Clause 14.7 (a) III.

c) Painting of Motors, Gear Boxes and other Equipment

i) Surface Preparation

The surfaces to be painted shall be completely free from oil, grease, rust and foreign matter of any kind.

ii) Priming

One coat of an approved epoxy primer shall be applied to form a uniform coat and to fill all porosities in the castings. After 24 hours the primer shall be wet sanded to produce a uniform smooth surface.

iii) Undercoat

One coat of suitable undercoat tinted to a shade just lighter than the finishing colour with suitable staining agent, which is compatible with the paints, shall be applied.

iv) Finishing

One coat of approved high gloss enamel in the specified colour shall be applied. N.B. Flanged faces shall receive the full specified coating.

d) Painting of Pipes

i) Surface Preparation

The surfaces shall be wire brushed to remove loose rust and loose millscale.

ii) Priming

An approved one coat primer shall be applied.

iii) Undercoat

Undercoat shall be specified in Clause 14.8.

iv) Finishing

The finishing coat shall be as specified in Clause 14.8 (c) (iv). The total dry film thickness for the coating system shall not be less than 90 micrometers. N.B. Flanged faces shall receive the full specified coating.

3.14.9 Painting of Galvanised Surfaces with Alkyd System

This paint system shall be used as specified for painting of side sheeting, ducting and plenum walls, underside of roof sheeting and the outside surfaces of rain water gutters where a decorative effect is required. It shall only be used where the corrosive conditions are mild.

i) Surface Preparation

The surfaces shall be prepared in the manner as described in Clause 14.4 above.

ii) Priming

To the cleaned surfaces apply one coat of an approved Calcium Plumbate primer.

iii) Undercoat

Apply one coat of approved high gloss enamel in the specified colour. The total paint dry film thickness for the system shall not be less than 100 micrometers.

3.14.10 Painting of Equipment and Steelwork with Epoxy System

i) Surface Preparation

a) Equipment

Where the equipment is specified to be painted after installation it shall be delivered to site unpainted. The surfaces to be painted shall be completely free from oil, grease, rust and all other foreign matter. If possible, castings shall be fettled prior to priming.

b) Supports and Steelwork

All surfaces shall be abrasive blast-cleaned. The abrasive shall be free from oil, grease, and corrosive contaminants such as chlorides and the like.

ii) Priming

Apply one coat of approved epoxy primer to form a uniform coat, and to fill all porosities in the casting. After 24 hours the primer shall be wet sanded to produce a uniform, smooth surfaces.

iii) Finishing

Apply two coats of an approved Epoxy Enamel in the specified colour, the second coat to be applied within 24 hours of the fist. N.B. Flanged faces shall receive the full specified coating system.

3.14.11 Painting of Galvanised Surfaces with Epoxy System

This paint system shall be used for painting of galvanised surfaces in highly corrosive conditions.

i) Surface Preparation

These surfaces shall be prepared in the manner as described in Clause 15.4 above.

ii) Priming

To the cleaned surfaces apply one coat of approved Epoxy Zinc Chromate Primer.

iii) Finishing

Apply two coats of an approved epoxy enamel. The second finishing coat shall be applied within 24 hours after the application of the fist finishing coat, and shall be distinguishable in colour from the first. The total minimum dry film thickness for the paint system shall be 88mm.

3.14.12 Painting of Chequer Plate of Egg-Crate Flooring and Supporting

Frames with Epoxy Tar System

This paint system shall be abrasive blasted or acid pickled and passiveated.

i) Surface Preparation

Surfaces shall be abrasive or acid and passivated.

ii) Finishing

Three coats of approved epoxy Tar shall be applied. Consecutive coats shall be in distinguishing colours.

3.14.13 Painting of Galvanised Surfaces with Epoxy Tar System

This paint system shall be used for the painting of internal surfaces of galvanised gutters.

i) Surface Preparation shall be described in Clause 14.4

ii) Finishing

To the cleaned surfaces apply one coat of approved Calcium Plumbate Primer.

iii) Undercoat

Apply one coat of suitable undercoat tinted to a shade just lighter than the finishing colour with a suitable tinting agent which shall be compatible with the paint.

iv) Finishing

The Contractor shall apply two coats of approved Epoxy Tar. The second coat shall be applied within 24 hours of the first coat. The total paint dry film thickness shall be not less than 200 micrometers.

3.14.14 Painting of Steelwork with Chlorinated Rubber System

This system shall be used in areas where the steelwork is exposed to occasional corrosive conditions.

a) In Fabricator's Yard

i) Surface Preparation

Abrasive blast-clean all steel surfaces. The abrasive shall be free form oil, grease and any corrosive contaminants.

ii) Priming

One coat of approved chlorinated rubber undercoat shall be applied to give minimum dry film thickness of 75 micrometers.

iii) Undercoat

One coat of approved chlorinated Rubber Undercoat shall be applied to give a minimum dry film thickness of 75 micrometers.

b) On-Site Painting

After erection, the following procedure shall be adopted:-

i) Damaged areas shall be repaired as described in clause 14, 4 above and spot priming shall comprise all the shop coats.

ii) Finishing

One coat of approved chlorinated rubber enamel shall be applied in the specified colour, to give a dry film thickness of not less than 25mm.

3.14.15 Painting of Galvanised Surfaces with Micaceous Iron Oxide Pigmented Alkyd System

Unless the Engineer has given his written consent, the galvanised sheets shall be primed on the ground before erection.

i) Surface Preparation. The surfaces shall be prepared in the manner as described in Clause 1.14.4.

ii) Priming To the clean surfaces apply one coat of an approved calcium plumbate primer.

iii) Undercoat. Apply one coat of an approved Alkyd micaceous Iron Oxide structural paint.

iv) Finishing. Apply one coat of an approved Alkyd micaceous Iron Oxide structural paint in colour as specified.

(v) Damaged Areas these shall be repaired in a manner as described in clause 1.14.4

The total paint dry film thickness shall not be less than 114 micrometers.

3.14.16 Specialised Painter

All painting shall be carried out by a painting specialist employed by the contractor.

3.15 PROTECTION OF UNPAINTED SURFACES

Bright Machined Parts

All bright machined parts shall have a protective treatment applied by the manufacturer before despatch and this treatment shall be kept intact up to the time of handover unless it has been removed for installation. If the surface is exposed after installation a further protective coating shall be applied in accordance with the manufacturer's requirements.

3.16 PIPING AND FITTINGS

3.16.1 Materials

Pipework shall be run as shown on the contract drawings. All piping used in the construction of the works shall be straight, cleanly finished, round in cross-section, free from cracks, surface flows, laminations and other defects and free from scale.

3.16.2 Neatness

All pipe runs shall be arranged to present a neat appearance with where practicable shall be parallel both with one another and with the building structure, paying due regard however to the grading and venting requirements. All vertical pipes shall be plumb.

Pipes shall be bent round piers and all other projections and recesses and all offsets due to varying thicknesses of plaster, walls, floors and ceilings and other structural works were such changes in direction of piping are indicated on the drawings or not. Details of the skirting heights, sill heights and floor finishes shall be determined before any work is commenced. No pipework offsets shall be allowed on piping.

3.16.3 Prevention of Dirt Entering Pipes, valves etc.

All pipes, fittings, valves, etc. shall be guaranteed to be free from corrosion and internal obstruction. Pipes and fittings showing signs of corrosion shall not be fitted.

The open ends of all pipework and valves shall be protected. Wrought-iron screwed caps or plugs or plastic covers only shall be used to cover open ends. Wood, rag or paper plugs shall be used. Pipework delivered for use on the Contract Works shall

be stored clear off the ground on suitable racks or stands and with the ends protected as described above.

3.16.4 Pipe Cutting and Cleaning

All cuts from Standard lengths of pipe shall have all burrs and swarf removed, the ends shall be trimmed square and the pipe shall be thoroughly cleaned both internally and externally before erection.

3.16.5 Accessibility

All valves, drains and supports shall be positioned so as to facilitate maintenance. Grouping of valves, drains unions flanges etc. shall be preferred to scatted siting. Joints shall not be formed in the thickness of walls, floors or ceilings. All pipework, valves fittings and equipment forming the piping installation shall be erected so that it can be dismantled and be readily accessible for repair and replacement.

Readily accessible means that the flange, union, etc., can be reached and worked upon either in the open or else by removal of a purpose made duct cover, manhole or similar cover. The fitting is not accessible if as fixed it cannot be manipulated.

Where pipework is to be installed in an inaccessible position it shall be welded or brazed. Unions or flanges shall be provided as equipment to facilitate dismantling. Care shall be taken to ensure that pipe flanges, valves etc are staggered relative to similar projections or adjacent pipes and obstructions such as bemas columns and pipe supports, where necessary.

3.16.6 Grading of Pipework

All pipework shall be installed with continuous gradients to allow for drainage and for venting air. The rise or fall of piping in the direction of flow shall be as laid out in the schedule below (unless noted otherwise on the drawings or instructed by the Engineer.

Service	Rise or Fall	Minimum Gradient mm per meter
Water	Rise (preferred)	2
Steam	fall	4
Condensate	fall	4
Compressed Air	fall	8

3.16.7 Pipes laid in Ground

Pipes laid in the ground shall be assembled with care and shall be well bedded in to ensure that pipework and fittings shall not be damaged by movement of the ground. (Steel pipes shall either be supplied with factory applied bitumen/fibreglass wrapping and joints site-wrapped with bitumen tape, or the entire pipeline shall be primed with Densopaste, protected with Denso tape applied with a 55% overlay and protected with PVC wrapping securely fixed).

Excavation in ground and backfilling of trenches with sealed backfill shall be by others unless specified otherwise.

3.16.8 Pipes Joints

a) Types of Joints

Joints shall be screwed, welded or flanged as specified for each particular service elsewhere in this specification. Joints shall comply with relevant Kenya Bureau of Standards or BS specification. All flanges shall be at 90^0 to the centre line of the pipe and the holes shall straddle the centre line.

b) Screwed Joints

Pipes for screwed joints shall be provided with taper threads to B.S. 21 Part 1. Steel pipes shall be carefully reamed out before the plain end is threaded. Threads shall be right, clean and free of burrs prior to installation. Before making a joint, the male screw thread shall be wrapped with Polytetrafluoroethene (PTFE) tape. Alternative jointing compounds shall not be used without the express approval of the Engineer. Should a screwed joint prove defective under test or in operation, the joint shall be broken and remade, caulking will be permitted.

c) Flanged Joints - Steel Pipes

All flanges, bolts, nuts and washers shall be manufactured from mild or stainless steel to B.S. 4504 Part 2 "Table of Piped Flanges (for land use)" to the table appropriate to the pressure specified. Bolt holes in flanges shall be drilled, not punched, and spot faced for nuts.

Pipes not galvanised shall be provided with flanges crewed or welded for nominal bores of 80mm and below and with welded flanges for larger sizes. Galvanised pipes shall be provided with galvanised screwed flanges for nominal bores 80mm and below and with welded flanges for larger sizes. For galvanised piping all welding shall be carried out before galvanising.

Welded flanges shall be of the machine-faced, slip-on pattern with neck secured by welding both at the neck and bore of the flange to pipe, with the pipe finishing 3mm inside the bore. Care shall be taken not to distort the machined face. The use of alternative flanging to the ASA standards throughout the installation will be considered upon application.

d) Flanged joints - Polypropylene Pipe

Flanges on polyprolene pipes shall be of the full face type up to and including 100mm NB, and the stub flange type with mild steel backing ring for sizes 125mm NB and above, these shall also be used on sizes below 100 mm NB upon the Engineer's request.

All drilling in flanges and backing rings shall be to B.S. 4504 Part 2 "Table of Pipe Flanges" (for land use) and the holes shall be drilled, not punched, and spot faced.

Thickness of flanges and backing rings shall be as specified for each service and the material for the flanges and stub flanges shall be identical to that of the pipe. The

use of the alternative flanging to ASA standards throughout the installation will be considered upon application.

e) Gaskets and Bolts

The joint between flanges shall be made up with a joint ring graphite faced on both sides. Joint strings shall be suitable for the pipeline pressure and temperature duty and shall be identified for duty for which they are suitable. Joint rings shall be cut from sheets on site.

Bolts heads and nuts shall be hexagonal in form and washers shall be fitted beneath bolt heads and nuts. The lengths of bolts shall be such that not less than one thread nor more than 5mm of bolt protrudes through each nut when the joint is pulled up. All bolts and nuts shall be corrosion resistant.

f) Welded Joints - General

Welding technique, edge prepatin and welding rods or electrodes shall be selected to be suitable in all respects for the materials and duty of the pipeline, and comply with the applicable British Standards.

Each approved welder will be assigned a reference number which shall be stamped on each weld carried out by him. During the progress of the site work ultrasonic or radiographic examination or welds may be carried out by an independent authority at the expense of the Employer Welds found to be defective shall be cut out and the pipe made good, all the contractor at his own expense, and the new welds retested at the contractor's expense.

The Contractor shall cut out and prepare for mechanical testing in the presence of the Engineer, welded joints selected by the Engineer. Cutting out and preparing of test pieces and the making good of pipelines shall be at the contractor's expenses. The total number of such tests will not exceed one per cent of welded joints except that welds found to be defective shall not form part of this total.

Should a significant proportion of the tested welds of a particular welder prove to be defective due to faulty workmanship, all welds carried out by the particular welder shall be cut out and the pipeline made good by another welder whose work has proved satisfactory.

When the general hydraulic test of the completed systems is carried out, each weld shall be lightly hammered during the time pressure is maintained. If any leaks occur at welds, the portion of weld near the leak shall be removed by cutting or grinding and welded. Repairs shall not be attempted by caulking or fusion of surrounding metal.

g) Welded Joints - Steel Pipes

Oxy-acetylene welding shall generally be carried out in accordance with the "Recommended practise of oxy-acetylene welds in mild steel pipelines" publishing by the Heating and Ventilation Contractors Association. Metal arc welding shall be in accordance with Technical Memorandum T.3 issued by the British Welding Research Association.

The contractor shall obtain from the manufacturers tests certificates representative of welding rods and electrodes used and in accordance with B.S. 1453 or B.S. 639 respectively.

All welded joints, whether produced by oxy-acetylene flame or metal are processes shall be of prime quality. The butts shall be slightly convex with regular ripples and no undercutting, washing away or surface cavities shall be present. Notches at the root into the pipe bore in excess of 1.5mm will be accepted and the external reinforcement shall run out smoothly to the pipe surface on either side. All slag shall be removed after each run. Undercut edges, slag pockets, unsound metal and blowholes shall be chipped out as the work proceeds.

h) Welding - Polypropylene

The use of radial welding equipment for pipework joints shall be preferred. The butt machine used for the welding of polypropylene pipes shall be of a design approved by the Engineer. The machine is to carry out the butt welding of pipes from 100 mm NB up to and including 300 mm NB, must be capable of welding flanges and fittings onto the pipe, and be able to do angular butt welds for development of special bends.

The machine shall be capable of maintaining a welding force of 3500 N. The welding force to be maintained at each weld shall be 10N for each square centimetre of annular pipe surface, at a temperature of 250 plus of minus 10^0C, and therefore provision shall be made for the heating of both mating surfaces to a temperature of, and maintaining, 250 plus of minus 10^0C. All heating surfaces in contact with the piping material shall be Teflon coated.

i) Pipe Fittings

General

Fittings shall be to the standards specified elsewhere in this specification and shall be compatible in all respects with the materials and class of piping being installed. Where standard fittings are not available for the duty required, reductions on the run and to the branch shall be in all cases be made with reducing sockets. Reducing bushes and long screw connectors with backnuts shall not be used.

Bends shall preferably be of the long radius type except for the compressed air system and where space is restricted. In these cases short radius elbows may be used subject to the approval of the Engineer.

In general standard tees shall be used for all connections to pipes and headers. The welding on of sockets or branch pipes will be permitted only with the authority of the Engineer. Reducers shall be of the eccentric type, except on vertical pipelines where concentric reducers may be used. Transitions shall be swept and not abrupt. All connections to plant items shall be so arrange that the plat can be easily disconnected. All steam, compressed air and water connections shall be made to the top of the line unless noted otherwise on the drawings.

3.16.9 Pipe Supports and Guides

a) General

All supports, brackets, hangers clips and other fixing accessories necessary to support all piping system from the building structure or concrete bearers shall be provided and fixed under this Contract. As far as practicable standard bought dip galvanised components shall be used. Samples of these components shall be submitted for approval prior to the placing of order.

Steam and other pipes for high temperature duties be supported on rollers and guided with rollers at changes of direction or other points where necessary to prevent pipes leaving the supports, or on hangers with spherical washers or suitably articulated to take up movement.

Brackets and supporting frames of rolled steel sections shall be fabricated in accordance with the best accepted practice to form true, rigid, neat structures. Makeshift, untidy or unstable supports will be acceptable. Woodscrews, pop-rivets, self-tapping screws, or other fastenings subject to loosening by vibration shall not be used in the fabrication or attachment of pipe supports or fixings. Spring washers, lock nuts or other locking devices shall be used on nuts. Contact between dissimilar metals shall be avoided. A pipe shall not be supported from another pipe unless approved by the Engineer or specifically called for the drawings. Where a common hanger is used for more than one pipe, provision shall be made to accommodate unequal expansion.

b) Fixing to Structure

Fixing to the building structure shall not be carried out in any manner other than that specifically approved by the Engineer for the particular area of the building and type of finish. Care shall be taken to avoid unnecessary damage to finishing.

Competent labour shall be employed to ensure that supports are correctly sized, spaced and set out prior to fixing. All work shall be made good to the Engineer's approval.

For fixing to brick and concrete, holes of correct size shall be neatly drilled using special purpose twist drills, and fixings made by rowl-bolts or equal or bolts of the grouted type approved by the Engineer. Shot fixings shall not be used nor shall fixings be made into mortar between bricks. Fixing to lightweight or hollow structures shall be by means of suitable screw anchors, toggle bolts or approved alternative.

c) Spacing of Supports

Spacing of supports for steel and copper pipes shall not exceed the centres given in the following table:

MAXIMUM SPACING OF SUPPORTS (M)

Nominal Bore of pipe (mm)	Steel Pipes		Copper Pipes	
	Horizontal	Vertical	Horizontal	Vertical
15	2.0	2.4	1.4	1.9

20	2.4	3.0	1.4	1.9
25	2.7	3.0	1.7	2.2
32	2.7	3.0	1.7	2.7
35	3.0	3.6	2.0	3.0
40	3.4	4.0	2.0	3.0
50	3.7	4.5	2.0	3.4
65	3.7	5.0	2.4	4.0
80	4.1	5.0	3.0	4.0
100	4.4	5.0	3.0	4.0
125	4.4	5.5	3.0	4.0
150	4.8	6.0	-	-
200	5.1	6.3	-	-
250	5.8	6.5	-	-
300 and over	6.1		-	-

Special supports shall be provided for all heavy items of pipeline equipment such as stainers, valves, etc.

d) Positions of Supports

Supports shall be positioned to reduce, as afar as possible, stress on joints, valves and items of equipment. Due to regard shall be given to the maintenance of accessibility and to the requirements of access to their services to be fixed in the area.
Vertical pipes shall be supported at the bottom of the riser, or at an intermediate anchor point, to allow for expansion and to carry the entire weight of the riser. Intermediate supports will act as guides. Branches from risers shall not act as supports for the riser.

e) Guides

Guides shall be provided and fixed to prevent pipes leaving their supports due to expansion compensating devices.

f) Anchor Points

Anchor points shall be provided to resist the axial stress transmitted by the flexure of expansion loops or bellows.

Anchors shall be provided complete for attachment to the structure and where applicable shall be bolted or welded to the structure or positioned accurately for grouting in by others.

On steel pipelines anchors shall consist of heavy mild steel saddles welded all round to the pipe surface and provided with exterior lugs for bolting to the building structure or thrust block. Saddles shall be not less than the thickness of the pipe to which they are welded and of width equal to its nominal bore. On polypropylene pipelines shall const of 3mm thick polypylene pads completely surrounding the pipe and then attached to the supporting steelwork with U Bolts. Alternatively, anchors may consist of slip on flanges welded to the pipe and not bolted or welded in the approved manner to rolled steel members attached to the structure.

In the case of copper pipes, anchors shall generally consist of two flanges-to-copper adaptors interposed into the pipe run at the anchor point. Mild steel sections shall be bolted to either side of the flanged joint and attached to the building structure.

3.16.10 Provision for Expansion in Piping

Piping shall be installed in such a manner as to allow for thermal expansion. Where sufficient flexibility is not provided by changes of direction in the run, expansion loops or expansion compensators shall be provided. In general, fabricated expansion loops shall be used to allow 'nesting' of loops in adjacent pipes but purpose made expansion loops may be used if they are suitable for the pressure and expansion duty.

Expansion compensators shall be used only on Engineer's approval and then must be suitable for the working conditions and installed in full compliance with the manufacturer's recommendations regarding guiding, alignment and all other respects of erection and commissioning.

Care shall be taken that the compensators are not overstressed during pressure testing of pipelines, and if necessary, made-up spool-pieces of pipe shall be substituted during these tests.

All supports shall provide for the expansion movement in pipes. Hangers shall be free to 'swing' and rigid supports shall be of the roller type or pipes shall have 'slides' of rolled steel sections welded to them to permit free movement on supports without damage to the pipe or insulation.

3.16.11 Pipe Sleeves

a) General

Pipes shall not be build rigidly into walls, floors, ceilings, footings or under roads. Sleeves shall be provided under this contract, unless noted otherwise on the drawings, for building-in by others at all such locations.

The Contractor shall provide all sleeves in advance of building requirements and shall be responsible for ensuring that sleeves are properly positioned, aligned and built-in. Rectangular or circular openings will be provided by the builder in structural concrete slabs and it shall be the Contractor's responsibility to supply, position, align and secure sleeves, ready for casting in by the builder.

Puddle flanges shall be provided for building-in where pipes pass through bound walls or below ground.

b) Sizes

Sleeves shall not be used as pipe supports and a free annular space of at least 6mm shall be allowed between a pipe and its covering, if any and its sleeve. In load bearing walls or footings the annular space shall be of a minimum of 25mm. Where pipes change direction, sleeves shall be oversized to accommodate expansion movement of the pipe.

Sleeves shall extend through walls to within 5mm of the finished surface on both sides to allow for flush caulking over the sleeve with water proofing compound. Vertical

sleeves shall be project 50mm above the finished floor level and end 5mm above the underside of the slab. Polystyrene or similar material spacer discs shall be provided to locate the sleeve during casting of concrete, so that when the discs are removed the caulking clearance is left.

c) Materials

Sleeves in load-bearing walls and under roads shall be of cast-iron. Other sleeves shall be of standard galvanised pipe cut to length. Sleeves shall properly cut, reamed and trimmed square. Sleeves for casting in the concrete shall be securely fixed to form work by the contractor before concrete is poured. The annular space between each pipe and sleeve shall be firmly caulked at each end with polysulphide or equal waterproof compound which does not set hard.

3.16.12 Ventilation and Draining of Pipework

a) General

Sufficient provision shall be made at high points of piping and equipment for ventilation and at low points for draining. Drains shall be provided on all major sections of pipework so that they can be drained without draining the entire system. Vents shall be adequate to ensure that airlocks cannot form in the system.

b) Manual Vents

Manually operated air release points shall be provided on all water piping to permit the initial charging of the system. Each point shall comprise an air bottle fitted on tope of the pipe and with a welded cap and 15mm discharge pipe run to a fullway air-release valve at hand level and then to discharge at an agreed point. Pipes up to 40mm shall have air bottles of the same diameter as the pipe, air bottles for larger pipes shall be 40mm diameter. All air bottles shall be 300mm long.

c) Automatic Vents

Automatic vents shall be provided with lockshield isolating valves and 15mm discharge pipes run to approved positions. Steam mains shall be provided with thermostatically operated air vents at all high points in the system to allow for quick warming up of the system after a shutdown.

d) Drain Points

Steam lines shall be provided with steam trapped condensate drain points at all low points at least every 40 meters on long lines. Drain pockets of diameter equal to that of the steam pipe shall be provided on lines up to 100mm diameter and of diameter 50mm less than the pipe diameter for pipes above 100mm. The condensate line from the trap shall enter the top of the condensate in the header or main.

Water lines and equipment shall be drainable through 15mm lockshield isolating valves and discharge pipes run to approved positions. Compressed air lines shall have trapped automatic condensate drains at all low points in the system.

3.16.13 Valves and Strainers

a) General

Valves and strainers shall be of the types specified elsewhere in this specification, of best quality and suitable in all respects for the duties for which they are intended.

b) Valves

Except where loose key or lever operation is specified, all manual valves shall be provided with handweels. Closing shall be by clockwise rotation of the handwheel. All valves shall conform to the following design and materials specification:

Bronze	B.S. 1400 LG-2C or A.S.T.M.B. 62-63
Galvanised iron	B.S. 1452 GR14C or A.S.T.M.A. 445-63T
Ductile Iron	B.S. 1504-161A or A.S.T.M.A. 216 Grade WCB.

Mixing, thermostatic and other automatic valves shall be of 'fail-safe' design and where practicable self-acting.

1.16.14 Pressure Reducing Valve Sets

Pressure reducing valves shall be as equal and approved. They shall be installed complete with separator, isolating valves, strainer, pressure gauges, by-pass and control valves, etc. and a pressure relief valve mounted on the low pressure side, sized in accordance with accepted practice, to fully protect any equipment in the event of failure of the pressure reducing valve. The relief valve shall be set, and all gauges shall be in place before steam is allowed to pass through any P.R.V. set. The discharge pipe from the pressure relief valve shall be run to the nearest drain point approved by the Engineer.

1.16.15 Instruments and Gauges - Pipework

Where shown on the drawings pressure gauges and thermometers shall be provided. Pressure gauges shall be of the dial type with minimum 100mm dials and scaled to 50% in excess of maximum anticipated pressure.

They shall be fitted with isolating valves, gauge cocks and syphon bends and installed on extension pipes extended to a convenient position and properly supported. Gauges shall be tested against a deadweight tester in the presence of the Engineer and shall be accurate to within 2% over the working range. Pressure gauges shall be calibrated in KPA. Blow off holes in gauges shall be aimed in a safe direction, away from the operator. Thermometers shall be of brass mercury-in-glass type at least 150mm long and installed in thermometer pockets so that they may be removed without draining the pipeline. Angle or staring pattern thermometers as appropriate shall be used. Calibration shall be in ^{0}C.

3.16.14 Identification and Labelling

a) Pipework

All pipework, both insulated and uninsulated shall have coloured identification band and direction arrows marked on in clearly visible positions at maximum spacings of 6 meters on all runs. This spacing shall be reduced if necessary to ensure that each pipe and branch-passing through any form of space is coded, each branch has at least one coding band and there shall be a coding band within one meter of each valve, plant connections and flange or union.

The colours to be used for banding and arrows shall be agreed with the Engineer but shall comply as far as is possible with B.S. Bands and arrows shall be neatly stencilled using paint system compatible with the surfaces to which they are to be applied. Bands will consist of a base colour band and identification bands of contrasting colours and each 50mm wide.

All insulated pipework other than stainless steel, copper galvanised and polypropylene, shall be painted over the entire length prior to insulating with an approved anti-corrosive inert bituminous based paint, suitable for use on steam pipework. All other pipework shall be pained and code banded, as indicated elsewhere in this specification. On bare polypropylene, identification and direction of flow arrows shall be made by the sue of coloured adhesive tape (of a type approved by the Engineer) banded around the pipe in accordance with the foregoing positions.

b) Equipment Items

All plant and equipment items shall be labelled in a clearly visible position with the items name and, in the case of duplicate items, a number. Plant labels shall correspond with designations on the drawings. Labels shall be of rear engraved and filled 'trefoiled" of sandwich thermosetting plastic with black lettering on white background. Lettering size shall be at least 6mm.

c) Valves

Section isolating valves and valves in service areas shall be labelled to identify the zones they serve and with an abbreviated code to identify the service. A schedule of labels required will be provided by the Engineer.

Valve labels shall be sandwich thermosetting plastic with black lettering on a white background secured to the valve stem with a light chain. Sample labels shall be submitted for approval.

3.16.15 Pipework System Materials

1.17.1 General

All materials shall be suitable for the temperature rating of the system in which they are installed. These ratings are given in the detailed specification.

1.17.2 Steam Reticulation and Condensate Return

a) Piping

150 mm and below for welding.	B.S. 1387, heavy class seamless, plain ends prepared
Above 150 mm 6,35mm min.	B.S. 3601/22 or AP1 5.L Sch 20 with wall thickness

b) Fittings

Steel but-weld fittings to B.S. 1640 or equal, wall thickness not less than pipe thickness.

c) Flanges

B.S. 4504

d) Valves

Steam Isolating Valves

Upto to 40mm globe valves with cast bronze or ductile iron bodies, replaceable seat, bronze or stainless steel trim, union bonnet pattern and screwed by B.S. 21.

50mm to 150mm globe valves with cast bronze or ductile iron bodies, replaceable seat, bronze or stainless steel trim, union bonnet pattern and flanged to B.S. 4504.

200mm and above globe valves with cast bronze or ductile iron bodies valves with galvanised iron or ductile iron bodies replaceable seat, bronze or stainless trim, rising spindle pattern and flanged to B.S. 4504.

Steam Regulating Valves

These valves shall be needle valves of materials specification similar to isolating globe valves.

Condensate Valves

Upto to 40mm	Cast bronze of ductile iron bodies, replaceable seat, bronze or stainless steel trim, union bonnet pattern and screwed by B.S. 21.
50mm to 150mm	Galvanised iron or ductile iron bodies, replaceable seat, bronze or stainless steel trim, union bonnet pattern and flanged to B.S. 4504.

Gate Valves

Upto to 40mm	ductile iron bodies, replaceable seat, bronze or stainless steel trim, union bonnet pattern and screwed by B.S. 21.

Non return valves

Upto to 40mm	bronze swing check screwed to B.S. 21.

50mm to 150mm ductile iron bodies, replaceable seat, bronze or stainless steel trim, union bonnet pattern and flanged to B.S. 4504.

Sight Glasses

Bronze/Gunmetal bodies, single window combined sight-check valves may be used only where installed safe from Mechanical damage.

Steam Traps

For line draining Inverted bucket steam trap (stainless steel trim).

For equipment Ball float steam trap to correct pressure range or equal, unless otherwise specified on the drawings. (Stainless steel trim).

Air vents

Thermostatic vent depending on pressure.

Pressure Reducing Valves

Diaphragm pilot operated reducing valve. Stainless steel trim, phosphor bronze diaphragm, correctly sized for floor rate and with high turn-down accuracy and tight shut-off.

Strainers

Up to 50mm Malleable or galvanised iron body, stainless steel screen and screwed connections to B.S. 21

65mm and above Galvanised iron or S.G. iron body, stainless steel screen and fanged connections

3.16.16 Cold and warm 45^{0}C Water Reticulation

a) Piping
Piping - Steel

Up to 150mm Galvanised steel piping to B.S. 1387, medium class, screwed and socketed.

Above 150mm B.S. 3601/22 or API equivalent, 4.5mm wall thickness with plain ends for welding. To be hot dip galvanised after fabricating.

Piping - Polypylene

Up to 25 mm 1 500 kpa rated. Extruded from polypropylene - ethylene grade and shall be heat and U.V. stabilised to B.S. 4991 or ISOR 160.

32mm and above 600 kpa rated for cold water and 900 kpa for warm water. Extruded from propylene acetylene and shall be heat and U.V. stabilised to B.S. 4991 or ISOR 160.

b) Fittings

Fittings -Steel

Up to 100mm	Fusion welded and of exactly the same material as the polypropylene piping.
Above 125mm	butt welded or fusion welded and of exactly the same material as the polypropylene piping.

Fittings -Polyprolene

Up to 150mm	Galvanised malleable iron fitting to SABS 509.
Above 125mm	flanged to B.S. 4504. Fabricated or forged steel.

c) Flanges

Flanges - Steel

50mm to 150mm	B.S. 4504 screwed and galvanised.
Above 125 mm	Butt welded or fusion welded and of exactly the same material as the polyprolene piping.

Flanges - Polypropylene

Full face polypropylene or polypropylene stub flanges with mild steel backing rings drilled to B.S. 4504.

d) Gaskets

6mm rubber insertion.

e) Valves

Globe

Upto to 40mm	bronze body, bronze or stainless steel trim, replaceable seating, and screwed to B.S. 21.
65 and above	galvanised iron body, bronze or stainless steel trim, replaceable seating flanged to B.S. 4504.

Gate

Upto to 40mm	bronze body, bronze or stainless steel trim, replaceable seating, and screwed to B.S. 21.
65mm and above	galvanised iron body, bronze or stainless steel trim, replaceable seating flanged to B.S. 4504.

Check-valves

Upto to 40mm	bronze body, bronze or stainless steel trim, replaceable seating, and screwed to B.S. 21.

65 and above galvanised iron body, bronze or stainless steel trim, replaceable seating flanged to B.S. 4504.

Ball valves

Upto to 50mm chrome plated brass, teflon seat rings screwed to B.S. 21, with fixed operating handle.

Restrictor Valves

Ball stop with crew driver operation.

f) Strainers

Upto to 50mm Malleable iron bodies, stainless steel screen and screwed connections to B.S. 21.

65 and above galvanised iron or S.C. iron bodies, stainless steel screen and flanged connections.

1.17.4 Hot water (85^0C)

a) Piping

Piping - Steel

Stainless steel type 304 L to A.S.T.M specification A312. Wall thickness 2mm minimum longitudinally welded. NOTE All welds made in the pipe during manufacture shall be suitably cold worked to relive stresses and normalize crystal structure in order to prevent stress corrosion occurring while the pipe is in service at 85^0C. All joints in run and to fittings to be welded, using a suitable inert gas technique.

Piping - Polypropylene

Upto to 25mm 1,500 kpa rated. Extruded from polypropylene - ethylene grade and shall be U.V. stabilised, to B.S. 4991 or ISOR 160.

32mm and above 1,500 kpa rated. Extruded from polypropylene - ethylene grade and shall be U.V. stabilised, to B.S. 4991 or ISOR 160.

Piping - Copper

Shall comply with B.S. 2051

b) Fittings

Fittings - Steel

Stainless steel type 304L welded.

Fittings - Polypropylene

Upto to 100mm	Fusion welded of exactly the same material and pressure rating as the polypropylene piping.
125mm and above	Flanged and of exactly the same pressure rating and material as the polypropylene piping.

Fittings - copper

Upto to 50mm	Capillary to B.S. 864 or screwed to B.S. 21. Above 50mm flanged, brazed or bronze welded.

c) Flanges

Flanges - Steel

Stainless steel type 304L flat face - slip-on, to B.S. 4504.

Flanges - Polypropylene

Full face polypropylene or polypropylene stub flanges with mild steel backing rings drilling to B.S. 4504.

Flanges - copper

Bronze or gunmetal brazed or welded to pipe, B.S. 4504. Brass bolts, nuts and washers to be used.

d) Gaskets

6mm Rubber insertion.

e) Valves

Globe (throttling valve only)

Up to 40mm bronze body, bronze or stainless steel trim, replaceable seating and screwed to B.S. 21.

50mm and above Galvanised iron body, bronze or stainless steel trim, replaceable seating and screwed to B.S. 4505.

Gate

Up to 40mm bronze body, bronze or stainless steel trim, replaceable seating and screwed to B.S. 21.

50mm and above Galvanised iron body, bronze or stainless steel trim, replaceable seating and screwed to B.S. 4505.

Valves

Up to 40mm bronze body, bronze or stainless steel trim, replaceable seating and screwed to B.S. 21.

50mm and above Galvanised iron body, bronze or stainless steel trim, replaceable seating and screwed to B.S. 4505.

Check Valves

Up to 40mm bronze body, bronze or stainless steel trim, replaceable seating and screwed to B.S. 21.

50mm and above Galvanised iron body, bronze or stainless steel trim, replaceable seating and screwed to B.S. 4505.

Ball Valves

Up to 40mm chrome plated brass, teflon seat rings, screwed to B.S. 21 with fixed operating handle.

Restrictor Valves

Ballstop with screwdriver option.

Finish - Machined brass unless specified otherwise.

f) Strainers

Up to 50mm Malleable iron body, stainless steel screen and screwed connections to B.S. 21 65mm and above malleable iron body, stainless steel screen and flanged connections

1.17.5 Hot water (85^0C)

a) Piping

Piping - Steel

Upto 150mm Steel piping (Black) to B.S. 1387 medium class plain ends for welding.

Above 150mm Steel piping to B.S. 3601/22 or API Equivalent 4, 5 mm wall thickness plain ends for welding.

Piping - Polypropylene

Upto to 100mm 1,500 kpa rated. Extruded from polypropylene - ethylene grade and shall be U.V. stabilised, to B.S. 4991 or ISOR 160.

b) Fittings

Fittings - Steel

Butt-weld fittings to B.S. 1640.

Fittings - Polypropylene

Upto to 100mm	Fusion welded of exactly the same material and pressure rating as the polypropylene piping.
125mm and above	Butt welded or fusion welded and of exactly the same pressure rating and material as the polypropylene piping.

c) Flanges

Flanges - Steel

B.S. 4504 wrought steel, flat faced, slip on.

Flanges - Polypropylene

Full face polypropylene or polypropylene stub flanges with mild steel backing rings drilling to B.S. 4504.

d) Valves

Up to 50mm	ball valves with bronze body, hard chromed bronze ball, teflon seats, screwed, to B.S. 21. Alternatively forged steel body, stainless steel ball.
65mm and above	globe valves with galvanised iron body, bronze seating rising spindle, flanged to B.S. 4504.

Check Valves

Non-slam double swing check valves with galvanised iron body, bronze flaps and neoprene seat, fitted between flanges.

Traps

15mm	Automatic trap with internal strainer, or approved equal.
20mm	Angle strainer fitted before trap or approved equal. All traps to have balance pipe.

Filter, Regulator, Lubricator Sets

8 mm	Complete with pressure gauge and manual operated drains on filter unit.
10, 15, & 25mm	Complete with pressure gauge and manual operated drains on filter unit.

Filter and Regulator

As for filter, regulator and lubricator sets but without lubricator.

e) Moisture separators

Up to 40mm	Vertical type screwed inlet and outlet to B.S. 21 complete with drain trap.

32mm and above Horizontal type flanged connections, complete with drain trap.

1.18.6 Chilled Water Pipework

a) Piping

upto 80 mm B.S. 1307 medium class, screwed and socketed.

100mm to 150mm B.S. 1387 medium class. Plain ends prepared for welding.

Above 150 mm B.S. 3601/22 or API equivalent with wall thickness 5 mm minimum. Plain ends prepared for welding.

b) Fittings

Steel butt-weld fittings to B.S. 1640 or equal, wall thickness not less than pipe thickness or screwed malleable iron fittings as applicable.

c) Flanges B.S. 4504

d) Gaskets Rubber insertion

e) Valves
Cocks - Balancing Valves

Upto to 50mm bronze body, bronze or stainless steel trim, replaceable seating and screwed to B.S. 21.

65mm and above Galvanised iron body, outside screw and yoke, bolted bonnet, replaceable seating, rising stem incorporation back seal, bronze or stainless steel trim, and flanged to B.S. 4504.

Gate

Upto to 50mm bronze body, bronze or stainless steel trim, replaceable seating and screwed to B.S. 21.

65mm and above Galvanised iron body, outside screw and yoke, bolted bonnet, replaceable seating, rising stem incorporation back seal, bronze or stainless steel trim, and flanged to B.S. 4504.

Check Valves

Upto to 50mm bronze body, bronze or stainless steel trim, replaceable seating and screwed to B.S. 21.

65mm and above Galvanised iron body, bronze seating, swing-check, flanged to B.S. 4504

f) Strainers

All strainers to be installed as follows:

Upto 50mm diameter screwed to B.S. 21. 50mm and over flanged to B.S. 4504.

Screwed ends Bronze body, stainless steel screen.

Flanged ends Galvanised iron body, stainless steel screen.

1.18.7 Condenser Water Pipework

a) Piping

upto 80 mm	B.S. 1307 medium class, screwed and socketed.- galvanised.
100mm to 150mm	B.S. 1387 medium class. Flanged ends - galvanised after manufacture.
Above 150 mm	B.S. 3601/22 or API equivalent with wall thickness 5 mm minimum, flagged ends - galvanised after manufacture.

b) Fittings

up to 80 mm	Galvanised malleable iron fittings to B.S. 143 screwed to B.S. 21.
Above 80 mm	Flanged to suit.

c) Flanges

up to 80 mm	B.S. 4504 screwed and galvanised.
Above 80 mm	B.S. 4504 slip on. Pipe and Flange galvanised after manufacture.

d) Gaskets Rubber insertion

e) Valves

Valves shall be all as specified for chilled water, 17.18.6 e.

f) Strainers

Strainers shall be all as specified for chilled water 17.18.6 e.

PART D

GENERAL SPECIFICATION FOR PLASTICS SYSTEM

4 PART D - GENERAL SPECIFICATION FOR PLASTICS SYSTEMS

4.1 Soil and Waste Systems

UPVC Soil System

5.1.1 The pipes and fittings shall comply in all respects with the requirements of British Standard BS 4514: 2001 and shall, where appropriate, bear the British Standard Kitemark.

5.1.2 Pipes shall be supplied in plain ended lengths.

5.1.3 The minimum acceptable wall thickness of pipe fittings and shall be:-

Nominal ins	Size mm	Pipe mm	Fittings mm
3	82	3.20	3.2
4	110	3.20	3.2
6	160	3.30	3.5

5.1.4 The method of jointing to be employed shall be that of solvent welding using the manufacturer's approved cement. Seal ring fittings shall be used where necessary to accommodate thermal movement, or the sockets of standard fittings shall be converted to seal ring joints by the addition of a seal ring adaptor.

5.1.5 The grade UPVC used for the pipe shall have a minimum softening point of 82^0C when tested by the vicat method as described in British Standard 2782:1976, Method 102A.

5.1.6 The grade of UPVC used for the fittings shall have a minimum softening point of 79^0C when tested by the Vicat method described in British Standard 2782:2004, Method 102A.

5.1.7 The pipe and fittings shall be colour grey, to British Standard 5252: 10.A.07, black, or for water closet connections, white.

5.1.8 The rubber seals for seal ring joints shall be of a section that gives more than one point of contact with the pipe and shall be to the material requirements of British Standard 2494:1986. Water closet connections shall be to the same British standard.

5.1.9 Waste boss connections when fitted to pipes shall consist of two parts with inner and outer flanges, solvent welded as a complete unit with inbuilt gradients for the waste pipes of $1\ 1/4^0$. Where it is not possible to gain access to the bore of the soil pipe, self-locking bosses with integral clamping action may be used provided that the mating surfaces are suitable for and used with solvent weld cement.

5.1.10 Alternative waste boss connections may be made using unequal junctions conforming to British Standard 4514:2001 with solvent weld joints conforming to British Standard 4514:2001.

5.1.11 When used internally holderbats shall be made of mild steel protected from corrosion by galvanised or plastic coating. They shall have two-position fixing suitable for either acting as a pipe support but allowing thermal movement or as a clamp fit on a fitting creating a fixed

point. For optimum fit to pipe supports PVC packing pieces may be used. PVC holderbats may be used for external use.

5.1.12 Access shall be provided where necessary either by means of an integrally moulded door in an access fitting with an externally fitted rubber seal and secured with two galvanised bolts and nuts or alternatively by a two-piece clamp type door fitted into the pipe run.

4.2 MUPVC WASTE SYSTEM

5.2.1 The pipe and fittings shall comply in all respects with the requirements of British Standard 5255:1989.

5.2.2 Pipes shall be supplied in plain ended lengths.

5.2.3 The minimum acceptable wall thickness of pipe and fittings shall be:-

Nominal Size ins	Size mm	Pipe and Fittings Wall Thickness mm
1 1/4	32	1.8
1 1/2	38	1.9
2	50	2.0

5.2.4 The method of jointing to be employed shall be that of solvent welding using the manufacturer's approved cement. Seal ring joints shall be introduced where it is necessary to accommodate expansion.

5.2.5 The grade UPVC used for the pipe shall have a minimum softening point of 94^0 when tested by the Vicat method as described in British Standard 2782:2004, Method 102A.

5.2.6 The grade of UPVC used for the fittings shall have a minimum softening point of 80^0C when tested by the Vicat method as described in British Standard 2782:2004, Method 102A.

5.2.7 The pipe and fittings shall be colour grey, to British Standard 5252: 1976 10.A.07, black or white.

5.2.8 The rubber seal rings shall be of a section that gives more than one point of contact with the pipe and shall be to the material requirement of British Standard 2494:1990.

5.2.9 Traps shall be moulded from white polypropylene and shall have a universal compression outlet. The fittings shall comply in all respects to British Standard BDEN 274 where applicable, and shall bear the British Standard Kitemark. Traps of configurations not covered by the British Standard shall comply with the performance specification of the standard.

4.3 SOIL AND WASTE SYSTEMS - WORKMANSHIP

5.3.1 The installation, method of jointing and fixing shall comply in all respects to the manufacturer's site work instructions.

5.3.2 Maximum intervals between pipe supports shall be:-

Nominal Size ins	mm	Horizontal m	Vertical m
1 1/4	32	0.5	1.2
1 1/2	38	0.5	1.2
2	50	0.9	1.2
3	82	0.9	1.8
4	110	0.9	1.8
6	160	1.0	1.8

5.3.3 Pipes shall be fixed in straight runs and all horizontal runs shall be laid to gradients in accordance with British Standard 5572:1994 Code of Practice for Sanitary Pipework, and in any event not less than 18mm/m unless otherwise instructed.

5.3.4 Expansion joints shall be provided at a maximum of 4 metre centres for soil, 2 metre centres for waste and between fixed points over 1 metre centres.

5.3.5 The work shall be inspected and tested during installation at agreed stages.
All work which will be concealed shall be tested before it is finally enclosed.

A final test shall be made upon completion of soundness and performance in accordance with British Standard 5572:1994 Code of Practice for Sanitary Pipework.

4.4 Rainwater Systems:

5.4.0 UPVC Half Round Rainwater System Pipe and Gutter

5.4.1 Gutters shall be true half round section 110mm outside diameter complying in all respects with the requirements of British Standard BS EN 1462:2004

5.4.2 Gutters shall be supplied in plain ended lengths.

5.4.3 The minimum acceptable wall thickness of gutter shall be 2.20mm

5.4.4 Rainwater pipes shall be circular in section, 65mm nominal diameter complying in all respects to British Standard BS EN 1462:2004.

5.4.5 Rainwater pipes shall be supplied in plain ended lengths.

5.4.6 The minimum acceptable wall thickness of rainwater pipe shall be 1.80mm.

5.4.7 Pipe support brackets must be adequate to screen expansion gaps.

5.4.8 The grade of UPVC used for gutter and pipe shall have a minimum softening point of 75^0C when tested by the Vicat method as described in British Standard 2782:2004, Method 102A.

5.4.9 The pipe and gutter shall be colour grey, to British Standard 5252: 10.A.07, black or white.

4.5 UPVC Square Rainwater System Pipe and Gutter

5.5.1 Gutters shall be rectilinear section 116mm wide maximum.

5.5.2 Gutters shall be supplied in plain ended lengths.

5.5.3 The minimum acceptable wall thickness of gutters shall be 2.20mm

5.5.4 Rainwater pipes shall be square in section, 58mm internal dimension.

5.5.5 Rainwater pipes shall be supplied in plain ended lengths.

5.5.6 The minimum acceptable wall thickness of rainwater pipes shall be 1.80mm.

5.5.7 Pipe support brackets must be adequate to screen expansion gaps.

5.5.8 The grade of UPVC used for gutter and pipe shall have a minimum softening point of 75^0C when tested by the vicat method as described in British Standard 2782:2004, Method 102A.

5.5.9 The pipe and gutter shall be colour grey, to British Standard 5252: 1976 10.A.07, black or white.

4.6 UPVC Rainwater Fittings

1.6.1 All fittings shall comply with the relevant requirements of British Standard BS EN 1462:2004

1.6.2 All gutters, pipe and fittings shall be colour grey to British Standard 5252:1976 10.A.07, black or white.

1.6.3 Gutter connecting fittings shall have integrally moulded seal retaining cavities housing a rubber seal or hallow section.

1.6.4 Gutter connecting fittings shall incorporate provision for fixing to fascia boards, rafters or brickwork such that the fixing screws shall not be in contact with the inner surface of the gutter and shall have provision for expansion of the gutter clearly marked in the fitting.

1.6.5 The grade of UPVC used for fittings shall have a minimum softening point of 75^0C when tested by the Vicat method 102A as described in British Standard 2782:2004, Method 102A.

4.7 Workmanship

5.7.1 All rainwater systems shall be installed in accordance with the manufacturer's site work instructions.

5.7.2 Gutters shall be supported on support brackets at one metre centres. In areas of heavy snow load, brackets shall be provided at 800mm centres.

5.7.3 Gutters shall be installed to accommodate the thermal movement.

5.7.4 Expansion joints shall be provided at maximum 4 metre centres.

5.7.5 Screws for fixing shall be round headed No.10 and long enough to make full use of the thickness of a traditional 25mm nominal softwood fascia. They shall have a rust-proofed finish. When fixing to other fascia, fastenings of equivalent holdings power shall be used.

4.8 BURIED DRAIN SYSTEM:

5.8.0 UPVC Buried Drain System

1.8.1 The pipes and fittings shall comply in all respects with the requirements of British Standard 4660:2000 and shall, where appropriate, bear the British Kitemark.

1.8.2 Pipes shall be supplied in plain ended lengths.

1.8.3 The minimum acceptable wall thickness of pipe and fittings shall be:-

Nominal Size	Pipe	Branch Junction Only		All Other Fittings	
		Socket	Body	Socket	Body
ins	mm	mm	mm	mm	mm
4	110	3.2	3.5	3.8	3.2	3.4
6	160	4.1	4.3	4.7	4.3	4.7

1.8.4 The method of jointing to be employed shall be lip-seal socketed fittings jointing to other materials shall be made in the manner specified by the manufacturer.

1.8.5 The grade of UPVC used for the pipe shall have a minimum softening point of 82^0C when tested by the Vicar method as described in British Standard 2782:2004, Method 102A.

1.8.6 The grade of UPVC used for the fittings shall have a minimum softening point of 79^0C when tested by the vicat method as described in British Standard 2782:2004, Method 102A.

1.8.7 The pipe and fittings shall be colour golden brown approximating to British Standard 381C:1971 No.414. The seal retaining caps shall be black polypropylene.

1.8.8. The rubber of lip seal joints shall be to the material requirement of British Standard 2494:1986.

1.8.9 Holderbats shall be made of mild steel protected from corrosion by galvanising or plastic coating. They shall have a two position fixing suitable for either acting as pipe support but allowing thermal movement or as clamp fit on a fitting creating a fixed point. For optimum fit to pipe supports PVC packing pieces may be used.

1.8.10 The base of soil and bent stack connection to the buried drain shall be made with a bend of minimum centre line radius of 250mm.

1.8.11 Minor changes of direction where permitted shall be made with a variable bend that has a constant effective length.

4.9 BURIED DRAIN SYSTEM - WORKMANSHIP

1.9.1 The installation, method of jointing and fixing shall comply in all respects to the manufacturer's sitework instructions.

1.9.2 Excavation of Trenches

Trenches shall be excavated to a sufficient depth to allow a 100mm minimum bed below the underside of the pipe. Trench width shall be not less than the outer diameter of the pipe plus 300mm and not wider than necessary.

1.9.3 Trench Invert

The base of the trench shall be such that even support is given to the pipe for its full length. Soft spots shall be removed and replaced with compacted or granular material. High spots and rock shall be removed to allow a full 100mm bed depth.

1.9.4 Pipe Bed

The bed shall be composed of granular material to the specification called for in clause 1.9.7 and shall cover the full trench width and length and be boned to gradient.

1.9.5 Laying and Jointing

Pipes and fittings shall be laid true to gradient in straight lines and jointed in accordance with manufacturer's instructions. All pegs used for alignment and other purposes must be removed after use and before side filling. All joints shall be watertight.

Pipes barrels shall be in continuous contact with the trench when laid.

1.9.6 Side Filling

The side filling of pipes shall be composed of hard granular material which shall be to the requirements of clause 1.9.7

Side filling must be placed equally on both sides of the pipes and compacted, so as to buttress the pipes against the trench walls. Side filling shall continue up to pipe crown level as a minimum and above this level if required by the Engineer.

1.9.7 Back Filling

The first 300mm of backfill above crown level shall be taken from selected trench spoil all passing 25mm sieve. It shall be placed in two 150mm layers each firmly, tamped. Above the 300mm level mechanical filling and compacting may be used.

Where cover is less than 450mm the pipe shall be covered with 75mm of selected material laid to support a concrete tile or slab indicating the presence of a service.

1.9.8 Granular Material for Bed and Sidefill

All material for bed and sidefill shall be hard and granular passing 20mm sieve and shall contain not more than 5 per cent fines passing 3mm sieve.

The material may be composed of crushed stone, clinker, quarry scalping, ballast, gravel, shingle or all-in aggregate to British Standard 882:1965.

The material shall have a compaction factor of 0.3 or less.

4.10 COLD WATER SYSTEMS:

5.10.0 UPVC Cold Water System

5.10.1 Pipe shall comply in all respects with the requirements of British Standard 3505:1986.

Fittings shall comply in all respects with the requirements of British Standard 4346 Part 1:1969.

5.10.2 Pipes shall be supplied in plain ended lengths.

5.10.3 The minimum acceptable wall thickness of pipe and fittings shall be:-

Nominal Size ins	Pipe and Fittings mm
3/8	1.5
1/2	1.7
3/4	1.9
1	2.2
1 1/4	2.7
1 1/2	3.1
2	3.9
3	5.7
4	7.3

1.10.4 The method of jointing to be employed shall be that of solvent welding using the manufacturer's approved cement, which shall comply with the requirements of British Standard 4346 Part 3. 1982.

5.10.5 The grade UPVC used for pipes shall have a minimum softening point of 75^0C and for the fittings a minimum softening point of 72^0C when tested by the Vicat method as described in British Standard 2782:2004, Method 102A.

5.10.6 The pipe and fittings shall be coloured dark grey.

5.11.0 Workmanship

1.11.1 The installation method of jointing and fixing shall comply in all respects to the manufacturer's site work instructions.

5.11.2 At 20^0C the maximum intervals between pipe supports shall be:-

Nominal Size ins	Horizontal m	Vertical m
3/8	0.75	Up to twice the permitted horizontal spacing of support centres shall be accepted provided the pipe is well protected within a structure.
1/2	0.84	
3/4	0.94	
1	1.07	
1 1/4	1.14	
1 1/2	1.28	
2	1.44	
3	1.72	
4	1.90	

5.11.3 Pipes passing through walls or floors shall be sleeved to allow unrestricted movement.

5.11.4 The work shall be inspected and tested during installation at agreed stages.

All work which will be concealed shall be tested before it is finally enclosed.

A final test shall be made upon completion for soundness and performance to the satisfaction of the Local Water Authority.

PART E

5 PART E - PARTICULAR SPECIFICATION FOR THE FIRE FIGHTING SERVICES

5.1 PARTICULAR SPECIFICATION FOR THE FIRE FIGHTING SERVICES

5.1.1 General

The particular specification details the requirements for the supply, installation and commissioning of the hosereel installation. The hosereel installation shall comply in all respects to the requirements set out in European Standards BS EN694 for hosereels and tested, approved and CE marked according to En671 – 1 or other International Standards. The system shall comprise of a pumped system for hosereels on all floors.

The Contractor shall include for all appurtenances and appliances not necessarily called for in this specification or shown on the contract drawings but which are necessary for the completion and satisfactory functioning of the works.

No claims for extra payment shall be accepted from the Contractor because of his non-compliance with the above requirements.

If in the opinion of the Contractor there is a difference between the requirements of the specification and the contract drawings, he shall clarify these differences with the Engineer before tendering.

5.1.2 Scope of Works

The Contractor shall supply/deliver, erect, test and commission all the automatic fire fighting hosereel installation which is called for in this Specification and shown on the Contract Drawings listed in the Drawing Schedule.

5.1.3 Pipework

The pipework for the hosereel installation shall be galvanised wrought steel tubing `Medium' Grade Class `B' to B.S. EN 10255:2004 malleable iron fittings to B.S. 21.

5.1.4 Pipe Fittings

The pipe fittings shall be wrought steel pipe fittings welded or seamless fittings conforming to B.S. EN 10241:2000 or malleable iron fittings to B.S. 143 and 1256:2000.

All changes in direction will be with standard bends or long radius fittings. No elbows permitted.

5.1.5 Flanges

The flanges shall comply with en 1092 – 1:2002. All flanges shall comply to a nominal pressure rating of 16 bar (PN 16) and shall be of either galvanised iron or steel.

5.1.6 Gaskets

The gaskets for use with flanges to en1092-1:2002 shall comply with en 1514-2:1997 for pressure up to and not exceeding 64 bar.

5.1.7 Non-Return Valves

The non-return valves up to and including 80mm diameter shall be to EN 12334:2001 with flanges to B.S. EN 1092-1:2002 (PN 16).

The valves shall be of galvanised iron construction with gunmetal seat and bronze hinge pin.

5.1.8 Gate Valves

The gate valves up to and including 80mm diameter shall be non-rising stem and wedge disc to (B.S. 5154: 1991) with screwed threads to B.S. 21 taper thread or flanged to B.S. EN 1092:-1:2002

5.1.9 Sleeves

Where pipework passes through walls, floors or ceilings, a sleeve shall be provided one diameter larger than the diameter of the pipe, the space between to be packed with mineral wool, to the Engineer's approval.

5.1.10 Floor and Ceiling Plates

Where pipes passes through walls, floors or ceilings, floor, wall and ceiling plates shall be secured around the pipe. The plates shall be of stainless steel construction and will serve no other purpose than to present a neat finish, to the exposed installation.

5.1.11 Hosereel

The hosereels to the installation shall consist of recessed automatic hosereels.

All the above hosereels shall comply with European Standards BS EN694, tested, approved and CE marked to EN671 – 1 or other International Standards.

The hosereels shall be supplied and installed complete with first-aid non-kinking hose 30 metres long, with nylon spray/jet/shut-off nozzle inlet to the reel are to be supplied.

The orifice to the nozzle shall not be less than 4.8mm to maintain a minimum flow of 0.4 L/S to the jet.

The hosereels shall be installed at 1.5mm centre above the finished floor level in locations shown on Contract Drawings.

5.1.12 Earthing

Earthing installation shall be electrically earthed by a direct earth connection. The installation of the earthing to be carried out by the Electrical Contractor.

5.1.13 Hosereel Pump Set

The Hosereel pump set shall incorporate a pressure monitoring device having two independently adjustable contacts arranged to close on falling pressure. Contact No.1 is set to close on fall in pressure due to opening of Hosereel valve or similar. Operation of this switch initiates the full automatic sequence set, including remote alarm and indication.

5.1.14 BasePlate

Fabricated steel with support for control panel and pipework, together with four lifting eye bolts for ease of installation.

5.1.15 Valves/Pipework

Each set consists of identical pumps with isolating valves on each pump suction and isolating and non-return valves on each pump discharge. The delivery line from the pump is fitted with a pressure switch, test cock/vent, delivery pressure gauge, and a further isolating valve for routine testing.

Suction and discharge manifolds terminate in flanges drilled to BS4504 PN16. The pipework is fabricated steel.

5.1.16 Membrane Pressure Vessel

A membrane pressure vessel has been integrated into the system to provide a positive charge, thus preventing pump operation as a result of any minor system leakage.

Control Panel

As described.

Electrics

The set, being pre-wired eliminates the need for wiring on site, except for the connection of an electrical power source (3 phase, 3 wire supply) to the control panel.

Testing

The complete unit to be manufactured, tested and delivered as a packaged unit, finished in hard gloss red paint.

5.1.17 Finish Painting

Upon completion of testing and commissioning of the hosereel installation the pipework shall be primed and finish painted with 2 No. coats of paint to the Architect's requirements.

5.1.18 Testing and Commissioning

The hosereel installation is to be flushed out before testing to ensure that no builder's debris has entered the system. The installation is to be then tested to one and a half times the working pressure of the installation to the approval of the Engineer. Simulated fault condition of the pumping equipment, is to be carried out before acceptance of the system by the Engineer and Architect.

5.1.19 Instruction Period

The Contractor shall allow in his contract sum for instructing of the use of the equipment to the Client's maintenance staff. The period of instructions may be within the contract period but may also be required after the contract period has expired.

The period of time required shall be stipulated by the Client but will not exceed seven days in which time the Client's staff shall be instructed in the operation and maintenance of the equipment.

5.2 PARTICULAR SPECIFICATION FOR PORTABLE FIRE EXTINGUISHERS

5.2.1 General

The particular specification details the requirements for the supply and installation and commissioning of the Portable Fire Extinguishers which shall conform to European Standards BS EN 3 or other International Standards. The Contractor shall include for all appurtenances and appliances not necessarily called for in this specification or shown on the Contract Drawings but which are necessary for the completion and satisfactory functioning of the works.

If in the opinion of the Contractor there is a difference between the requirements of the specification and the Contract Drawings, he shall clarify these differences with the Engineer before tendering.

5.2.2 Water/Co_2 Extinguishers

The portable 9-litre water filled CO_2 cartridge operated portable fire extinguishers shall comply with the requirements of B.S. EN3 or other International Standards. Unless manufactured with stainless steel, bodies shall have all internal surfaces completely coated with either a lead tin, lead alloy or zinc applied by hot dipping. There shall be no visibly uncoated areas.

The extinguishers shall be clearly marked with the following:-

a) Method of operation

b) The works "WATER TYPE" (GAS PRESSURE) in prominent letters

c) Name and address of the manufacturer or responsible vendor

d) The nominal charge of the liquid in letters

e) The liquid level to which the extinguisher is to be charged

f) The year of manufacture

g) A declaration to the effect that the extinguisher has been tested to a pressure of 24.1 bars.

h) Instructions for periodical checking and panel for signing when checked, dates and initials.

5.2.3 Portable Carbon Dioxide Fire Extinguishers

The portable carbon dioxide fire extinguishers shall comply with B.S. EN3 or other International Standards.

The body of the extinguishers shall be a seamless steel cylinder manufactured to one of the following Standards, B.S. 401, B.S. 1288 or other International Standards.

The filling ratio shall comply with B.S. 5355 with valves fittings for compressed gas cylinders to B.S. 341. Where a hose is fitted it shall be flexible and have a minimum working pressure of 206.85 bar, the hose is not to be under internal pressure until the extinguisher is operated.

The nozzle shall be manufactured of brass gunmetal, aluminium or stainless steel and may be fitted with a suitable valve for temporarily stopping the discharge if such means are not incorporated in the operating head.

The discharge born shall be so as to direct the discharge and limit the entrainment of air. It shall be construed of electrically non-conductive material.

The following and markings shall be applied to the extinguishers:

a) The words 6 Kg. carbon dioxide fire extinguishers and to include the appropriate nominal gas content.

b) Method of operation.

c) The words "Re-charge immediately after use".

d) Instructions for periodical checking and panel with space for date and initials.

e) The number of the Standard B.S. EN 3 or other International Standards.

f) The manufacturer's name or identification markings.

5.2.4 Dry Powder Portable Fire Extinguishers

The portable dry powder fire extinguishers shall comply with B.S. EN 3 or other International Standards. The body shall be constructed of steel not less than the requirements of B.S. 1449 or aluminium to B.S. 1470: and shall be suitably protected against corrosion.

The dry powder charge shall be non-toxic and retain its free flowing properties under the normal storage conditions. Any pressurizing agent used as an expellant shall be in dry state; in particular compressed air.

The discharge tube and gas tube if either is fitted shall be made of steel, brass, copper or other not less suitable material. Where a hose is provided it shall not exceed 1,060mm and shall be acid and alkali resistant. Provision shall be made for securing the nozzle when not in use.

The extinguisher shall be clearly marked with the following information;

a) The words "Dry Powder Fire Extinguisher".

b) Method of operation in prominent letters.

c) The working pressure and the weight of the powder charge in kilogrammes.

d) Manufacturer's name or identification mark.

e) The words "RECHARGE AFTER USE" if rechargeable type.

f) Instructions to regularly check the weight of the pressure container (gas cartridge) or inspect the pressure indicator on stored pressure types when fitted, and remedy any loss indicated by either and to have panel for dates and initials.

g) The year of manufacture.

h) The pressure to which the extinguisher was tested.

i) The number of this British Standard to B.S. EN3 or other International Standards.

j) When appropriate complete instructions for charging the extinguisher shall be clearly marked on the extinguisher or otherwise be supplied with the refill.

5.2.5 Foam Fire Extinguisher

The portable foam extinguisher shall comply with the requirements of B.S. EN3 or other International Standards. The body shall be constructed from 16 s.w.g. steel to B.S. 1449, polythene lined to give protection against internal corrosion while the neck ring shall be in steel to B.S. 980 and welded internally to the body.

The gas cartridge shall be a standard fitting 75 capacity $C0_2$ gas cartridge, plastic coated and also complying with B.S. 5423. The discharge hose shall be made from polyester reinforced flexible P.V.C. and nozzle in moulded A.B.S. Provision shall be made for securing the nozzle when not in use.

The extinguisher shall be clearly marked with the following information:-

a) The words “FOAM FIRE EXTINGUISHER”.

b) Method of operation in prominent letters.

c) The working pressure and the quantity of charge in litres.

d) Manufacturer’s name or identification.

e) The words “RECHARGE AFTER USE” if rechargeable type.

f) Instructions for periodical checking and panel for dates and initials.

g) The number of this British Standard B.S. EN3 or other International Standards.

5.2.6 Fire Blanket

The fire blanket shall be made from 3-ply composite material consisting of two layers of glass fibre fabric sandwiching an inner layer of fire retardant film to measure 2000 x 2000mm and shall be fitted with special tapes folded so as to offer instantaneous single action release blanket from storing jacket.

10.2.6.A Painting & Finishing

The contractor shall paint or cause to be painted all the service pipework in the respective colour coding as specified to B.S. 1710 and elsewhere in this specifications.

PART F

GENERAL TECHNICAL SPECIFICATION - COMMISSIONING

6 PART F - GENERAL TECHNICAL SPECIFICATION - COMMISSIONING

6.1 General

Before any commissioning work takes place, the Contractor shall submit a set of schematic commissioning drawings showing duct runs, and other equipment, air flows, water flows and controls. These drawings to be accompanied by the method proposed for commissioning of the plant, as by the method proposed for commissioning of the plant, as well as the number of people involved, their names and experience. The Engineer's approval on the above item is essential before any commissioning takes place.

6.2 Maintenance Manuals

The Contractor shall provide, before any commissioning works starts, three copies of the maintenance and operating manuals for the plant supplied. These manuals shall be sewn and bound in book form with hard plastic covers to withstand constant use, and shall be properly indexed to facilitate quick references. Prior to the submission of the three copies mentioned above the Contractor shall submit one draft copy of the maintenance and operating manuals for approval. The works shall not be considered to be completed for the purposes of taking over until such manuals have been supplied to the Engineer, and subsequent equipment test results have been included in them.

The manuals shall include:-

a) A list of recommended servicing tools and specialist plant.
b) A list of recommended spares necessary for a period of 2 years operation.
c) Exploded drawings or spares lists from which every item of every place of plant can be positively identified of each item of plant.
d) A list of giving the name and address of the manufacturer of each item of plant.
f) A copy of all test certificates obtained with the plant.
g) A list of recommended lubricants.
h) A preventive maintenance programme for all plant.
i) Operating instructions for each item of plant.
j) Performance data, equipment tests and characteristic curves.

6.3 Initial Testing and Plant Commissioning

7.3.1 Initial Testing

a) Pressure Testing - Piping

All pipework system shall be pressure tested by filling with water and raising the pressure to 1.5 times working pressure.

They shall then be left for a period of at least one hour during which all joints must remain water-tight. Any fault found during the pressure test shall be remedied and the test reapplied until the same is dealt with completely.

The pipework shall be tested in sections to suit the construction programme and all services in concealed locations shall be tested before they are finally concealed. No insulation shall be applied before tests have been carried out.

The Contractor shall provide all test equipment and all additional items such as toes, valves, drain fittings, etc, which are necessary to enable the systems to be treated in sections. Each test shall be witnessed by the Engineer or his nominated agent and also a signed certificate of approval shall be obtained.

b) Drawing and Cleaning

On completion of the pressure test on a section of pipework the water used for testing shall be drained away as quickly as possible to remove as much dirt and dross as possible. After completion for a pipework circuit the circuit shall be flushed through to remove all pipe scale, dress and similar material.

c) Pressure Testing - Ducting

See section on ducting

d) Insulation Tests

All electrical wiring and controls integral with the plant supplied shall be subjected to insulation tests. All instrument and other equipment required for the tests shall be provided by the Contractor.

e) Drives

All drives shall be run and tested for direction rotation and correspondence of alignment.

7.3.2 **Plant**

The Contractor shall check over and test and satisfy himself that all items of plant are correctly assembled and aligned before start-up. This work is to be carried out by skilled commissioning Engineers who are completely familiar with the plant involved.

The Engineer shall witness plant commissioning as required by him and the contractor must advise the Engineer prior to any commissioning work taking place.

On completion of the plant commissioning the Contractor shall provide written confirmation to the Engineer that he has completed all commissioning work to the Engineer that he has completed all commissioning work and is satisfied that the time items of plant are operating satisfactorily.

7.3.3 **Test of Completion**

On completion of the Contractor's initial testing and commissioning as specified above, the plant shall be put into normal operation and the final adjustment of the plant shall be made. Thereafter the Tests on completion shall be carried out to ensure that the plant will fulfil the function for which it has been designed. These tents shall extent for a period of at least four weeks and shall include the following:

a) Simulated tests for all alarm and safely cut out equipment.
b) Simulated tests on automatic controls.
c) Capacity tests to ensure that the plant supplied will handle the quantities specified.

The Contractor shall utilise the Engineer's manual Equipment performance and capacity.

The Contractor shall at his own cost render all assistance and supply all labour, appliances and any other materials, as may be required to carry out these tests. All instruments shall be accurately calibrated before the tests begin.

On completion of the whole of the tests and when the Contractor is satisfied that the entire plant is operating satisfactorily and will fulfil the function for which it has been designed, he shall submit to the engineer triplicate copies of all tests records and charts together with reports on all the tests called for in this specification. The Engineer shall reserve the right to ask for previous tests in order to prove that the operation of the plant is satisfactory and in accordance with the specification and drawings,

The Contractor shall be responsible for the proper operation and running maintenance of the plant throughout the period of the tests. The Contractor shall provide full time experienced commissioning Engineers and artisan staff during the entire testing period.

At the commencement of and during the whole of the testing period the Contractor shall be required to have stored on site all essential spares and tools considered necessary to enable repair work of defective parts to be carried out immediately in the event of a breakdown.

The operation and Maintenance manual shall be completed and handed over to the Engineer before the start of any commissioning work and in any case, prior to the issuing by the engineer of the taking-over certificates. The period of maintenance shall be deemed to have started upon the date of issuing of the taking-over certificate.

6.4 **Operator Training Period**

The Operator Training Period on the whole of the works or on any part thereof shall commence at the date to be fixed after the issue of the taking over certificate and mutually agreed with the Engineer.

This period shall continue for a period sufficient to ensure that the operations are full conversant with the functions they are to perform, but shall not exceed a period of 5 days.

The Contractor shall provide full-time instructions during the entire operator training period, who shall be fully experienced in the class of work and shall be capable of training the operating and maintenance staff in the duties they are to perform.

6.5 Period of Maintenance (Defect Liability)

The expression period of maintenance shall mean a period of 12 months from the date of taking over in accordance with Clause 3.3. Hereof.

7 BILLS OF QUANTITIES

7.1 GENERAL NOTES TO TENDERERS

1. The Bills of Quantities form part of the contract documents and are to be read in conjunction with the contract drawings and general specifications of materials and works.

2. The prices quoted shall be deemed to include for all obligations under the sub-contract including but not limited to supply of materials, labour, delivery to site, storage on site, installation, testing, commissioning (**excluding 16% VAT**).

3. All prices omitted from any item, section or part of the Bills of Quantities shall be deemed to have been included to another item, section or part thereof.

4. The brief description of the items given in the Bills of Quantities are for the purpose of establishing a standard to which the sub-contractor shall adhere. Otherwise alternative brands of **equal** and **approved** quality will be accepted.

5. Should the sub-contractor install any material not specified here in before receiving **written approva**l from the Project Manager, the sub-contractor shall remove the material in question and, **at his own cost**, install the proper material.

6. The grand total of prices in the price summary page must be carried forward to the **volume 1**.

7. The Bills of Quantities are divided generally into three sections: -

a. Contractual Requirement – Bill 1

The sub-contractor shall study the conditions and make provision to cover their cost in this Bill. The number of contractual items to be priced by the Tenderer have been limited to tangible items such as site office, temporary works and others. However, the Tenderer is free to include and price any other items he deems necessary taking into consideration conditions he is likely to encounter on site.

b. Installation Items – Other Bills

The brief description of the items in these Bills of Quantities should in no way modify or supersede the detailed descriptions in the contract Drawings, conditions of contract in volume 1 and specifications. The unit of measurements and observations are as per those described in the contract documents.

c. (c) Summary

The summary contains tabulation of the separate parts of the Bills of Quantities carried forward with provisional sum, and any prime cost sums included. The sub-contract shall insert his totals and enter his grand total tender sum in the space provided below the summary.

This grand total tender sum shall be carried forward to main summary of volume 1 of the main works.

PROPOSED LABOR WARD AT THE NAIROBI HOSPITAL

PLUMBING, DRAINAGE & SANITARY FITTINGS

BILLS OF QUANTITIES

SECTION D.W. (I) TITLE: PRELIMINARIES & CONTRACTUAL REQUIREMENTS

Item	Description	Unit	Qty	Rate	KShs.
	PRELIMINARIES & CONTRACTUAL REQUIREMENTS				
A.	Preparation of working drawings, printing and distribution.	Sum			-
					-
B.	Preparation of 'As Installed Drawings", printing and distribution as specified. Drawings to include:				-
	(a) Blue Prints - 4 sets of each.	Sum			-
	(b) AutoCAD on Flash Drive (5 GB) – 2 No.	Sum			-
	(c) Operational Instructions, manuals and test certificates	Sum			-
					-
C	Allow for any other preliminary stated in the conditions of contract	Sum			-
D	Any other item necessary to complete the installations in this section (please state)	Sum		-	``
	Carried to Main Summary Page				-

SECTION D.W. 2: INTERNAL WATER SUPPLY

Item	Description	Unit	Qty	Rate	Cost KShs.
	INTERNAL WATER SUPPLY				
2.1	**INTERNAL COLD WATER SUPPLY -**				
	To supply and install PPR tubing and fittings as described and shown on the drawings.				
	Tenderers must allow for jointings, clippings, couplings ,reducers etc. necessary for the proper and satisfactory functioning of the installation when pricing.				
	The following in PPR or approved equivalent.				
A	50mm dia tubing.	LM	0		-
B	40mm dia tubing.	LM	0		-
C	32mm dia ditto	LM	72		-
D	25mm tubing	LM	36		-
E	20mm dia ditto	LM	36		-
	Extra over tubing for:-				-
F	50 mm dia bend with male/female threads	No.	0		-
G	40 mm dia bend with male/female threads	No.	0		-
H	32mm dia ditto	No.	6		-
I	25mm dia ditto	No.	8		-
J	20mm dia ditto	No.	8		-
K	50 mm dia tee	No.	0		-
L	40 mm dia tee	No.	0		-
M	32mm dia ditto	No.	6		-
N	25mm dia ditto	No.	12		-
O	20mm dia ditto	No.	12		-
	Brass work				-
P	50mm dia non-rising stem solid wedge gate valve as peglars or equal and approved with connections to PPR tubing .	No	0		-
Q	32 mm dia ditto	No	2		-
R	25 mm dia ditto	No	10		-
Carried to sub-collection page					-

SECTION D.W. 2: INTERNAL WATER SUPPLY

Item	Description	Unit	Qty	Rate	Cost KShs.
2.2	**INTERNAL HOT WATER SUPPLY -** **To supply and install CPVC tubing and fittings as described and shown on the drawings.** **ers must allow for jointings, clippings, couplings ,reducers etc. necessary for the proper and satisfactory functioning of the installation when pricing.** **All pipe runs to be insulated using closed cell Polyethylene pipe insulation with aluminium foil cover as Jumbolag or an approved equivalent.** **The following in CPVC specificically suitable for Hot water upto 95 C to engineer's approval.**				
A	50mm dia tubing.	LM	0		-
B	40mm dia tubing.	LM	0		-
C	32mm dia ditto	LM	72		-
D	25mm tubing	LM	106		-
E	20mm dia ditto	LM	48		-
	Extra over tubing for:-				-
F	50 mm dia bend with male/female threads	No.	0		-
G	40 mm dia bend with male/female threads	No.	0		-
H	32mm dia ditto	No.	12		-
I	25mm dia ditto	No.	16		-
J	20mm dia ditto	No.	16		-
K	50 mm dia tee	No.	0		-
L	40 mm dia tee	No.	0		-
M	32mm dia ditto	No.	6		-
N	25mm dia ditto	No.	24		-
O	20mm dia ditto	No.	24		-
	Brass work				-
P	50mm dia non-rising stem solid wedge gate valve as peglars or equal and approved with connections to PPR tubing .	No	0		-
Q	32 mm dia ditto	No	2		-
R	25 mm dia ditto	No	9		-
Carried to sub-collection page					-

SECTION D.W. 2: INTERNAL WATER SUPPLY

Item	Description	Unit	Qty	Rate	Cost KShs.
	SUB-COLLECTION PAGE				
2.1	Internal Cold Water Supply				-
2.2	Internal hot water supply				-
	SUB-TOTAL				-
	Carried to Main Collection Page				-

SECTION: D.W. 3 SANITARY FITTINGS

Item	Description	Unit	Qty	Rate	Cost KShs.
3.1	**SANITARY FITTINGS - (page 1)**				
	Supply, assemble and install the following sanitary fittings including all the necessary joints to service, overflow, waste pipes and jointing materials, mortices, plugs, screws, bolts, nuts, gaskets etc and making good as described and shown on the drawings:-				
	Water Closet				
A	"Duravit-D-Code" WC consisting of Wall Hung WC Pan 54 cm complete with Soft Close Toilet Seat and Cover Ref:#253509, #006739, and all neccesary accessories for proper functioning of the installation.	No.	7		-
B	Geberit delta Concealed cistern complete with mounting accessories. Cistern to be of dual flush 6/4 litres with actuation push buttons to manufacturers details/ Architects approval.	No.	7		-
C	"Duravit Karree" wall toilet roll holder with cover. Item No. 0099551000	No.	7		-
D	Coat hook in Satin aluminium finish (Ref No. SAF 4166) as manufactured by Insta-office safco.	No.	7		-
E	Wall mounted toilet brush holder and brush of approved colour as Ideal Standard or approved equivalent	No.	7		-
F	Chrome plated Arabic shower fixed next to the water closet complete with chrome plated wall bracket as Cobra, scholsser angle valve or equal and approved.	No.	7		-
J	Mediclinic Hidgedown support Bar with internal toilet roller holder in white **Ref:BG0800**	No.	7		-
K	Mediclinic Straight Grab Rail **Ref:BR0600**	No.	21		-
	Wash Hand Basin & Accessories				-
G	Vanity top wash basin as Duravit – D-Code germshield antibacteria in white ref # 033754 with centre tap hole, size 545 x 435mm complete with all accessories	No.	12		-
H	Semi Pedestal wash basin as Duravit – D-Code germshield antibacteria in white ref # 231055 with centre tap hole, size 545 x 435mm complete with semi pedestal ref # 085717 and all neccesary accessories	No.	3		-
I	Hangrohe - Focus : Electronic Basin Mixer Tap with 230 V Main connection (Ref: #31174000) complete with all accessories to engineer's approval.	No.	15		-
J	Chrome plated 1¼" basin waste complete with flange, shank, chain & plug.	No.	15		-
K	Chrome plated 1¼" bottle trap with 75 mm deep seal and 200 mm long tail pipe, cap-nut and wall flange complete with cap-nut, wall flange, plug, chain and angle regulating valves.	No.	15		-
sub-total carried to sub-collection					-

SECTION: D.W. 3: SANITARY FITTINGS

Item	Description	Unit	Qty	Rate	Cost KShs.
3.2	**SANITARY FITTINGS - (Page 2)**				
	Paper Towel Dispenser				-
A	"Mediclinic PR0783" paper towel dispenser capacity 600 tissues stainless steel satin finish complete with fixing screws. (Code No. PR0783).	No.	15		-
B	White epoxy steel 12 litres capacity Electronic pedal operated receptacle and bins as mediclinics Ref No. PP1312, or equal and approved equivalent	No.	15		-
	Soap Dispenser				-
C	Mediclinics DJ0030 in White epoxy finish, with Mediclinics lock system, refill window, Anti-dripping and anti-corrosion valve, Capacity: 1.1 litre glued/screwed to wall liquid soap dispenser complete with initial charge, key and mounting brackets.	No.	15		-
	Hand Drier				-
D	"Mediclinic M96" Push Button Hand drier with 4 mm thick white melamine one-piece cover, complete with fixing accessories, power connection (in concealed conduit) to a local electrical isolator.	No.	2		-
					-
	Shower				-
B	Shower Set as "Hangrohe Radiance " Complete with 4-way diviter, handshower on rail, and all neccesary accessories for proper functioning of the installation. Overhead shower to be square as "Hangrohe Radiance E 300 1jet EcoSmart 9 l/min"or equal and approved.	no.	6		-
C	Fold-down shower seat for persons with disabilities as Mediclinics or approved equivalent	no.	6		-
D	Stainless steel soap basket with chrome finish as Tapis to engineers approval	no.	6		-
E	20mm dia x 600mm long single towel rail complete with end brackets with concealed screws as Mediclinics	no.	6		-
F	Stainless steel ring type tumbler holder as Mediclinics	no.	6		-
Carried to sub-collection					-

SECTION: D.W. 3: SANITARY FITTINGS

Item	Description	Unit	Qty	Rate	Cost KShs.
3.3	**SANITARY FITTINGS - Page 3**				
	Angle valves				-
A	Schlosser Germany: Angle Valve : 1/2x3/8in: CP #1710	no.	30		-
	Mirrors				-
B	3mm Mirror from plain bevelled glass plates size 800X600 wide with dome headed C.P screws and approved back paddling	No.	15		-
C	Ditto but 800x2000mm	No.	0		-
D	Ditto but 800x1800mm	No.	0		-
	Hand Sanitizer				
E	Anti-bacterial hand sanitizer dispenser. Dispenser to be battery-operated with with LED lights for low battery and low product indication. Dispenser to be as Mediclinics or approved equivalent.	No.	2		-
	Sluice Sink				
A	Stainless Steel combined disposal hopper with flush-hopper, concealed cistern, flush valve, and with single bowl s/s sink for rinsing, with drainer. Sink to be fitted with hot and cold water elbow action mixer tap as "Talis" or "Hansgrohe". Hopper to be complete with all piping, fittings and acessories and to be as Twyford PS8106SS.	No.	1		-
F	Wide Groove Stainless steel single bowl signle drainer kitchen sink as manufactured by Franke a, finished in bright machine polish and to incorporate sound deadening pads. Size 1200 x 500mm wide. The sink top shall be pierced for tap hole(s) and for a 40mm waste hole, outlet and overflow.Fittings to include for chrome plated chain waste 40mm dia. with overflow slots and 1 No. stainless steel bottle trap 40mm dia. with S trap outlet.	No	0		-
H	Swivel Kneck Kitchenette Sink as Grohe or approved equivalent. Tap to be chrome plated. Kitchen tap to architects approval	No.	0		-
I	Allow for careful removal of all existing sanitary fittings and handover to the client. Rate to include cart away of materials that will not required.	item	1		-
	Carried to sub-collection page				-

SECTION: D.W.3: SANITARY FITTINGS

Item	Description	Unit	Qty	Rate	Cost KShs.
	SUB-COLLECTION PAGE				
3.1	Sanitary fittings - page 1				-
3.2	Sanitary fittings - page 2				-
3.3	Sanitary fittings - page 3				-
	SUB-TOTAL				-
	Carried to Main Collection Page				-

SECTION D.W. 4: SOIL & WASTE DRAINAGE

Item	Description	Unit	Qty	Rate	Cost Kshs.
4.1	**SOIL AND WASTE DRAINAGE - PIPEWORK** **Supply and install the following drainage UPVC and PVC pipe system as described and shown on the drawings** **All pipes and fittings in this installation shall upvc and pvc to BS 5572:1978 and B.S.5750 as manufactured by "Key Terrain" or equal and approved. All jointings and fixings shall be in accordance with the manufacturers instructions and as described.** **Tenderers must allow for jointings, clippings, couplings, holders bats, plugging, reducers, spacers etc. necessary for the proper functioning of the installation when pricing**				
A	150 mm dia Grey pipe	LM	0		-
B	100 mm dia Brown pipe	LM	100		-
C	100 mm dia Grey pipe	LM	120		-
D	50 mm dia pipe	LM	60		-
E	40 mm dia pipe	LM	60		-
					-
	Extra over pipe for:-				-
F	150mm dia sweep bend	No.	0		-
G	100mm dia sweep bend	No.	32		-
H	50mm dia 45^{o} sweep bend	No.	12		-
I	50mm dia 91^{o} sweep bend	No.	12		-
J	40mm dia ditto	No.	6		-
K	100mm dia access sweep bend	No.	16		-
L	100mm dia long radius bend	No.	16		-
M	40mm rodding eye	No.	8		-
N	100mm dia ditto	No.	8		-
O	50mm dia ditto	No.	4		-
P	100mm dia WC connector	No.	7		-
Q	110mm dia. weathering slate	No.	0		-
R	100 mm diameter Light Grey Weathering Apron	No.	0		-
S	100mm dia vent cowl	No.	4		-
T	Floor traps complete with stainless steel floor trap covers (AISI 316) to engineers approval.	No.	14		-
					-
U	Allow for connection to existing drainage line	item	1		-
Carried to sub-collection					0.00

SECTION D.W.4.0: SOIL & WASTE DRAINAGE

Item	Description	Unit	Qty	Rate	Cost KShs.
	SOIL AND WASTE DRAINAGE				
A	Excavate trench in murram ground from ground depth not exceeding 2000 mm average 1200 mm including bedding pipe in bed class "B" for 100 mm dia pipe	LM	100		-
B	Allow for keeping the works free from water and mud by bailing, pumping or any other method	Item	1		-
C	Allow for connecting to the existing inspection chambers	Item	1		-
D	Allow for materials for the construction of a standard inspection chamber including excavation and make good depth not exceeding 900mm average 600mm. Chamber walls in 150mm block work with water proof cement render and formed channels bend.	No.	12		-
E	Medium duty cast iron inspection chamber cover with frame size: 600 x 450mm including bedding the frame in concrete and bitumen sand air seal.	No.	12		-
F	Ditto but heavy duty cover.	No.	0		-
G	Allow for materials for the construction of a standard inspection gulley trap complete with gulley trap covers to engineers approval	No.	12		-
	Carried to sub-collection				0.00

SECTION D.W. 4: SOIL & WASTE DRAINAGE

Item	Description	Unit	Qty	Rate	Cost KShs.
	SUB-COLLECTION PAGE				
4.1	Soil & Waste Drainage - Pipework				-
4.2	Soil & Waste Drainage - Cont				-
	SUB-TOTAL				-
	Carried to Main Collection Page				-

SECTION D.W. 5 : FIREFIGHTING SERVICES

Item	Description	Unit	Qty	Rate	Cost KShs.
	FIRE FIGHTING SERVICES				
5.1	**PORTABLE FIRE EXTINGUISHERS**				
A	9Kg dry powder multi-purpose fire Class A, B and C as manufactured by Angus Fire Armour ABC multipurpose model AP9K or equal and approved. complete with:- - charge and fixing bracket - pictorial instructions - colour coding to BS 7863 - discharge horn and hose. - pressure indicator	No.	1		-
B	5 kg Carbon Dioxide Steel Stored pressure gas fire extinguishers conforming to BS EN 5423 complete with:- - charge and fixing bracket - pictorial instructions - colour coding to BS 7863 - discharge horn and hose. - pressure indicator	No.	1		- -
C	1210 x 1210mm Fire Blankets in woven fibre-glass material to be installed in Kitchen	No.	0		-
	Carried to sub-collection page				-

SECTION D.W. 5 : FIREFIGHTING SERVICES

Item	Description	Unit	Qty	Rate	KShs.
	SUB-COLLECTION PAGE				
5.1	Portable extinguishers				-
	SUB-TOTAL				-
	Carried to Main Collection Page				-

MAIN COLLECTION PAGE

Item	Description				Price (KShs.)
	PROPOSED LABOUR WARD IMPROVEMENTS				
	PLUMBING, DRAINAGE & FIREFIGHTING				
	MAIN COLLECTION PAGE				
I	Preliminaries				-
2	Internal Water Supply				-
3	Sanitary fittings				-
4	Soil & Waste Drainage				-
5	Firefighting Services				-
PC 1	**Allow a PC sum of Ksh. 1.5 million for Medical grade Birthing tub.**				**1,500,000.00**
	Sub-Total (Inclusive of VAT)				
	TOTAL FOR P,D,FF CARRIED TO MAIN SUMMARY PAGE				**-**

8 TECHNICAL SCHEDULE AND APPENDICES

8.1 TECHNICAL SCHEDULE

The tenderer must complete in full the technical schedule. Apart from the information required in the technical schedule, the tenderer **MUST SUBMIT** comprehensive manufacturer's technical brochures and performance details for all items listed in this schedule (fill forms attached).

ITEM No.	Description	Manufacturer	Country of origin	Remarks (Catalogue No. etc.)
A	Plumbing Pipework			
B	Drainage Pipework			
C	Sanitary fittings			

8.2 DOCUMENTATION REQUIREMENTS

Document	With Bid	Before Manufacture	During FAT	Upon Delivery
Preliminary general arrangement drawing (with dimensions)	YES			
QA / QC Plan in accordance with ISO 9001:2008		YES		
General arrangement drawing (with dimensions)		YES		
Schematics/Line diagrams for construction	N/A	YES	N/A	N/A
Recommended Spares List	N/A	N/A	N/A	YES
Routine Test Reports / Certificates			YES	
Type Test Reports / Certificates	N/A	N/A	YES	N/A
Commissioning Procedure	N/A	N/A	N/A	YES
As-built General arrangement drawing			YES	
As-built Schematics			YES	
Site Test Reports / Certificates				YES
Special Test Reports / Certificates	N/A	N/A	YES	NO

APPENDICES

9.1 Appendix I: Tender Evaluation Criteria

TENDER EVALUATION CRITERIA

TECHNICAL & FINANCIAL EVALUATION

SEC	REQUIREMENT SUMMARY	CRITERIA	TARGET SCORE	BIDDER'S SCORE
1	**TECHNICAL EVALUATION**			
a	Performance	Maximum of 10 as evaluated by Eng.	**10**	
b	Warranty	Maximum of 10 as per below schedule 1 year and below ---> Score of 2 1-3 years ---> Score of 6 3-10 years ---> Score of 10	**10**	
c	Product Life	Maximum of 10 as per below schedule 5-10 years ---> Score of 2 10-15 years ---> Score of 5 15 years and above ---> Score of 10	**10**	
d	Spare parts/Consumables and their availability. Local Back-up (maintenance)		**5**	
e	Technical data provided (brochures, technical specs, manuals, drawings etc)		**10**	
g	Understanding of the tender document		**5**	
3	**COSTS**			
a				
a	Price of the bid relative to the other bidders	Maximum of 25 as per below schedule Outside of 20% Range of Engineer's Estimate/Market Rate ---> Score of 0 Lowest ---> Score of 25 Second Lowest ---> Score of 20 Third Lowest ---> Score of 15 Fourth Lowest ---> Score of 10 Fifth Lowest ---> Score of 5	**25**	
b	Unit Rate Schedule (Appendix V below)	Maximum of 25 as per below schedule Lowest ---> Score of 25 Second Lowest ---> Score of 20 Third Lowest ---> Score of 15 Fourth Lowest ---> Score of 10 Fifth Lowest ---> Score of 5	**25**	
TOTAL SCORE			**100**	

The evaluation criteria provide that the bidder who scores **highest** points is technically responsive therefore, qualifies for recommendation of award of the contract unless otherwise stated.

9.2 Appendix II; Statement of Compliance

Technical Schedules shall be submitted by tenderers to facilitate and enable the Engineer to evaluate tenders but only when the fittings and accessories upon which the tenderer has based his tender sum differs in manufacture, type or performance from the description contained within this specification.

Tenderers shall submit separate leaflets and catalogues giving technical and physical details for all fittings and accessories described in the Technical Schedule at the time of tendering.

Completion of Technical Schedule shall not relieve the Contractor from complying with the requirements of the Specification except as may be approved by the Engineer.

…….. **(Signed)**

…….. **(Date)**

9.3 Appendix III; Exchange Rate Fluctuations

Adjustment will be made to the price of imported materials to compensate for variations in the foreign exchange rate. For this purpose, the tenderer is required to state the exchange rate in Kenya Shillings for the currency of the Country of origin of imported materials as applied to the actual remittance effecting payment to manufacturers of the materials.

Exchange Rate: …….

Signed (as in Tender) ……

Date ……

9.4 Appendix IV; System Warranties

The tenderer shall outline the warranties for all systems installed on this site as specified elsewhere.

These shall include but not limited, to the following:

- Pipework & Accessories
- Sanitary fittings

- Etc.

9.5 Appendix V; Schedule of Unit Rates

The tenderers shall provide a schedule of unit rates (under Tables (a) and (b) below) that shall be used to build up rates for variation items not specified in the bill of quantity.

This section, and the terms filled herein shall form part of the contract, and shall be considered locked for the duration of the project.

Rates filled herein shall be evaluated as part of the tender evaluation process. Attention is drawn to the tender evaluation criteria included in this tender package.

The sub-contractor shall disclose the cost of the material offered by the supplier, including or manufacturer or any other sources to the Engineer used to build up the rates in respect to schedule of table (a) and table (b) below. The engineer can reject the disclosed sources where the conflict of interest seems to prevail.

Table (a) and Table (b) shall be deemed to be exhaustive in capturing all cost components and the percentages filled herein shall be considered to be locked for the duration of the contract.

9.5.1 Locally Available Items

Unit rates for items that can be procured locally shall be generated according to table (a) below. Table (a) consists of the below items:

- Material cost – This is the supplier's unit cost for the item, i.e. the cost at the shop/supplier.
- Labor – This is to include all transportation, security, hoisting, installation, tools and consumables, testing, commissioning, costs, etc. The tenderer is to provide his/her labor cost as a percentage of material cost.
- Overheads and Profit – This is to capture all contractor's overheads, margins, profit, etc. The tenderer is to provide his/her overheads and profit as a percentage of material cost.
- Further to this, tenderers are expected to list all other cost carriers not deemed to have been captured in the table below, as a percentage of material cost.

9.5.1.1 Table (a): Locally Available Items.

Material Cost Kshs. (a)	Labour (as a percentage of material cost) (b)	Overheads and Profit (as a percentage of material cost) (c)	List any other component as necessary (as a percentage of material cost) (e)	Total Installed Cost of item Kshs. (VAT exclusive) (a+b+c+d)

9.5.2 Imported Items

Unit rates for items that will require importation shall be generated according to table (b) below. Table (b) consists of the below items:

- Material cost – This is the supplier's unit cost for the item as landed and cleared in Kenya. It includes FOB price, Carriage Insurance & Freight, Inspection Charges, Duty, Port Levies, Clearance Charges and VAT

- Labor – This is to include cost for transportation from port to site, security, hoisting, installation, tools and consumables, testing, commissioning and associated costs, etc. The tenderer is to provide his/her labor cost as a percentage of material cost.
- Overheads and Profit – This is to capture all contractor's overheads, margins, profit, etc. The tenderer is to provide his/her overheads and profit as a percentage of material cost.
- Further to this, tenderers are expected to list all other cost carriers not deemed to have been captured in the table below, as a percentage of material cost.

9.5.2.1 Table (b): Imported Items.

Material Cost Kshs. (a)	Labour (as a percentage of material cost) (b)	Overheads and Profit (as a percentage of material cost) (c)	List any other component as necessary (as a percentage of material cost) (e)	Total Installed Cost of item Kshs. (VAT exclusive) (a+b+c+d)

…….. **(Signed)**

…….. **(Date)**

…….. **(Official Stamp)**

9.6 Appendix VI; Day Work Terms for Labour

(To Be Completed By Tenderer)

Description of Artisan	**Cost Per Hour**
Supervisor	…….
Grade A Plumber	…….
Grade B Plumber	…….
Grade C Plumber	…….
Labour	…….
Apprentices	…….

9.7 Appendix VII; Technical Schedule

TECHNICAL SCHEDULE

The tenderer must complete in full the technical schedule. Apart from the information required in the technical schedule, the tenderer **MUST SUBMIT** comprehensive manufacturer's technical schedules details for all items listed in this schedule (fill forms attached).

Description	Manufacturer	Country of origin	Remarks (Catalogue No. etc.)
• Pipework & Accessories • Sanitary fittings			

PART A

GENERAL MECHANICAL SPECIFICATION

1 PART B - GENERAL MECHANICAL SPECIFICATION

1.1 General

This section specifies the general requirements for plant, equipment and materials forming part of the Sub-Contract Works and shall apply except where specifically stated elsewhere in the Specification or on the Contract Drawings.

1.2 Quality of Materials

All plant, equipment and materials supplied as part of the Sub-Contract Works shall be new and of first-class commercial quality, shall be free from defects and imperfections and where indicated shall be of grades and classifications designated herein.

All products or materials not manufactured by the Sub-Contractor shall be the products of reputable manufacturers and so far as if they had been manufactured by the Sub-Contractor.

Materials and apparatus required for the complete installation as called for by the Specification and Contract Drawings shall be supplied by the Sub-Contractor unless mention is made otherwise.

Materials and apparatus supplied by others for installation and connection by the Sub-Contractor shall be carefully examined on receipt and stored. Should any defects be noted, the Sub-Contractor shall immediately notify the Engineer.

Defective equipment or that damaged in the course of installation or tests shall be replaced or repaired to the approval of the Engineer.

1.3 Regulations and Standards

The Sub-Contract Works shall comply with the current editions of the following:-

(a) The Kenya Government Regulations.

(b) The United Kingdom Institution of Electrical Engineering Regulations for the electrical equipment of buildings.

(c) The United Kingdom Chartered Institution of Building Services' Guides.

(d) The Kenya Bureau of Standards Specifications.

(e) British Standards and Codes of Practice as published by the British Standards Institution.

(f) The Local Council By-laws.

(g) The electricity Supply Authority By-laws.

(h) The Kenya Building Regulations.

1.4 Electrical Requirements

Plant and equipment supplied under this Sub-Contract shall be complete with all necessary motor starters, control boards, and other control apparatus. Where control panels incorporating several starters are supplied they shall be complete with a main isolator.

The supply power up to and including local isolators will be provided and installed by the Electrical Sub-Contractor. All other wiring shall be as described in the Particular Specification.

The sub-contractor shall supply three copies of all schematic, cabling and wiring diagrams for the Engineer's approval.

The starting current of all electric motors and equipment shall not exceed the maximum permissible starting currents described in the Kenya Power and Lighting Company Ltd's By-laws.

All electrical plant and equipment supplied by the Sub-Contractor shall be rated for the supply voltage and frequency obtained in Kenya, that is 415 volts, 50HZ, 3-phase or 240 volts, 50HZ, 1-phase as specified in the particular specification.

Any equipment that is not rated for the above voltage and frequencies may be rejected by the Engineer.

1.5 Transport and Storage

All plant and equipment shall, during transportation be suitably packed, crated and protected to minimise the possibility of damage, and to prevent corrosion or other deterioration.
On arrival at site all plant and equipment shall be examined and any damage to parts and protective priming coats made good before storage or installation.

Adequate measures shall be taken by the Sub-Contractor to ensure that plant and equipment do not suffer any deterioration during storage.

Prior to installation all piping, plant and equipment shall be thoroughly cleaned.
If, in the opinion of the Engineer any equipment has deteriorated or been damaged to such an extent that it is not suitable for installation, the Sub-Contractor shall replace this equipment at his own cost.

1.6 Site Supervision

The Sub-Contractor shall ensure that there is an English-speaking supervisor on the site at all times during normal working hours.

1.7 Installation

Installation of all special plant and equipment shall be carried out by the Sub-Contractor under adequate supervision form skilled staff provided by the plant and equipment manufacturer or his appointed agent, in accordance with the best standards of modern practice to the relevant regulations and standards described under clause 2.3 of this section.

1.8 Testing

1.8.1 General

All testing shall be carried out to the entire satisfaction of the Engineer.

The following sub-clause are intended to define the Sub Contractor's responsibilities with respect to testing and inspection.

1.8.2 Materials Tests

All materials for plant and equipment to be installed under this sub-contract shall be tested, unless otherwise directed, in accordance with the relevant B.S. Specification concerned.

For materials where no B.S Specification exists tests are to be made in accordance with the best modern commercial methods to the approval of the Engineer having regard to the particular type and application of materials concerned.

The Sub-Contractor shall prepare specimens and performance tests and analyses to demonstrate conformance of the various materials with the applicable standards.

If stock material, which has not been specifically manufactured for the plant and equipment specified is used, then the sub-contractor shall submit satisfactory evidence to the Engineer that such materials conform to the requirements stated herein in which case test of material may be partially or completed waived. Certified mill test reports of plates, piping and other materials shall be deemed acceptable.

1.8.3 Manufactured Plant and Equipment - Works Tests

The rights of the Engineer relating to the inspection, examination and testing of plant and equipment during manufacture shall be applicable to the Insurance Companies or Inspection Authorities so nominated by the Engineer.

The sub-contractor shall give two weeks' notice to the Engineer of the manufacturer's intention to carry out work tests and inspection.

The Engineer or his representative shall be entitled to witness such tests and inspections. The costs of such tests and inspections shall be borne by the Sub-Contractor.

Six copies of all test and inspection certificates and performance graphs shall be submitted to the Engineer for his approval as soon as possible after the completion of such tests and inspections.

Plant and equipment which is shipped before the relevant test certificate has been approved by the Engineer shall be shipped at the Sub-Contractor's own risk and should the test and inspection certificate not be approved, new tests may be ordered by the Engineer at the Sub-Contractor's expense.

1.8.4 Pressure Testing

All pipework installation shall be pressure tested in accordance with the requirements of the various sections of this Specification. The installation may be tested in sections to suit the progress of the works but all tests must be carried out before the work is buried or concealed behind building finishes. All tests must be witnessed by the Engineer or his representative, and the Sub-Contractor shall give 48 hours' notice to the Engineer of his intention to carry out such tests.

Any pipework that is buried or concealed before witnessed pressure tests have been carried out shall be exposed at the expense of the Sub-Contractor and the specified tests shall then be applied.

The Sub-Contractor shall prepare test certificates for signature by the Engineer and shall keep a progressive and up-to-date record of the sections of the work that have been tested.

1.9 Colour Coding

Unless stated otherwise in the Particular Specification all pipework shall be colour coded in accordance with the latest edition of B.S.1710.

1.10 Welding

1.10.1 Preparation

Joints to be made by welding shall be accurately cut to size with edges sheared, flame cut or machined to suit and the required type of joint. The prepared surfaces shall be free from all visible defects such as laminations, surface imperfections due to shearing or flame cutting operation, etc., and shall be free from rust scale, grease and other foreign matter.

1.10.2 Method

All welding shall be carried out by the electric arc process using covered electrodes in accordance with B.S. 639.

Gas welding may be employed in certain circumstances providing that prior approval is obtained from the Engineer.

1.10.3 Welding Codes and Construction

All welded joints shall be carried out in accordance with the following specification:-

a) Pipe Welding

All pipe welds shall be carried out in accordance with the requirements of B.S. 806.

b) General Welding

All welding of mild steel components other than pipework shall comply with the general requirements of B.S.5135:1974.

1.10.4 Welder's Qualifications

Any welder employed on this sub-contract shall have passed the trade test as laid down by the Government of Kenya.

Trade engineer may require to see the appropriate certificate obtained by any welder and should it be proved that the welder does not have the necessary qualifications the Engineer may instruct the Sub-Contractor to replace him by a qualified welder.

PART B

GENERAL MECHANICAL VENTILATION AND AIR CONDITIONING SPECIFICATION

2 PART C - GENERAL MECHANICAL VENTILATION AND AIR CONDITIONING SPECIFICATION

2.1 GENERAL

This section specifies the general requirements for mechanical ventilation and air conditioning plant, equipment and materials forming part of the Sub-Contract works and shall apply except where specifically stated elsewhere in this Specification or on the Contract Drawings.

2.2 INSTALLATION

Installation of all ductwork, plant and equipment shall be carried out under adequate supervision from skilled staff in the relevant codes and standards specified herein.

The Sub-Contractor shall be responsible for ensuring that sufficient provision is made to prevent the transmission of vibration from equipment to the supporting structure. In the case of fans, this shall be done by rot and vermin-proof flexible connections and anti-vibration mountings of an approved type.

The Sub-Contractor shall ensure that all ducting systems are provided with sufficient access hatches complete with covers, for maintenance purposes.

Dampers and other user equipment shall be installed with adequate access for operation and maintenance. Where dampers and other operational equipment are unavoidably installed beyond normal reach and in such a position as too be difficult to reach from a short step ladder, extension spindles shall be provided.

The variety and type of supports for ducts, and fans shall be kept to a minimum and their design shall be such as to facilitate quick and secure fixing to metal, concrete, brickwork and wood.

Where the design of the structure is in reinforced concrete, supports shall be secured to the structure by means of redheads, rawbolts or other approved means.

Where the Sub-Contractor proposes to secure his supports by other means than to the main structural concrete, he shall consult with the Engineer before proceeding.

2.3 TESTING AND INSPECTION

2.3.1 Site Test

The Sub-Contractor shall supply all instruments and equipment necessary to carry out Site Tests and shall arrange with other Sub-Contractors for the testing of associated equipment which may affect the performance of the plant installed under these Sub-Contract Works.

2.3.2 Site Tests- Fans

All fans shall be charged with a suitable lubricant and shall be tested upon completion of the ancilliary system erection to ascertain that the performance of each fan complies with the requirements of the Specification.

2.4 Completion of Works - Balancing and Commissioning

Following the Site Tests and prior to handover, mechanical ventilation or air conditioning systems shall be balanced by means of grilles, dampers and other special controls installed, so as to give the required air flow rates and where applicable the desired temperatures, pressures and humidity conditions in all areas served by the said systems.

The complete system shall be balanced and commissioned as a whole. Sectional balancing and commissioning on any one part of the system where this excludes final complete system balancing and commissioning, shall not be accepted.

Test volumes within ducts shall be within + or - 5% of the design volumes, and volumes at grilles and diffusers shall be within + or - 10% of the design volumes.

When the system has been balanced to the satisfaction of the Engineer, it shall be run under complete automatic control for 72 hours continuous operation to ascertain any faults in operation before acceptance and handover. Any faults discovered during this time shall be corrected and a further test or tests of 72 hours duration shall be carried out to ensure satisfactory operation, all at the expense of the Sub-Contractor.

2.5 Ductwork

The Sub-Contractor shall supply, deliver and erect all ductwork as shown on the Contract Drawings.

All ductwork shall be manufactured in accordance with the Heating and Ventilation Contractors Association (H.V.C.A.) Specification DW/121, current edition except where stated otherwise.

Ductwork shall be manufactured from galvanised mild steel sheet unless otherwise specified. All external ductwork shall be manufactured from black mild steel sheet and galvanised after manufacture. All seams shall be of lock form type. All ductwork systems shall be complete with all necessary dampers, bends, tees, tapers, transformation and special pieces.

Where removal is required for access or maintenance, ducting shall be provided with steel angle flange joints suitably painted and protected.

Only bends type 1 - 7 inclusive as detailed in the H.V.C.A. Specification will be permitted.

Only duct connections type 42 - 44 inclusive 53 and 54 as detailed in the H.V.C.A. Specification will be permitted. All joints shall be fixed as to be suitable for the direction of the air flow.

All positions of plant and ductwork shall be checked on site before detailed manufacturing drawings are prepared and ductwork manufacture commenced.

Transformation and paper pieces shall, wherever possible, be constructed so that the included angle does not exceed 30 degrees C.

All flanged joints shall be sealed by the use of asbestos string, compressed between the flanges, and where slip joints occur, these shall be sealed by "Prestik" or other similar suitable jointing compound and adhesive tape 40mm wide. Exposed sheet metal edges shall be painted with galvanize before sealing.

Dampers shall be of aerofoil section and manufactured from galvanised mild steel sheet. Damper blades shall not exceed 150mm in width and the edges of the blades shall be sealed with a 3mm thick felt or rubber seal to minimise leakage. Operating quadrants shall be provided with locknuts and the quadrant shall be clearly marked with `Open' and

`Closed' positions. Multileaf damper blades shall be operated by one arm through a linkage external to the duct.

The Sub-Contractor shall provide sufficient access doors and handholds in the ductwork for the purpose of maintenance and inspection. Access doors shall be of the hinged type and door openings in the ductwork shall be adequately stiffened and made airtight with purpose made rubber gaskets around the door perimeter.

All supports and brackets shall be wire brushed and painted one coat of red oxide paint prior to and after erection. All nuts and bolts shall be sheradized. The fastening of electrical cables to ductwork will not be permitted.

Where ductwork has insulation incorporating an external vapour seal, the ductwork shall be insulated from the support by a rot-proof softwood, hardwood or other suitable closed cell insulator of not less than 25mm greater thickness than the insulation to be applied so that the vapour seal may be bonded to the face of the timber, all as detailed in Clause 6.4 of the H.V.C.A. Specification DW/121, latest edition.

Where ductwork passes through floors and walls, etc., galvanised sheet sleeves or builders work timber frames shall be provided. The space between duct and sleeve or frame shall be paced with asbestos rope or mastic to prevent air movement or noise transmission from one space to another. Ducts must not come into direct contact with the building fabric.

Hangers and brackets shall be manufactured from rolled mild steel angle or channel sections and shall generally be of the drop rod hanger or cantilever type. The hangers shall be spaced to ensure adequate support and where practicable shall be fitted at each ductwork joint.

The Sub-Contractor shall supply and install, where called for, louvred inlets and outlets with insect-proofed screens. The louvres shall be constructed throughout from extruded aluminium sections and shall have a lacquered or anodised finish to prevent corrosion. The louvres shall be weather-proof and have a free area of not less than 50%.

The Sub-Contractor shall ensure that wherever fans or similar equipment are connected to the ductwork system, the connections are made with a heavy duty rot and vermin-proof neoprene, or similar material, flexible connection to prevent vibration transmission to the ductwork or building fabric. Flexible connections shall be secured by a pre-drilled mating flange, or when fixing to a spigot, the spigot should be beaded and a jubilee clip or split flat iron ring should be used.

The Sub-Contractor shall provide test holes in all branch ducts and in the main duct on the discharge of the fan. The holes shall be suitably spaced in accordance with B.S. 848, shall be situated on a straight length of ductwork and where possible, not less than 2 metres downstream or any bends or damper. After the completion of testing the Sub-Contractor shall provide and fix properly metal or plastic plugs to all test holes. The use of rubber or cork bungs will not be permitted.

2.6 INSULATION

2.6.1 General Description

All heated, cooled and recirculated air ductwork shall be insulated.

Insulation shall be of 25mm thick expanded polystyrene sheet, or spray applied polyurethane foam to a uniform thickness of 25mm. Polystyrene shall be fixed so that the edges butt closely without gap and insulation shall overlap at corners by the thickness of the insulation. The sheet shall be fixed by means of a suitable adhesive and plastic impingement pines attached to the ductwork.

2.6.2 Ductwork in Plant Rooms

The insulation described in Clause 5.1 above shall be finished by the application of a 15mm thick layer of hard setting plastic compound trowelled to a smooth finish. All corners shall be protected by setting in a 1mm thick aluminium angle strip into the hard setting finish. Insulation shall be bevelled to angle of 45 degrees at all connecting flanges, access hatches and all other places where operation or maintenance is likely to cause the breaking of the insulation.

The insulation shall then be given a vapour sealing by the application of two coats of anti-condensation paint.

2.6.3 Ductwork External to Plant Rooms

The insulation described in Clause 5.1 above shall be finished by the application of two coats of bitumastic.

2.6.4 Finish Painting

Upon completion of the installation and after all tests have been carried out too the satisfaction of the Engineer the plant, equipment, supports etc., shall be examined and all priming coats damaged during erection made good.

Any plant or equipment, ductwork, etc., which is to be insulated, shall have had the priming paint protection made good before the application of the insulation.

PART C

3 GENERAL TECHNICAL SPECIFICATION

3.1 PART C - GENERAL TECHNICAL SPECIFICATION

3.1.1 Materials and Workmanship

All materials shall be of adequate quality for the duty specified and the workmanship shall be in accordance with the best accepted modern practice. Unless otherwise stated the Mechanical Contractor shall be obliged to comply with the requirements of the latest edition of the relevant Bureau of Standards Specification where applicable. Failing this, the latest edition of the relevant Britain Standard Specification shall provide the required standard. If the Mechanical Contractor desires to use any other standard specification or code of practice, it shall be referred to the Engineer for approval.

3.1.2 Structural Steelwork

The structural steel used in the Mechanical Contract shall be mild steel to B.S. 15. Black bolts and nuts shall be in accordance with B.S. 916. Black metal washers shall be in accordance with B.S. 916.

High Strength friction grips, bolts, nuts and washers shall be in accordance with B.S. 3139, Part 1, and their application shall conform to B.S. 3139, Part 1, and their application shall conform to B.S. 3294, Part 1 torque wrenches or impact tools where used be recalibrated before each shift.

All fabrication and erection procedures shall be in accordance with B.S. 449 as amended, Part 5. Before commencing the fixing of the steelwork the erector shall check the seating for line, level and bolt setting, and any errors which cannot be accommodated by the steelwork erector shall be reported to the Engineer.

3.1.3 Steel Fabrication and Baseplates

The manufacture of all fabricated items of plant shall be generally in accordance with B.S. 449 as amended, Part 5.

The fabrication and manufacture of the plant and equipment shall be completed in the Mechanical Contractor's workshops before delivery to site. No fabrication of complete units shall take place on site, sitework shall be confined to only such minor alterations and adjustments as are found to be necessary during erection. If major alterations are found necessary the items of plant covered shall be returned to the Mechanical Contractor's workshop for modification on replacement and shall be tested and checked before re-delivery to site.

Drive baseplates shall be robustly constructed and adequately stiffened to prevent twisting and distortion. The ration of the base length to its height shall not be more than 10:1.

All surfaces shall be free from recesses and cavities to prevent the accumulation of dirt and/or waste material, and shall be designed to facilitate ease of cleaning and maintenance.

Where driving units are directly coupled to the driven component all mounting surfaces shall be accurately machined to ensure alignment. After final assembly and testing, the individual items of plant shall be accurately dowelled in position on the baseplate to prevent misalignment during installation or during operation.

The Mechanical Contractor shall include in the design for any measures required to counter the effects of vibration which might be caused by operation of equipment.

3.1.4 Stainless Steel

All items fabricated in stainless steel shall be in the grade specified and detailed designs shall be compatible with fabrication techniques. The designs of articles to be pressed or welded shall be discussed with the fabricator before manufacture. All stainless steel items shall have a 'half-moon' finish to the satisfaction of the Engineer. Edges shall be finished by either welding on 12mm stainless steel round bar in the same grade as the article or by turning down to an acceptable radius.

3.1.5 Welding

3.1.5.1 Welding

Welding shall be carried out in accordance with the BC Code of Practice for welding No.044 Parts 1, 2, 3, & 4.

3.1.5.2 Freedom from Surface Defects

All welded fillets or butt joints shall be ground smooth and shall be free from porosity, cavities and entrapped slag. All welds shall conform to the requirements of B.S. 1856.

Welds which are to be hot dip zinc coated shall be neatly formed and the surfaces shall be acceptable and free from cracks in the welds or heat affected zone, from overlap undercuts, porosity, entrapped slag and spatter in or associated with the welds. The welds shall seal completely the edges of all overlapping or contacting surfaces.

3.1.5.3 Smoothness of joints where Weld is re-commenced or Terminated

The joints in the weld run where welding has been recommenced or terminated shall be smooth and shall show no pronounced hump or crater in the weld surface.

3.1.5.4 Shape of Profile

The profile of the weld shall be uniform, of appropriately equal leg length and free form overlap at the toes of the weld. Unless otherwise specified the surface shall be either flat or slightly convex in the case of welds and with a reinforcement of not more than 3 mm in the case of butt welds.

3.1.5.5 Uniformity of Surface

The weld face shall be uniform in appearance through its length.

3.1.5.6 Electrodes

Electrodes shall be of an approved type for the material being used and shall be kept in a dry condition. All electrodes shall conform to the latest issue of B.S. 693 'Electrodes for Manual Metal Arch Welding of Mild Steel and Medium High Tensiles Steel'.

3.1.6 Qualification of Welders

Welding on or off the site shall be carried out only by welders qualified to the approval of the Engineer. Each welder to be used on the Mechanical Contract Works will be required to carry to test welds to the approval of the Engineer and in the presence of the Engineer's Representative. Only welders whose test welds have been passed by the Engineer shall be employed on the Mechanical Contract Works and then only for the class of welding for which they have been tested. Initial testing of welders and such periodical tests as may be required by the Engineer shall be carried out at the Mechanical Contractor's expense using materials supplied by the Mechanical Contractor.

3.1.7 HOT DIP (Galvanised Zinc Coatings)

3.1.7.1 General

All hot dip zinc coatings shall conform to the requirements of the latest issue of specification 'Hot-Dip (Galvanised Zinc coatings' with particular reference to the following.

Tubular constructions shall be provided vent holes in appropriate locations to prevent internal pressure build-up during the hot zinc bath shall be referred to the galvaniser who shall state his requirements for the vent holes desired. Welding flux shall be chipped away, all welds shall be wire brushed, ground or grit or shot blasted if necessary before hot zinc coating.

The surfaces to be hot-dip coated shall be free from paint, oil, grease, and similar impurities. Identification numbers of individual pieces shall be clearly stamped on surfaces of members prior to hot-zinc coating, numbers painted or welded on the surfaces of these members shall be unacceptable.

Exposed surfaces, except welds when necessary, need not be grit or shot blasted, but the engineer shall decide to call for grit or shot-blasting in cases of unsuitable surface finish on material for hot-dip zinc coating. The Engineer shall have the right to inspect all steel components before galvanising, and shall have the right to reject or ask for remedial treatment of any material which is considered unsuitable. This applies particularly to welds, burrs, and surfaces having visible surface defects.

Globular extra heavy deposits for zinc which interfere with the intended use of the material shall not be acceptable. Excessively protuberant lumps and nodules shall be removed by hot wiping or skilful application of mechanical means provided that a sufficient minimum thickness of unbroken zinc coating remains after such treatment. Flows on small parts and working surfaces shall be repaired only by stripping, dressing and re-dipping.

3.1.7.2 Threads

The galvanising on threads or bolts shall be such as to fit a gauge made by overtapping a nut to the following increased limits of size to 7H tolerances:

	Bolt Sizes	M6	M8	M10		M12	M16	M24
Overcut,mm	To be Agreed	To be Agreed	0,33	0,33	0,38	0,38	0,38	

For threaded articles less than 10mm diameter mechanical plating will be acceptable instead of hot dip zinc coating (galvanising).

Nuts shall be capable of being spun over the full length of the thread by hand ungalvanised internal threads shall be coated immediately after cutting, before they are allowed to rust, with preventive compound of type agreed between the supplier and the Engineer.

3.1.7.3 Bolts

Bolts to be galvanised shall be standard black bolts manufactured according to B.S 916 (and having threads produced to medium class tolerances G8). Any bolt which has been subjected to cold forming (heading) operation during manufacture shall be stree-relieved at a temperature between 600^0C for a minimum period of 20 minutes and subsequently cooled in air.

3.1.7.4 Protection of Coating (Passivation)

Immediately after withdrawal from the bath of molten zinc, galvanised material shall be quenched in water containing approximately 1% of sodium dichromat slightly acidified with sulphuric acid. Other bath compositions may be used provided that they contain recognised passivating agents unless otherwise specified.

Alternatively by agreement between the galvaniser and the Engineer, protection may be applied by other means, such as, for instance, a lacquer containing chromate salts.

3.1.7.5 White Rust (White Storage Stain)

All galvanised material shall be free from gross deposits of white rust. If material has been affected by white rust, the deposit may be removed, by means of non-metallic brushes and provided that the thickness of zinc coating in the affected area meets the requirements of the specification the material can be accepted.

No galvanised material shall be used for erection unless such material:-

a) has been zinc coated under the KBS certification scheme, and this is indicated by the diamond standardisation mark, which should appear on all labels, delivery notes, and other similar documents relating to such material. Such documents should also indicate the name of the galvaniser concerned.

Structural material should also bear a paint mark applied by the galvaniser to indicate standardisation mark quality. The Engineer may call for certificates from the galvaniser indicating that each consignment of material complies with the specification and was galvanised under the certification mark scheme: or

b) The galvanised material has been inspected, and each consignment is accompanied by an inspector's certificate indicating that the material is acceptable and complies with the requirements. Structural material should also bear a paint mark applied by the inspector to indicate that the material has been inspected and accepted. Bolts, nuts and other material of small size should be in a bag or container containing a label bearing the inspector's stamp.

3.1.7.6 Castings

Because of the corrosion-inducing conditions, and in order to obtain satisfactory mechanical properties of tensile, shear and yield strengths, resistance to impact and transverse loads and hardness properties, all ferrous castings other than those included in the proprietary 'bought out' items of equipment shall comply with the specification hereunder. If the Contractor wishes to offer alternative materials, he shall submit comprehensive details of such alternatives and obtain the prior written approval of the Engineer before proceeding with manufacture.

Material:	Pearlitic Nodular Structure.
Mechanical Properties:	Ultimate Tensile Strength - 725 mpa Elongation - 2% Hardness - 240 to 300 brinell (after normalizing)
Inoculation:	All castings shall be inoculated with 3% copper.
Heat Treatment:	To provide the optimum physical properties consistent with the pearlitic nodular structure of the material, and to provide a hardness within the range 207 to 235 brinell.

Test Certificates: The contractor shall submit to the Engineer all test certificates of analysis including all relevant details of the micro-structure and mechanical properties. The number of tests to be performed and for which certificates of analysis are required shall depend on the respective casting and shall be a greed in writing with the Engineer.

3.1.8 VEE-BELT DRIVES

All vee-belt drives shall conform to B.S. 1440: 1962 - "Endless V-belt drives" and shall be as specified below:

a) Application

Unless otherwise specified or agreed to by the Engineer, Vee-Belt drives shall only be used in applications of constant and slightly varying load conditions. Belt speeds shall not exceed 900 metres per minute, unless otherwise agreed. For reasons of spares interchangeability and maintenance, standard stock vee-belts shall be used.

b) Pulleys

The belt pulleys shall be manufactured from a close-grained cast iron and shall be accurately balanced. The belt grooves shall be properly machined to the correct groove angle and depth.

All sharp corners at the top of the groove shall be removed and the groove sides shall be polished smooth to avoid excessive belt wear. The grooves of mating pulleys shall accurately match each other, particularly regarding width, angle and alignment.

c) Adjustment

Adjustment inward, i.e. towards the driven pulley, shall be provided to ensure sufficient movement of the driving pulley to enable the vee-belts to be fitted by hand, without the use of a lever of any king to force the belts over the pulleys.

The outward adjustment shall provide for correct belt tensioning to ensure that slipping does not occur. All belt tensions shall be re-checked within 24hours and again within a week to start-up to ensure that the initial slack, if any, is taken up.

d) Speed Ratio

Speed ratios greater than 7:1 shall not be acceptable unless otherwise agreed by the Engineer.

3.1.9 Bearings

3.1.9.1 Anti-Friction

Anti-friction bearings shall include all bearings which provide rolling contact between one or more sets of hardened steel balls or rollers located between hardened steel rings or raceways. Anti-friction bearings shall be of approved manufacture.

To facilitate maintenance, spares interchangeability and standardisation, anti-friction bearings of standard designs and manufacture shall be employed. All anti-friction bearings shall be provided with greasing facilities in accordance with the manufacturer's requirements.

3.1.9.2 Bushed Bearings

Only where specifically stated and in cases of low velocities and light loads in moisture-free conditions will bushed bearings be accepted. All bushed bearing shall be made of an approved friction quality and shall be capable of withstanding severe usage.

All bushed bearings shall be provided with lubrication facilities to ensure adequate lubrication and shall be properly grooved to distribute the lubricant uniformly over the bearing surface. Grooves shall not be cut into the journal, but always into the surrounding bush. The edges of all chamfers and grooves shall be rounded to avoid sharp corners and to facilitate the introduction of the oil or grease.

3.1.9.3 Self-Lubricating or Oil-less Bearings

Self-lubricating or oil-less bearings shall only be used on application of light loads and low velocities in moisture-free and low humidity conditions and where bearings are of difficult access and likely to be neglected during servicing. The types of bearing metal composition used shall have frictional and wear resistant properties akin to those of grease lubricated bushed bearings.

3.1.9.4 Keys and Key Ways

All keys and Keyways and taper pins shall conform to B.S. 46: Part 1, 1958.

3.1.9.5 Limits and Fits

Limits and tolerances for shafts and hoes shall conform to B.S.3614.

3.1.10 General Machinery Protection

3.1.10.1 Coupling and Shaft Guards

All high speed couplings, projecting shaft ends and every dangerous moving part of machinery shall be protected by a guard manufactured from not less than 1.6mm mild steel plate. The guards shall be neatly formed and securely fixed in position.

3.1.10.2 Belt Guards

All belt or rope drives shall be adequately protected by a belt guard.

The guard shall be manufactured from wire mesh or open type expanded metal, securely braced and stiffened with suitable rolled steel sections and bolted in position. Guard supports shall not short-circuit vibration isolators on form. Provision must be made for test openings to permit RPM reading of fan and motor without the removal of the belt guard.

3.1.10.3 Painting

All guards shall be finished in a light orange colour to B.S. 381C in accordance with Clause 2.8.4 Class 'C'.

3.1.10.4 EQUIPMENT BASES

Unless stated elsewhere in this specification, inertia base formers for machinery shall be provided to the Main Contractor for casting, by the Contractor for casting, by the Contractor. The bases shall consist of reinforced concrete cast into sheet metal formers at least 150mm deep.

The formers shall comply with the standard set by Mason Industries, for both size and construction. Bases shall be mounted on properly selected spring isolators incorporating noise isolation pads.

Either free-standing stable steel spring or caged spring with snubber may be used. Spring isolators shall be provided with levelling bolts. Noise isolation pads shall be large enough to prevent excessive rocking of equipment during start up and normal operation. Bases and supports shall be arranged to give a clearance of approximately 25mm between the underside of the bases and the floor. Bases shall be large enough to accommodate motors and the equipment they drive.

3.1.10.5 Identification and Labelling

All plant and equipment items, including items such as dampers, pumps, etc, shall be labelled in a clearly visible position with the item name and, in the case of duplicate items, a number. Plant labels shall correspond with labels on starters, isolators, etc.

Labels shall be of sandwich thermosetting plastic with black lettering on a white background. Lettering shall be at least 6mm high and labels shall be in keeping with the size of equipment and legibility with regard to position.

3.1.11 Painting

3.1.11.1 Painting Materials

All paint shall be non-toxic, driers and the like, and other materials shall conform with the requirements of the relevant British Standard Specification. All paints shall be of the best quality and of approved brand and manufacture. All materials shall be used in strict accordance with the manufacturer's instructions and otherwise in strict accordance with the best standard practice. Undercoats of paintwork and primers shall be as supplied by the manufacturer of the paint begin used for the finishing coat. If necessary, paint shall be strained free from skins and similar impurities immediately before application. Priming coats shall be applied over the whole surface and well brushed in order to obtain the maximum penetration. All materials shall be delivered to the job in their original unopened containers with the manufacturer's name and description of contents thereon and no adulteration will be allowed.

3.1.11.2 Colours

Samples of the final colours required shall be submitted for approval before painting the work in hand and the work shall then be finished to the colour or colours as approved. Each coat of paint shall be a distinctive colour working up to the finished colour as approved.

3.1.11.3 External Painting

External painting shall not be undertaken during rainy, damp, frosty or other inclement weather or where such weather is reasonably to be expected within the next 24 hours.

3.1.11.4 Internal Painting

Before internal painter's work is commenced all floors shall be swept clean, and dirt and rubbish removed, and the rooms left practically free from dust; dust-free conditions being maintained during the progress of the work. No sweeping or dusting shall be done whilst the painting is in progress.

Unless otherwise stated, no paint shall be applied within 50mm of areas which are to be welded. Welds and adjacent parent metal shall be de-slagged, inspected and approved and area shall be abrasive-blasted or ground, and all contaminants shall be removed

prior to painting. Wire brushing of the weld shall only be allowed if the paint specification calls for wire-brushing. The weld area shall then be flushed with fresh water and allowed to dry before receiving the full paint system.

Areas where the paint coating has been damaged during transportation erection or by any means whatever, shall be repaired as follows:

Damaged areas or rust spots shall be removed by means of a wire brush or emery paper and the surrounding paint which is still intact shall be feathered for a distance of 20mm beyond the damaged area. Spot priming shall consist of all the coats previously applied and shall overlap the undamaged area by 20mm. Surfaces which are to rest on concrete or other floors or which will be inaccessible after erection shall receive full specified paint system before erection or assembly. Unless otherwise specified, steel embedded with concrete shall not be painted except to within 50mm below the concrete/air interface.

Mating or contact surfaces shall be protected from corrosion by ensuring that the two surfaces brought into contact with each other shall be prepared and primed in accordance with the specification. The primed surfaces shall be brought together while the paint is still wet. Surfaces which are to be friction-bolted shall be prepared in accordance with the specification (i.e. blast-cleaned or wire-brushed) but shall receive no paint coating. All sharp edges shall receive the specified dry film thickness of paint.

Where the shop coat has been allowed to age for a few months before painting, it shall be lightly sanded or rubbed with steel wool and scrubbed with clean water suing a bristle brush. Before painting galvanised iron surfaces, they shall be treated with galvanised Iron Cleaner" or equal and approved cleaner, used in strict accordance with the manufacturer's instructions. Where a temporary protective coating has been applied to prevent wet storage stain, the surface shall be thoroughly scrubbed down by means of a bristle brush and the approved cleaner until all the temporary protection has been removed. The treated surfaces shall then be thoroughly washed down with clean water and the surfaces allowed to dry before painting.

All galvanised sheeting shall be painted on the ground before erection. This will also ensure that overlaps are well protected. Where it is impracticable to apply the coating system before erection, prior consent to paint after erection shall be obtained form the Engineer.

Paint dry-film thickness shall be measured using a non-destructive thickness gauge such as the MIKROTEST or equivalent.

3.1.11.5 Inspection of Surfaces

All surfaces to be painted shall be carefully inspected by the Contractor who shall satisfy himself that the surfaces are in a perfect state to take the paintwork specified. No claim will be entertained arising from defective work due to not strictly insisting on receiving from defective work due to not strictly insisting on receiving from other trades, surfaces in a proper condition, fit to receive the type of paint specified. All surfaces shall be perfectly clean, free from dust, dirt, grease, blotches, and other blemishes before painting, staining or application of any coat.

All surfaces shall be properly prepared before painting or staining. Each coat of paint, except the last, shall be rubbed down with a fine glass paper before the next coat is applied.

Unless otherwise directed, the last coat of paint or finishing shall be done when all other work in the Contract is completed and the premises free from all rubbish and dirt. On completion, all painter's work shall be touched up where necessary and any defects made good. All paint and stain spots shall be removed and all surfaces left in a perfect condition.

3.1.11.6 Iron and Steel Surfaces

The contractor shall ensure that primed steelwork which is to be delivered to site is stacked on bearers and is clear of the ground. Wherever possible channels, angles, and other equipment and material shall be stacked so that water cannot collect on the steel.

Iron and steel surfaces shall be scrapped or shot blasted to produce a clean surface before painting. Paint shall not be applied over any surface containing traces of grit, grease, oil and the like, loose rust, loose millscale or corrosion products and foreign matter of any kind.

All air used for blast-cleaning or spraying shall be free from all traces of water and oil. When blast-cleaned, a satisfactory blast profile (i.e. anchor pattern) shall be achieved. If the abrasive used for blast-cleaning is sand, it shall be free of clay. All metal surfaces to which paint is to be applied shall be moisture dry. Paint surfaces which are to be over-coated shall be hard-dry before over-coating, unless otherwise specified.

3.1.11.7 Painting of Steel Surfaces with Polyurethane System

This system is based on a polyurethane which is cured with an Aliphatic Di-Isocyanate. No polyurethane products which are cured with Aromatic Di-Isocyanate curing agents will be acceptable. This system shall be used as specified in highly corrosive conditions and where a high quality finish is required.

a) In Fabricator's Premises

i) Surface Preparation. All steel surfaces shall be abrasive blast-cleaned to a near-white finish and shall be free from oil and grease and any corrosive contaminants.

ii) Priming. Within 4 hours of blast-cleaning, one coat of an approved zinc chromate epoxy primer shall be applied to give a minimum dry film thickness of 38 micrometers.

iii) Undercoat. One coat of an approved undercoat compatible with both the primer and the finishing coat to give a minimum dry film thickness of 50 micrometers

b) On Site Painting

After erection the following procedures shall be adopted:-

i) Damaged areas shall be repaired as per clause 15.4 above, and spot priming shall comprise all the shop coats.

ii) Undercoat. Unless the undercoat has already been applied it shall be applied before erection as described in Sub-Clause (a) iii) above.

iii) Finishing. Two finishing coats of approved polyurethane enamel in the specified colour shall be applied to give a minimum dry film thickness of 25 micrometers per coat. The two coats shall be distributable in colour and the second coat shall be applied within 24 hours of the first. The total Minimum dry film thickness for the complete paint system shall be 138 micrometers.

3.1.11.8 Painting of Steel Surfaces with Alkyd System

This system shall be used as specified on columns, roof trusses, steel window frames and door jambs, pipes, pumps and equipment in areas where corrosion is mild and a decorative appearance is required.

i) Surface.

Where a decorative rather than corrosive resistant finish is required, steel surfaces may be specified to be mechanically or hand wirebrushed to remove loose rust millscale.

Where a more corrosive resistant finish than the above is specified, all steel surfaces shall be abrasive blast-cleaned to a near white finish. The abrasive shall be free from oil and grease and corrosive contaminants such as chlorides and the like.

ii) Etch Priming. (Applicable to abravise-blasted surfaces only).

Within 24 hours of cleaning, apply one coat of an approved single pact within 4 hours of cleaning, apply one coat of an approved single pack zinc chromate etch primer to give a dry film thickness of not less than 20 micrometers.

iii) Priming. (For abrasive - blasted surfaces).

Apply one coat of an approved zinc chromate primer (green) to give a dry film thickness of not less than 38 micrometers.

For wire brushed surfaces to the clean steel apply one coat, by rush or roller, of an approved red lead primer to give a dry film thickness of not less than 38 micrometers.

b) **On-Site Painting of Steelwork**

i) Damaged Areas

Before and after erection damaged areas shall be repainted as for Clause 15.4 above, and spot priming shall comprise all the shop coats.

ii) Undercoat

Apply one coat of an approved undercoat to give a minimum dry film thickness of 38 micrometers. The undercoat may be tinted to a shade just lighter than the finishing colour using approved stainers.

iii) Finishing

Apply at least one coat of an approved high gloss enamel in the specified colour, to give a minimum dry film thickness of 25 micrometers.

The total dry film thickness for the complete system shall not be less than 100 micrometers for wire-brushed surfaces, and 120 micrometers. The total dry film thickness for the complete system shall not be less than 100 micrometers for wire-brush surfaces and 120 micrometers for abrasive-blasted surfaces.

Note: Where window frames, door jambs and the like have been painted in the fabricator's yard with red oxide primer, this shall be rubbed down and primed in accordance with Clause 15.7 (a) III.

c) **Painting of Motors, Gear Boxes and other Equipment**

i) Surface Preparation

The surfaces to be painted shall be completely free from oil, grease, rust and foreign matter of any kind.

ii) Priming

One coat of an approved epoxy primer shall be applied to form a uniform coat and to fill all porosities in the castings. After 24 hours the primer shall be wet sanded to produce a uniform smooth surface.

iii) Undercoat

One coat of suitable undercoat tinted to a shade just lighter than the finishing colour with suitable staining agent, which is compatible with the paints, shall be applied.

iv) Finishing

One coat of approved high gloss enamel in the specified colour shall be applied. N.B. Flanged faces shall receive the full specified coating.

d) **Painting of Pipes**

i) Surface Preparation

The surfaces shall be wire brushed to remove loose rust and loose millscale.

ii) Priming

An approved one coat primer shall be applied.

iii) Undercoat

Undercoat shall be specified in Clause 15.8.

iv) Finishing

The finishing coat shall be as specified in Clause 15.8 (c) (iv). The total dry film thickness for the coating system shall not be less than 90 micrometers. N.B. Flanged faces shall receive the full specified coating.

3.1.11.9 Painting of Galvanised Surfaces with Alkyd System

This paint system shall be used as specified for painting of side sheeting, ducting and plenum walls, underside of roof sheeting and the outside surfaces of rain water gutters where a decorative effect is required. It shall only be used where the corrosive conditions are mild.

i) Surface Preparation

The surfaces shall be prepared in the manner as described in Clause 15.4 above.

ii) Priming

To the cleaned surfaces apply one coat of an approved Calcium Plumbate primer.

iii) Undercoat

Apply one coat of approved high gloss enamel in the specified colour. The total paint dry film thickness for the system shall not be less than 100 micrometers.

3.1.11.10 Painting of Equipment and Steelwork with Epoxy System

i) Surface Preparation

a) **Equipment**

Where the equipment is specified to be painted after installation it shall be delivered to site unpainted. The surfaces to be painted shall be completely free from oil, grease, rust and all other foreign matter. If possible, castings shall be fettled prior to priming.

b) **Supports and Steelwork**

All surfaces shall be abrasive blast-cleaned. The abrasive shall be free from oil, grease, and corrosive contaminants such as chlorides and the like.

ii) Priming

Apply one coat of approved epoxy primer to form a uniform coat, and to fill all porosities in the casting. After 24 hours the primer shall be wet sanded to produce a uniform, smooth surfaces.

iii) Finishing

Apply two coats of an approved Epoxy Enamel in the specified colour, the second coat to be applied within 24 hours of the fist. N.B. Flanged faces shall receive the full specified coating system.

3.1.11.11 Painting of Galvanised Surfaces with Epoxy System

This paint system shall be used for painting of galvanised surfaces in highly corrosive conditions.

i) Surface Preparation

These surfaces shall be prepared in the manner as described in Clause 15.4 above.

ii) Priming

To the cleaned surfaces apply one coat of approved Epoxy Zinc Chromate Primer.

iii) Finishing

Apply two coats of approved epoxy enamel. The second finishing coat shall be applied within 24 hours after the application of the fist finishing coat, and shall be distinguishable in colour from the first. The total minimum dry film thickness for the paint system shall be 88mm.

3.1.11.12 Painting of Chequer Plate of Egg-Crate Flooring and Supporting

Frames with Epoxy Tar System

This paint system shall be abrasive blasted or acid pickled and passiveated.

i) Surface Preparation

Surfaces shall be abrasive or acid and passivated.

ii) Finishing

Three coats of approved epoxy Tar shall be applied. Consecutive coats shall be in distinguishing colours.

3.1.11.13 Painting of Galvanised Surfaces with Epoxy Tar System

This paint system shall be used for the painting of internal surfaces of galvanised gutters.

i) Surface Preparation shall be described in Clause 15.4

ii) Finishing

To the cleaned surfaces apply one coat of approved Calcium Plumbate Primer.

iii) Undercoat

Apply one coat of suitable undercoat tinted to a shade just lighter than the finishing colour with a suitable tinting agent which shall be compatible with the paint.

iv) Finishing

The Contractor shall apply two coats of approved Epoxy Tar. The second coat shall be applied within 24 hours of the first coat. The total paint dry film thickness shall be not less than 200 micrometers.

3.1.11.14 Painting of Steelwork with Chlorinated Rubber System

This system shall be used in areas where the steelwork is exposed to occasional corrosive conditions.

a) In Fabricator's Yard

i) Surface Preparation

Abrasive blast-clean all steel surfaces. The abrasive shall be free from oil, grease and any corrosive contaminants.

ii) Priming

One coat of approved chlorinated rubber undercoat shall be applied to give minimum dry film thickness of 75 micrometers.

iii) Undercoat

One coat of approved chlorinated Rubber Undercoat shall be applied to give a minimum dry film thickness of 75 micrometers.

b) **On-Site Painting**

After erection, the following procedure shall be adopted:-

i) Damaged areas shall be repaired as described in clause 15, 4 above and spot priming shall comprise all the shop coats.

ii) Finishing

One coat of approved chlorinated rubber enamel shall be applied in the specified colour, to give a dry film thickness of not less than 25mm.

3.1.11.15 Painting of Galvanised Surfaces with Micaceous Iron Oxide Pigmented Alkyd System

Unless the Engineer has given his written consent, the galvanised sheets shall be primed on the ground before erection.

i) Surface Preparation. The surfaces shall be prepared in the manner as described in Clause 1.15.4.

ii) Priming To the clean surfaces apply one coat of an approved calcium plumbate primer.

iii) Undercoat. Apply one coat of an approved Alkyd micaceous Iron Oxide structural paint.

iv) Finishing. Apply one coat of an approved Alkyd micaceous Iron Oxide structural paint in colour as specified.

(v) Damaged Areas These shall be repaired in a manner as described in clause 1.15.4

The total paint dry film thickness shall not be less than 114 micrometers.

3.1.11.16 Specialised Painter

All painting shall be carried out by a painting specialist employed by the contractor.

3.1.12 Protection of Unpainted Surfaces

Bright Machined Parts

All bright machined parts shall have a protective treatment applied by the manufacturer before despatch and this treatment shall be kept intact up to the time of handover unless it has been removed for installation. If the surface is exposed after installation a further protective coating shall be applied in accordance with the manufacturer's requirements.

3.1.13 Piping and Fittings

3.1.13.1 Materials

Pipework shall be run as shown on the contract drawings. All piping used in the construction of the works shall be straight, cleanly finished, round in cross-section, free from cracks, surface flows, laminations and other defects and free from scale.

3.1.13.2 Neatness

All pipe runs shall be arranged to present a neat appearance with where practicable shall be parallel both with one another and with the building structure, paying due regard however to the grading and venting requirements. All vertical pipes shall be plumb.

Pipes shall be bent round piers and all other projections and recesses and all offsets due to varying thicknesses of plaster, walls, floors and ceilings and other structural works were such changes in direction of piping are indicated on the drawings or not. Details of the skirting heights, sill heights and floor finishes shall be determined before any work is commenced. No pipework offsets shall be allowed on piping.

3.1.13.3 Prevention of Dirt Entering Pipes, valves etc.

All pipes, fittings, valves, etc. shall be guaranteed to be free from corrosion and internal obstruction. Pipes and fittings showing signs of corrosion shall not be fitted.

The open ends of all pipework and valves shall be protected. Wrought-iron screwed caps or plugs or plastic covers only shall be used to cover open ends. Wood, rag or paper plugs shall be used. Pipework delivered for use on the Contract Works shall be stored clear off the ground on suitable racks or stands and with the ends protected as described above.

3.1.13.4 Pipe Cutting and Cleaning

All cuts from Standard lengths of pipe shall have all burrs and swarf removed, the ends shall be trimmed square and the pipe shall be thoroughly cleaned both internally and externally before erection.

3.1.13.5 Accessibility

All valves, drains and supports shall be positioned so as to facilitate maintenance. Grouping of valves, drains union's flanges etc. shall be preferred to scatted siting. Joints shall not be formed in the thickness of walls, floors or ceilings. All pipework, valves fittings and equipment forming the piping installation shall be erected so that it can be dismantled and be readily accessible for repair and replacement.

Readily accessible means that the flange, union, etc, can be reached and worked upon either in the open or else by removal of a purpose made duct cover, manhole or similar cover. The fitting is not accessible if as fixed it cannot be manipulated.

Where pipework is to be installed in an inaccessible position it shall be welded or brazed. Unions or flanges shall be provided as equipment to facilitate dismantling. Care shall be taken to ensure that pipe flanges, valves etc. are staggered relative to similar projections or adjacent pipes and obstructions such as bemas columns and pipe supports, where necessary.

3.1.13.6 Grading of Pipework

All pipework shall be installed with continuous gradients to allow for drainage and for venting air. The rise or fall of piping in the direction of flow shall be as laid out in the schedule below (unless noted otherwise on the drawings or instructed by the Engineer.

Service	Rise or Fall	Minimum Gradient mm per meter
Water	Rise (preferred)	2
Steam	fall	4
Condensate	fall	4
Compressed Air	fall	8

3.1.13.7 Pipes laid in Ground

Pipes laid in the ground shall be assembled with care and shall be well bedded in to ensure that pipework and fittings shall not be damaged by movement of the ground. (Steel pipes shall either be supplied with factory applied bitumen/fibreglass wrapping and joints site-wrapped with bitumen tape, or the entire pipeline shall be primed with Densopaste, protected with Denso tape applied with a 55% overlay and protected with PVC wrapping securely fixed).

Excavation in ground and backfilling of trenches with sealed backfill shall be by others unless specified otherwise.

3.1.13.8 Pipes Joints

a) Types of Joints

Joints shall be screwed, welded or flanged as specified for each particular service elsewhere in this specification. Joints shall comply with relevant KBS or BS specification. All flanges shall be at 90^0 to the centre line of the pipe and the holes shall straddle the centre line.

b) Screwed Joints

Pipes for screwed joints shall be provided with taper threads to B.S. 21 Part 1. Steel pipes shall be carefully reamed out before the plain end is threaded. Threads shall be right, clean and free of burrs prior to installation. Before making a joint, the male screw thread shall be wrapped with Polytetrafluoroethene (PTFE) tape. Alternative jointing compounds shall not be used without the express approval of the Engineer.

Should a screwed joint prove defective under test or in operation, the joint shall be broken and remade, caulking will be permitted.

c) Flanged Joints - Steel Pipes

All flanges, bolts, nuts and washers shall be manufactured from mild or stainless steel to B.S. 4504 Part 2 "Table of Piped Flanges (for land use)" to the table appropriate to the pressure specified. Bolt holes in flanges shall be drilled, not punched, and spot faced for nuts.

Pipes not galvanised shall be provided with flanges crewed or welded for nominal bores of 80mm and below and with welded flanges for larger sizes. Galvanised pipes shall be provided with galvanised screwed flanges for nominal bores 80mm and below and with welded flanges for larger sizes. For galvanised piping all welding shall be carried out before galvanising.

Welded flanges shall be of the machine-faced, slip-on pattern with neck secured by welding both at the neck and bore of the flange to pipe, with the pipe finishing 3mm inside the bore. Care shall be taken not to distort the machined face. The

use of alternative flanging to the ASA standards throughout the installation will be considered upon application.

d) Flanged joints - Polypropylene Pipe

Flanges on polyprolene pipes shall be of the full face type up to and including 100mm NB, and the stub flange type with mild steel backing ring for sizes 125mm NB and above, these shall also be used on sizes below 100 mm NB upon the Engineer's request.

All drilling in flanges and backing rings shall be to B.S. 4504 Part 2 "Table of Pipe Flanges" (for land use) and the holes shall be drilled, not punched, and spot faced.

Thickness of flanges and backing rings shall be as specified for each service and the material for the flanges and stub flanges shall be identical to that of the pipe. The use of the alternative flanging to ASA standards throughout the installation will be considered upon application.

e) Gaskets and Bolts

The joint between flanges shall be made up with a joint ring graphite faced on both sides. Joint strings shall be suitable for the pipeline pressure and temperature duty and shall be identified for duty for which they are suitable. Joint rings shall be cut from sheets on site.

Bolts heads and nuts shall be hexagonal in form and washers shall be fitted beneath bolt heads and nuts. The lengths of bolts shall be such that not less than one thread nor more than 5mm of bolt protrudes through each nut when the joint is pulled up. All bolts and nuts shall be corrosion resistant.

f) Welded Joints - General

Welding technique, edge preparing and welding rods or electrodes shall be selected to be suitable in all respects for the materials and duty of the pipeline, and comply with the applicable British Standards.

Each approved welder will be assigned a reference number which shall be stamped on each weld carried out by him. During the progress of the site work ultrasonic or radiographic examination or welds may be carried out by an independent authority at the expense of the Employer Welds found to be defective shall be cut out and the pipe made good, all the contractor at his own expense, and the new welds retested at the contractor's expense.

The Contractor shall cut out and prepare for mechanical testing in the presence of the Engineer, welded joints selected by the Engineer. Cutting out and preparing of test pieces and the making good of pipelines shall be at the contractor's expenses. The total number of such tests will not exceed one per cent of welded joints except that welds found to be defective shall not form part of this total.

Should a significant proportion of the tested welds of a particular welder prove to be defective due to faulty workmanship, all welds carried out by the particular welder shall be cut out and the pipeline made good by another welder whose work has proved satisfactory.

When the general hydraulic test of the completed systems is carried out, each weld shall be lightly hammered during the time pressure is maintained. If any leaks occur at welds, the portion of weld near the leak shall be removed by cutting

or grinding and welded. Repairs shall not be attempted by caulking or fusion of surrounding metal.

g) Welded Joints - Steel Pipes

Oxy-acetylene welding shall generally be carried out in accordance with the "Recommended practise of oxy-acetylene welds in mild steel pipelines" publishing by the Heating and Ventilation Contractors Association. Metal arc welding shall be in accordance with Technical Memorandum T.3 issued by the British Welding Research Association.

The contractor shall obtain from the manufacturers tests certificates representative of welding rods and electrodes used and in accordance with B.S. 1453 or B.S. 639 respectively.

All welded joints, whether produced by oxy-acetylene flame or metal are processes shall be of prime quality. The butts shall be slightly convex with regular ripples and no undercutting, washing away or surface cavities shall be present. Notches at the root into the pipe bore in excess of 1.5mm will be accepted and the external reinforcement shall run out smoothly to the pipe surface on either side. All slag shall be removed after each run. Undercut edges, slag pockets, unsound metal and blowholes shall be chipped out as the work proceeds.

h) Welding - Polypropylene

The use of radial welding equipment for pipework joints shall be preferred. The butt machine used for the welding of polypropylene pipes shall be of a design approved by the Engineer. The machine is to carry out the butt welding of pipes from 100 mm NB up to and including 300 mm NB, must be capable of welding flanges and fittings onto the pipe, and be able to do angular butt welds for development of special bends.

The machine shall be capable of maintaining a welding force of 3500 N. The welding force to be maintained at each weld shall be 10N for each square centimetre of annular pipe surface, at a temperature of 250 plus of minus 10^0C, and therefore provision shall be made for the heating of both mating surfaces to a temperature of, and maintaining, 250 plus of minus 10^0C. All heating surfaces in contact with the piping material shall be Teflon coated.

i) Pipe Fittings

General

Fittings shall be to the standards specified elsewhere in this specification and shall be compatible in all respects with the materials and class of piping being installed. Where standard fittings are not available for the duty required, reductions on the run and to the branch shall be in all cases be made with reducing sockets. Reducing bushes and long screw connectors with backnuts shall not be used.

Bends shall preferably be of the long radius type except for the compressed air system and where space is restricted. In these cases short radius elbows may be used subject to the approval of the Engineer.

In general standard tees shall be used for all connections to pipes and headers. The welding on of sockets or branch pipes will be permitted only with the authority of the Engineer. Reducers shall be of the eccentric type, except on vertical pipelines where concentric reducers may be used. Transitions shall be swept and not abrupt. All connections to plant items shall be so arrange that the plat

can be easily disconnected. All steam, compressed air and water connections shall be made to the top of the line unless noted otherwise on the drawings.

3.1.13.9 Pipe Supports and Guides

a) General

All supports, brackets, hangers clips and other fixing accessories necessary to support all piping system from the building structure or concrete bearers shall be provided and fixed under this Contract. As far as practicable standard bought dip galvanised components shall be used. Samples of these components shall be submitted for approval prior to the placing of order.

Steam and other pipes for high temperature duties be supported on rollers and guided with rollers at changes of direction or other points where necessary to prevent pipes leaving the supports, or on hangers with spherical washers or suitably articulated to take up movement.

Brackets and supporting frames of rolled steel sections shall be fabricated in accordance with the best accepted practice to form true, rigid, neat structures. Makeshift, untidy or unstable supports will be acceptable. Woodscrews, pop-rivets, self-tapping screws, or other fastenings subject to loosening by vibration shall not be used in the fabrication or attachment of pipe supports or fixings. Spring washers, lock nuts or other locking devices shall be used on nuts. Contact between dissimilar metals shall be avoided. A pipe shall not be supported from another pipe unless approved by the Engineer or specifically called for the drawings. Where a common hanger is used for more than one pipe, provision shall be made to accommodate unequal expansion.

b) Fixing to Structure

Fixing to the building structure shall not be carried out in any manner other than that specifically approved by the Engineer for the particular area of the building and type of finish. Care shall be taken to avoid unnecessary damage to finishing.

Competent labour shall be employed to ensure that supports are correctly sized, spaced and set out prior to fixing. All work shall be made good to the Engineer's approval.

For fixing to brick and concrete, holes of correct size shall be neatly drilled using special purpose twist drills, and fixings made by rowl-bolts or equal or bolts of the grouted type approved by the Engineer. Shot fixings shall not be used nor shall fixings be made into mortar between bricks. Fixing to lightweight or hollow structures shall be by means of suitable screw anchors, toggle bolts or approved alternative.

c) Spacing of Supports

Spacing of supports for steel and copper pipes shall not exceed the centres given in the following table:

MAXIMUM SPACING OF SUPPORTS (M)

Nominal Bore of pipe (mm)	Steel Pipes		Copper Pipes	
	Horizontal	Vertical	Horizontal	Vertical

15	2.0	2.4	1.4	1.9
20	2.4	3.0	1.4	1.9
25	2.7	3.0	1.7	2.2
32	2.7	3.0	1.7	2.7
35	3.0	3.6	2.0	3.0
40	3.4	4.0	2.0	3.0
50	3.7	4.5	2.0	3.4
65	3.7	5.0	2.4	4.0
80	4.1	5.0	3.0	4.0
100	4.4	5.0	3.0	4.0
125	4.4	5.5	3.0	4.0
150	4.8	6.0	-	-
200	5.1	6.3	-	-
250	5.8	6.5	-	-
300 and over	6.1		-	-

Special supports shall be provided for all heavy items of pipeline equipment such as stainers, valves, etc.

d) Positions of Supports

Supports shall be positioned to reduce, as afar as possible, stress on joints, valves and items of equipment. Due to regard shall be given to the maintenance of accessibility and to the requirements of access to their services to be fixed in the area.
Vertical pipes shall be supported at the bottom of the riser, or at an intermediate anchor point, to allow for expansion and to carry the entire weight of the riser. Intermediate supports will act as guides. Branches from risers shall not act as supports for the riser.

e) Guides

Guides shall be provided and fixed to prevent pipes leaving their supports due to expansion compensating devices.

f) Anchor Points

Anchor points shall be provided to resist the axial stress transmitted by the flexure of expansion loops or bellows.

Anchors shall be provided complete for attachment to the structure and where applicable shall be bolted or welded to the structure or positioned accurately for grouting in by others.

On steel pipelines anchors shall consist of heavy mild steel saddles welded all round to the pipe surface and provided with exterior lugs for bolting to the building structure or thrust block. Saddles shall be not less than the thickness of the pipe to which they are welded and of width equal to its nominal bore. On polypropylene pipelines shall const of 3mm thick polypylene pads completely surrounding the pipe and then attached to the supporting steelwork with U Bolts. Alternatively, anchors may consist of slip on flanges welded to the pipe and not bolted or welded in the approved manner to rolled steel members attached to the structure.

In the case of copper pipes, anchors shall generally consist of two flanges-to-copper adaptors interposed into the pipe run at the anchor point. Mild steel sections

shall be bolted to either side of the flanged joint and attached to the building structure.

3.1.13.10 Provision for Expansion in Piping

Piping shall be installed in such a manner as to allow for thermal expansion. Where sufficient flexibility is not provided by changes of direction in the run, expansion loops or expansion compensators shall be provided. In general, fabricated expansion loops shall be used to allow 'nesting' of loops in adjacent pipes but purpose made expansion loops may be used if they are suitable for the pressure and expansion duty.

Expansion compensators shall be used only on Engineer's approval and then must be suitable for the working conditions and installed in full compliance with the manufacturer's recommendations regarding guiding, alignment and all other respects of erection and commissioning.

Care shall be taken that the compensators are not overstressed during pressure testing of pipelines, and if necessary, made-up spool-pieces of pipe shall be substituted during these tests.

All supports shall provide for the expansion movement in pipes. Hangers shall be free to 'swing' and rigid supports shall be of the roller type or pipes shall have 'slides' of rolled steel sections welded to them to permit free movement on supports without damage to the pipe or insulation.

3.1.13.11 Pipe Sleeves

a) General

Pipes shall not be build rigidly into walls, floors, ceilings, footings or under roads. Sleeves shall be provided under this contract, unless noted otherwise on the drawings, for building-in by others at all such locations.

The Contractor shall provide all sleeves in advance of building requirements and shall be responsible for ensuring that sleeves are properly positioned, aligned and built-in. Rectangular or circular openings will be provided by the builder in structural concrete slabs and it shall be the Contractor's responsibility to supply, position, align and secure sleeves, ready for casting in by the builder. Puddle flanges shall be provided for building-in where pipes pass through bound walls or below ground.

b) Sizes

Sleeves shall not be used as pipe supports and a free annular space of at least 6mm shall be allowed between a pipe and its covering, if any and its sleeve. In lad bearing walls or footings the annular space shall be of a minimum of 25mm. Where pipes change direction, sleeves shall be oversized to accommodate expansion movement of the pipe.

Sleeves shall extend through walls to within 5mm of the finished surface on both sides to allow for flush caulking over the sleeve with water proofing compound. Vertical sleeves shall be project 50mm above the finished floor level and end 5mm above the underside of the slab. Polystyrene or similar material spacer discs shall be provided to locate the sleeve during casting of concrete, so that when the discs are removed the caulking clearance is left.

c) Materials

Sleeves in load-bearing walls and under roads shall be of cast-iron. Other sleeves shall be of standard galvanised pipe cut to length. Sleeves shall properly cut, reamed and trimmed square. Sleeves for casting in the concrete shall be securely fixed to form work by the contractor before concrete is poured. The annular space between each pipe and sleeve shall be firmly caulked at each end with polysulphide or equal waterproof compound which does not set hard.

3.1.13.12 Ventilation and Draining of Pipework

a) General

Sufficient provision shall be made at high points of piping and equipment for ventilation and at low points for draining. Drains shall be provided on all major sections of pipework so that they can be drained without draining the entire system. Vents shall be adequate to ensure that airlocks cannot form in the system.

b) Manual Vents

Manually operated air release points shall be provided on all water piping to permit the initial charging of the system. Each point shall comprise an air bottle fitted on tope of the pipe and with a welded cap and 15mm discharge pipe run to a full way air-release valve at hand level and then to discharge at an agreed point. Pipes up to 40mm shall have air bottles of the same diameter as the pipe, air bottles for larger pipes shall be 40mm diameter. All air bottles shall be 300mm long.

c) Automatic Vents

Automatic vents shall be provided with lockshield isolating valves and 15mm discharge pipes run to approved positions. Automatic vents shall be as equal and approved. Steam mains shall be provided with thermostatically operated air vents at all high points in the system to allow for quick warming up of the system after a shutdown.

d) Drain Points

Steam lines shall be provided with steam trapped condensate drain points at all low points at least every 40 meters on long lines. Drain pockets of diameter equal to that of the steam pipe shall be provided on lines up to 100mm diameter and of diameter 50mm less than the pipe diameter for pipes above 100mm. The condensate line from the trap shall enter the top of the condensate in the header or main.

Water lines and equipment shall be drainable through 15mm lockshield isolating valves and discharge pipes run to approved positions. Compressed air lines shall have trapped automatic condensate drains at all low points in the system.

3.1.13.13 Valves and Strainers

a) General

Valves and strainers shall be of the types specified elsewhere in this specification, of best quality and suitable in all respects for the duties for which they are intended.

b) Valves

Except where loose key or lever operation is specified, all manual valves shall be provided with handweels. Closing shall be by clockwise rotation of the handwheel. All valves shall conform to the following design and materials specification:

Bronze	B.S. 1400 LG-2C or A.S.T.M.B. 62-63
Cast Iron	B.S. 1452 GR14C or A.S.T.M.A. 445-63T
Ductile Iron	B.S. 1504-161A or A.S.T.M.A. 216 Grade WCB.

Mixing, thermostatic and other automatic valves shall be of 'fail-safe' design and where practicable self-acting.

3.1.13.14 Pressure Reducing Valve Sets

Pressure reducing valves shall be as equal and approved. They shall be installed complete with separator, isolating valves, strainer, pressure gauges, by-pass and control valves, etc and a pressure relief valve mounted on the low pressure side, sized in accordance with accepted practice, to fully protect any equipment in the event of failure of the pressure reducing valve. The relief valve shall be set, and all gauges shall be in place before steam is allowed to pass through any P.R.V. set. The discharge pipe from the pressure relief valve shall be run to the nearest drain point approved by the Engineer.

3.1.13.15 Instruments and Gauges - Pipework

Where shown on the drawings pressure gauges and thermometers shall be provided.

Pressure gauges shall be of the dial type with minimum 100mm dials and scaled to 50% in excess of maximum anticipated pressure.

They shall be fitted with isolating valves, gauge cocks and syphon bends and installed on extension pipes extended to a convenient position and properly supported. Gauges shall be tested against a deadweight tester in the presence of the Engineer and shall be accurate to within 2% over the working range. Pressure gauges shall be calibrated in kpa. Blow off holes in gauges shall be aimed in a safe direction, away from the operator. Thermometers shall be of brass mercury-in-glass type at least 150mm long and installed in thermometer pockets so that they may be removed without draining the pipeline. Angle or staring pattern thermometers as appropriate shall be used. Calibration shall be in ^{0}C.

3.1.13.16 Identification and Labelling

a) Pipework

All pipework, both insulated and uninsulated shall have coloured identification band and direction arrows marked on in clearly visible positions at maximum spacings of 6 meters on all runs. This spacing shall be reduced if necessary to ensure that each pipe and branch-passing through any form of space is coded, each branch has at least one coding band and there shall be a coding band within one meter of each valve, plant connections and flange or union.

The colours to be used for banding and arrows shall be agreed with the Engineer but shall comply as far as is possible with B.S. Bands and arrows shall be neatly stencilled using paint system compatible with the surfaces to which they are to be applied. Bands will consist of a base colour band and identification bands of contrasting colours and each 50mm wide.

All insulated pipework other than stainless steel, copper galvanised and polypropylene, shall be painted over the entire length prior to insulating with an approved anti-corrosive inert bituminous based paint, suitable for use on steam pipework. All other pipework shall be pained and code banded, as indicated elsewhere in this specification. On bare polypropylene, identification and direction of flow arrows shall be made by the sue of coloured adhesive tape (of a type approved by the Engineer) banded around the pipe in accordance with the foregoing positions.

b) Equipment Items

All plant and equipment items shall be labelled in a clearly visible position with the items name and, in the case of duplicate items, a number. Plant labels shall correspond with designations on the drawings. Labels shall be of rear engraved and filled 'trefoiled'' of sandwich thermosetting plastic with black lettering on white background. Lettering size shall be at least 6mm.

c) Valves

Section isolating valves and valves in service areas shall be labelled to identify the zones they serve and with an abbreviated code to identify the service. A schedule of labels required will be provided by the Engineer.

Valve labels shall be sandwich thermosetting plastic with black lettering on a white background secured to the valve stem with a light chain. Sample labels shall be submitted for approval.

3.1.14 Pipework System Materials

3.1.14.1 General

All materials shall be suitable for the temperature rating of the system in which they are installed. These ratings are given in the detailed specification.

3.1.14.2 Steam Reticulation and Condensate Return

a) Piping

150 mm and below	B.S. 1387, heavy class seamless, plain ends prepared for welding.
Above 150 mm	B.S. 3601/22 or AP1 5.L Sch 20 with wall thickness 6,35mm min.

b) Fittings

Steel but-weld fittings to B.S. 1640 or equal, wall thickness not less than pipe thickness.

c) Flanges

B.S. 4504

d) Valves

Steam Isolating Valves

Upto to 40mm	globe valves with cast bronze or ductile iron bodies, replaceable seat, bronze or stainless steel trim, union bonnet pattern and screwed by B.S. 21.
50mm to 150mm	globe valves with cast bronze or ductile iron bodies, replaceable seat, bronze or stainless steel trim, union bonnet pattern and flanged to B.S. 4504.
200mm and above	globe valves with cast bronze or ductile iron bodies valves with cast iron or ductile iron bodies replaceable seat, bronze or stainless trim, rising spindle pattern and flanged to B.S. 4504.

Steam Regulating Valves

These valves shall be needle valves of materials specification similar to isolating globe valves.

Condensate Valves

Upto to 40mm	Cast bronze of ductile iron bodies, replaceable seat, bronze or stainless steel trim, union bonnet pattern and screwed by B.S. 21.
50mm to 150mm	Cast iron or ductile iron bodies, replaceable seat, bronze or stainless steel trim, union bonnet pattern and flanged to B.S. 4504.

Gate Valves

Upto to 40mm	ductile iron bodies, replaceable seat, bronze or stainless steel trim, union bonnet pattern and screwed by B.S. 21.

Non return valves

Upto to 40mm	bronze swing check screwed to B.S. 21.
50mm to 150mm	ductile iron bodies, replaceable seat, bronze or stainless steel trim, union bonnet pattern and flanged to B.S. 4504.

Sight Glasses

Bronze/Gunmetal bodies, single window combined sight-check valves may be used only where installed safe from Mechanical damage.

Steam Traps

For line draining	Inverted bucket steam trap (stainless steel trim).
For equipment	Ball float steam trap to correct pressure range or equal, unless otherwise specified on the drawings. (Stainless steel trim)

Air vents

Thermostatic vent depending on pressure.

Pressure Reducing Valves

Diaphragm pilot operated reducing valve. Stainless steel trim, phosphor bronze diaphragm, correctly sized for flor rate and with high turn-down accuracy and tight shut-off.

Strainers

Up to 50mm	Malleable or cast iron body, stainless steel screen and screwed connections to B.S. 21
65mm and above	Cast Iron or S.G. iron body, stainless steel screen and fanged connections

3.1.14.3 Cold and warm 45^{0}C Water Reticulation

a) Piping

Piping - Steel

Up to 150mm	Galvanised steel piping to B.S. 1387, medium class, screwed and socketed.
Above 150mm	B.S. 3601/22 or API equivalent, 4.5mm wall thickness with plain ends for welding. To be hot dip galvanised after fabricating.

Piping - Polypylene

Up to 25 mm	1 500 kpa rated. Extruded from polypropylene - ethylene grade and shall be heat and U.V. stabilised to B.S. 4991 or ISOR 160.
32mm and above	600 kpa rated for cold water and 900 kpa for warm water. Extruded from propylene acetylene and shall be heat and U.V. stabilised to B.S. 4991 or ISOR 160.

b) Fittings

Fittings -Steel

Up to 100mm	Fusion welded and of exactly the same material as the polypropylene piping.
Above 125mm	butt welded or fusion welded and of exactly the same material as the polypropylene piping.

Fittings -Polyprolene

Up to 150mm	Galvanised malleable iron fitting.
Above 125mm	flanged to B.S. 4504. Fabricated or forged steel.

c) Flanges

Flanges - Steel

50mm to 150mm	B.S. 4504 screwed and galvanised.
Above 125 mm	Butt welded or fusion welded and of exactly the same material as the polyprolene piping.

Flanges - Polypropylene

Full face polypropylene or polypropylene stub flanges with mild steel backing rings drilled to B.S. 4504.

d) Gaskets

6mm rubber insertion.

e) Valves

Globe

Up to 40mm	bronze body, bronze or stainless steel trim, replaceable seating, and screwed to B.S. 21.
65 and above	cast iron body, bronze or stainless steel trim, replaceable seating flanged to B.S. 4504.

Gate

Up to 40mm	bronze body, bronze or stainless steel trim, replaceable seating, and screwed to B.S. 21.
65mm and above	cast iron body, bronze or stainless steel trim, replaceable seating flanged to B.S. 4504.

Check-valves

Up to 40mm	bronze body, bronze or stainless steel trim, replaceable seating, and screwed to B.S. 21.
65 and above	cast iron body, bronze or stainless steel trim, replaceable seating flanged to B.S. 4504.

Ball valves

Up to 50mm	chrome plated brass, teflon seat rings screwed to B.S. 21, with fixed operating handle.

Restrictor Valves

Ball stop with c=screw driver operation as supplied by castle Brass or equal.

f) Strainers

Up to 50mm	Malleable iron bodies, stainless steel screen and screwed connections to B.S. 21.
65 and above	cast iron or S.C. iron bodies, stainless steel screen and flanged connections.

3.1.14.4 Hot water (85^0C)

a) Piping

Piping - Steel

Stainless steel type 304 L to A.S.T.M specification A312. Wall thickness 2mm minimum longitudinally welded. NOTE All welds made in the pipe during manufacture shall be suitably cold worked to relive stresses and normalize crystal structure in order to prevent stress corrosion occurring while the pipe is in service at 85^0C. All joints in run and to fittings to be welded, using a suitable inert gas technique.

Piping - Polypropylene

Up to 25mm	1,500 kpa rated. Extruded from polypropylene - ethylene grade and shall be U.V. stabilised, to B.S. 4991 or ISOR 160.
32mm and above	1,500 kpa rated. Extruded from polypropylene - ethylene grade and shall be U.V. stabilised, to B.S. 4991 or ISOR 160.

Piping - Copper

Type CU DHP complying with B.S. 2051

b) Fittings

Fittings - Steel

Stainless steel type 304L welded.

Fittings - Polypropylene

Up to 100mm	Fusion welded of exactly the same material and pressure rating as the polypropylene piping.
125mm and above	Flanged and of exactly the same pressure rating and material as the polypropylene piping.

Fittings - copper

Up to 50mm	Capillary to B.S. 864 or screwed to B.S. 21. Above 50mm flanged, brazed or bronze welded.

c) Flanges
Flanges - Steel

Stainless steel type 304L flat face - slip-on, to B.S. 4504.

Flanges - Polypropylene

Full face polypropylene or polypropylene stub flanges with mild steel backing rings drilling to B.S. 4504.

Flanges - copper

Bronze or gunmetal brazed or welded to pipe, B.S. 4504. Brass bolts, nuts and washers to be used.

d) Gaskets

6mm Rubber insertion.

e) Valves
Globe (throttling valve only)

Up to 40mm bronze body, bronze or stainless steel trim, replaceable seating and screwed to B.S. 21.

50mm and above Cast iron body, bronze or stainless steel trim, replaceable seating and screwed to B.S. 4505.

Gate

Up to 40mm bronze body, bronze or stainless steel trim, replaceable seating and screwed to B.S. 21.

50mm and above Cast iron body, bronze or stainless steel trim, replaceable seating and screwed to B.S. 4505.

Valves

Up to 40mm bronze body, bronze or stainless steel trim, replaceable seating and screwed to B.S. 21.

50mm and above Cast iron body, bronze or stainless steel trim, replaceable seating and screwed to B.S. 4505.

Check Valves

Up to 40mm bronze body, bronze or stainless steel trim, replaceable seating and screwed to B.S. 21.

50mm and above Cast iron body, bronze or stainless steel trim, replaceable seating and screwed to B.S. 4505.

Ball Valves

Up to 40mm chrome plated brass, teflon seat rings, screwed to B.S. 21 with fixed operating handle.

Restrictor Valves

Ballstop with screwdriver option.

Finish - Machined brass unless specified otherwise.

f) Strainers

Up to 50mm Malleable iron body, stainless steel screen and screwed connections to B.S. 21 65mm and above malleable iron body, stainless steel screen and flanged connections

3.1.14.5 Hot water (85^0C)

a) Piping

Piping - Steel

Up to 150mm Steel piping (Black) to B.S. 1387 medium class plain ends for welding.

Above 150mm Steel piping to B.S. 3601/22 or API Equivalent 4, 5 mm wall thickness plain ends for welding.

Piping - Polypropylene

Up to 100mm 1,500 kpa rated. Extruded from polypropylene - ethylene grade and shall be U.V. stabilised, to B.S. 4991 or ISOR 160.

b) Fittings

Fittings - Steel

Butt-weld fittings to B.S. 1640.

Fittings - Polypropylene

Up to 100mm	Fusion welded of exactly the same material and pressure rating as the polypropylene piping.
125mm and above	Butt welded or fusion welded and of exactly the same pressure rating and material as the polypropylene piping.

c) Flanges

Flanges - Steel

B.S. 4504 wrought steel, flat faced, slip on.

Flanges - Polypropylene

Full face polypropylene or polypropylene stub flanges with mild steel backing rings drilling to B.S. 4504.

d) Valves

Up to 50mm	ball valves with bronze body, hard chromed bronze ball, teflon seats, screwed, to B.S. 21. Alternatively forged steel body, stainless steel ball.
65mm and above	globe valves with cast iron body, bronze seating rising spindle, flanged to B.S. 4504.

Check Valves

Non-slam double swing check valves with cast iron body, bronze flaps and neoprene seat, fitted between flanges.

Traps

15mm	Automatic trap with internal strainer, or approved equal.
20mm	Angle strainer fitted before trap or approved equal. All traps to have balance pipe.

Filter, Regulator, Lubricator Sets

8 mm	Complete with pressure gauge and manual operated drains on filter unit.
	10, 15, & 25mm complete with pressure gauge and manual operated drains on filter unit.

Filter and Regulator

As for filter, regulator and lubricator sets but without lubricator.

e) Moisture separators

Up to 40mm	Vertical type screwed inlet and outlet to B.S. 21 complete with drain trap.
32mm and above	Horizontal type flanged connections, complete with drain trap.

3.1.14.6 Chilled Water Pipework

a) Piping

upto 80 mm	B.S. 1307 medium class, screwed and socketed.
100mm to 150mm	B.S. 1387 medium class. Plain ends prepared for welding.
Above 150 mm	B.S. 3601/22 or API equivalent with wall thickness 5 mm minimum. Plain ends prepared for welding.

b) Fittings

Steel butt-weld fittings to B.S. 1640 or equal, wall thickness not less than pipe thickness or screwed malleable iron fittings as applicable.

c) Flanges B.S. 4504

d) Gaskets Rubber insertion

e) Valves
Cocks - Balancing Valves

Upto to 50mm	bronze body, bronze or stainless steel trim, replaceable seating and screwed to B.S. 21.
65mm and above	Cast iron body, outside screw and yoke, bolted bonnet, replaceable seating, rising stem incorporation back seal, bronze or stainless steel trim, and flanged to B.S. 4504.

Gate

Upto to 50mm	bronze body, bronze or stainless steel trim, replaceable seating and screwed to B.S. 21.
65mm and above	Cast iron body, outside screw and yoke, bolted bonnet, replaceable seating, rising stem incorporation back seal, bronze or stainless steel trim, and flanged to B.S. 4504.

Check Valves

Upto to 50mm	bronze body, bronze or stainless steel trim, replaceable seating and screwed to B.S. 21.
65mm and above	Cast iron body, bronze seating, swing-check, flanged to B.S. 4504

f) Strainers

All strainers to be installed as follows:

Up to 50mm diameter screwed to B.S. 21. 50mm and over flanged to B.S. 4504.

Screwed ends Bronze body, stainless steel screen.

Flanged ends Cast Iron body, stainless steel screen.

3.1.14.7 Condenser Water Pipework

a) Piping

upto 80 mm	B.S. 1307 medium class, screwed and socketed.- galvanised.
100mm to 150mm	B.S. 1387 medium class. Flanged ends - galvanised after manufacture.
Above 150 mm	B.S. 3601/22 or API equivalent with wall thickness 5 mm minimum, flagged ends - galvanised after manufacture.

b) Fittings

Up to 80 mm	Galvanised malleable iron fittings to B.S. 143 screwed to B.S. 21.
Above 80 mm	Flanged to suit.

c) Flanges

Up to 80 mm	B.S. 4504 screwed and galvanised.
Above 80 mm	B.S. 4504 slip on. Pipe and Flange galvanised after manufacture.

d) Gaskets Rubber insertion

e) Valves

Valves shall be all as specified for chilled water, 17.18.6 e.

f) Strainers

Strainers shall be all as specified for chilled water 17.18.6 e.

3.2 GENERAL TECHNICAL SPECIFICATION - COMMISSIONING

3.2.1 General

Before any commissioning work takes place, the sub-contractor shall submit a set of schematic commissioning drawings showing duct runs, and other equipment, air flows, water flows and controls. These drawings to be accompanied by the method proposed for commissioning of the plant, as by the method proposed for commissioning of the plant, as well as the number of people involved, their names and experience. The Engineer's approval on the above item is essential before any commissioning takes place.

3.2.2 Maintenance Manuals

The Sub-Contractor shall provide, before any commissioning work starts, three copies of the maintenance and operating manuals for the plant supplied. These manuals shall be sewn and bound in book form with hard plastic covers to withstand constant use; and shall be properly indexed to facilitate quick references. Prior to the submission of the three copies mentioned above the Sub-Contractor shall submit one draft copy of the maintenance and operating manuals for approval. The works shall not be considered to be completed for the purposes of taking over until such manuals have been supplied to the Engineer, and subsequent equipment test results have been included in them.

The manuals shall include:-

(a) A list of recommended servicing tools and specialist plant.

(b) A list of recommended spares necessary for a period of 2 years operation.

(c) Exploded drawings or spares lists from which every item of every place of plant can be positively identified of each item of plant.

(d) A list of giving the name and address of the manufacturer of each item of plant.

(e) A copy of all test certificates obtained with the plant.

(f) A list of recommended lubricants.

(g) A preventive maintenance programme for all plant.

(h) Operating instructions for each item of plant.

(i) Performance data, equipment tests and characteristics curves.

3.2.3 INITIAL TESTING AND PLANT COMMISSIONING

3.2.3.1 Initial Testing

(a) Pressure Testing - Piping

All pipework system shall be pressure tested by filling with water and raising the pressure to 1.5 times working pressure. They shall then be left for a period of at least one hour during which all joints must remain water-tight. Any fault found during the pressure test shall be remedied and the test reapplied until the same is dealt with completely.

The pipework shall be tested in sections to suit the construction programme and all services in concealed locations shall be tested before they are finally concealed. No insulation shall be applied before tests have been carried out.

The Sub-Contractor shall provide all test equipment and all additional items such as toes, valves, drain fittings, etc. which are necessary to enable the systems to be treated in sections. Each test shall be witnessed by the Engineer or his nominated agent and also a signed certificate of approval shall be obtained.

(b) Draining and Cleaning

On completion of the pressure test on a section of pipework the water used for testing shall be drained away as quickly as possible to remove as much dirt and dross as possible. After completion for a pipework circuit the circuit shall be flushed through to remove all pipe scale, dress and similar material.

(c) Pressure Testing - Ducting

See section on ducting.

(d) Insulation Tests

All electrical wiring and controls integral with the plant supplied shall be subjected to insulation tests. All instrument and other equipment required for the tests shall be provided by the sub-contractor.

(e) Drives

All drives shall be run and tested for direction rotation and correspondence of alignment.

3.2.3.2 Plant Commissioning

The Sub-Contractor shall check over and test and satisfy himself that all items of plant are correctly assembled and aligned before start-up. This work is to be carried out by skilled commissioning Engineers who are completely familiar with the plant involved.

The Engineer shall vitreous plant commissioning as required by him and the contractor must advise the Engineer prior to any commissioning work taking place.

On completion of the plant commissioning, the Contractor shall provide written confirmation to the Engineer that he has completed all commissioning work and is satisfied that the items of plant are operating satisfactorily.

3.2.3.3 Test of Completion

No completion of the Sub-Contractor's initial testing and commissioning as specified above, the plant shall be put into normal operation and the final adjustment of the plant shall be made. Thereafter the Tests on completion shall be carried out to ensure that the plant will fulfill the function for which it has been designed. These shall extend for a period of at least four weeks and shall include the following:

(a) Simulated tests for all alarm and safely cut out equipment.

(b) Simulated tests on automatic controls.

(c) Capacity tests to ensure that the plant supplied will handle the quantities specified.

The Engineer reserves the right to witness all tests.

The Sub-Contractor shall utilise the Engineer's manual Equipment performance and capacity.

The Sub-Contractor shall at his own cost render all assistance and supply all labour, appliances and any other materials, as may be required to carry out these tests. All instruments shall be accurately calibrated before the tests begin.

On completion of the whole of the tests and when the sub-contractor is satisfied that the entire plant is operating satisfactorily and will fulfil the function for which it has been designed, he shall submit to the Engineer triplicate copies of all tests records and charts together with reports on all the tests called for in this specification. The Engineer shall reserve the right to ask for previous tests in order to prove that the operation of the plant is satisfactory and in accordance with the specification and drawings.

The Sub-Contractor shall be responsible for the proper operation and running maintenance of the plant throughout the period of the tests. The Sub-Contractor shall provide full time experienced commissioning Engineers and artisan staff during the entire testing period.

At the commencement of and during the whole of the testing period the Sub-Contractor shall be required to have stored on site all essential spares and tools considered necessary to enable repair work of defective parts to be carried out immediately in the event of a breakdown.

The operation and maintenance manuals shall be completed and handed over to the Engineer before the start of any commissioning work and in any case, prior to the issuing by the Engineer of the taking-over certificates. The period of maintenance shall be deemed to have started upon the date of issuing of the taking-over certificate.

3.2.4 OPERATOR TRAINING PERIOD

The Operator Training Period on the whole of the works or on any part thereof shall commence at the date to be fixed after the issue of the taking over certificate and mutually agreed with the Engineer. This period shall continue for a period sufficient to ensure that the operations are fully conversant with the functions they are to perform, but shall not exceed a period of 5 days.

The Contractor shall provide full-time instructions during the entire operator training period who shall be fully experienced in the class of work and shall be capable of training the operating and maintenance staff in the duties they are to perform.

3.2.5 PERIOD OF MAINTENANCE (Defects Liability)

The expression period of maintenance shall mean a period of 12 months from the date of taking over in accordance with Clause 3.3 hereof.

PART D:
PARTICULAR SPECIFICATION

FOR

MECHANICAL VENTILATION, AIR CONDITIONING AND REFRIGERATION SERVICES

4 PART D - PARTICULAR SPECIFICATION

FOR

MECHANICAL VENTILATION, AIR CONDITIONING AND REFRIGERATION SERVICES

4.1 Particular Conditions

4.2 Location of Site

The site of the proposed Sub-Contract works shall be at The Nairobi Hospital along Argwings Kodhek Road.

4.3 Description of the Project

The project comprises of Conversion of Meeting Rooms on Third Floor of Anderson Centre to Doctors Clinics.

4.4 Commencement of Works

The Sub-Contractor in submitting his tender shall be deemed to have included for commencing any necessary work on site at such time as will comply with the Main Contractor's programme.

4.5 Climatic Conditions

The following climatic conditions apply at site of the works and all plant, equipment, apparatus, materials and installations shall be suitable for these conditions.

Where not otherwise stated, all rating of plant, equipment and apparatus shall be interpreted at site ratings and NOT sea level or other ratings.

Maximum temperature	31.5^0C
Minimum temperature	24^0C
Average Diurnal Range	11.7^0C
Relative humidity range	48-93%
Altitude	10.5m above sea level
Latitude	01 19’S
Longitude	36^0 49'E
Mean Rainfall	911mm per year.
Maximum Rainfall	1475mm

The Sub-Contractor shall be deemed to have taken account of the above details in his prices and his planning of the execution of the works.

4.6 Scope of the Sub-Contract Works

The Sub-Contract shall comprise the supply, delivery, erection, testing, commissioning and setting to work of mechanical ventilation and air conditioning systems detailed in this Specification and the accompanying Contract Drawings.

The Sub-Contract Works shall include for all appurtenances and appliances not particularly called for in this Specification or on the Contract Drawings but which are necessary for the completion and satisfactory functioning of the Sub-Contract Works.

No claims for extra payment shall be accepted from the Sub-Contractor due to his failure to adhere to the above requirements. It is deemed that if, in the opinion of the sub-contractor at the time of tendering, there existed a difference between the Specification and the Contract Drawings that the Sub-Contractor clarified this difference with the Engineer before tendering.

The works to be installed under the Sub-Contract shall comprise air conditioning but not restricted to mechanical ventilation systems, air conditioning and refrigeration systems as described and shown on the drawings.

4.7 Design Conditions

The air conditioning systems are designed to maintain 23^0C internal conditions with an external ambient temperature of 31.5^0C db.

4.8 Air Conditioning System

Natural ventilation shall be encouraged as much as possible with mechanical ventilation and air conditioning being adapted to suit specific operational requirements.

The proposed air conditioning shall vary from complex AHUs systems to fan coil units depending in room occupancy, sound levels, energy saving considerations and environmental impact shall be carefully considered at design stage. Care shall be taken to ensure fresh air replenishments and filtration to acceptable limits. In the conference and low level grilles shall be incorporated to handle foul smell and solid particles.

The air handling units and indoor fan coil units shall be chosen and designed to suit duty requirements for the areas served. Care shall be exercised to ensure uniform distribution of air to avoid direct draughts to the occupants and also avoiding hot and cold spots. Air freshness shall also be critically addressed in the designs. The rooms and especially the conference rooms etc. shall be maintained at positive pressure to preclude dust ingress.

Air discharge units (grilles) and ducts shall be designed to ensure silent operation with attenuation incorporated in the designs. This is to ensure a serene atmosphere required. Grille patterns and finishes shall be selected in close liaison with the Architect to ensure harmony with the interior décor.

Maintenance and environmental considerations shall be critically addressed to ensure that equipment incorporated in the works are maintainable. Only environmentally friendly units, with local representation and spare parts distribution and from reknown models with proven past performance shall be considered. Systems with ozone depleting C.F.C based refrigerants shall not be considered.

Extract systems for landlocked cloak and changing rooms will be proposed to enhance air flows and remove odours. Areas with good cross ventilation shall be kept under natural ventilation.

High precision Air conditioning units shall be proposed in sensitive ICT and equipment rooms with duty and standby units to ensure reliability and long equipment live. The cooling loads shall be worked out in liaison with specialist equipment suppliers to ensure right sizing and appropriate controls. The designs shall allow for reasonable future expansion. All the air conditioning shall be BMS compliant for ease of monitoring, scheduled maintenance and operation.

All advantages shall be exploited for maximum benefit while limitations shall be carefully analysed and mitigated in design.

4.9 Extract Fans

These shall be similar or equal to WOODS fans manufactured by Woods of Colchester of the United Kingdom. The fan to be standard length type with a casing that covers the overall length of the impeller and the motor.

4.10 Hoods

The hood shall be fabricated from 1.8mm thick Aluminium sheet steel, covering the entire Hood. 'Vokes' filters will be included each size 500 x 686 x 565mm. Hoodlights as PL bulkhead fittings, 18 Watts, or equal and approved.

The hood should be installed at a minimum height of 1900mm from the finished floor level. A 75 x 40mm grease drain channel will be incorporated in the hood inclusive of 8 No. drain plugs. Hoods designs shall be issued on approval from the Client.

5 PART D - BILLS OF QUANTITIES

CONTENTS

5.1 GENERAL NOTES TO TENDERERS

1. The Bills of Quantities form part of the contract documents and are to be read in conjunction with the contract drawings and general specifications of materials and works.

2. The prices quoted shall be deemed to include for all obligations under the sub-contract including but not limited to supply of materials, labour, delivery to site, storage on site, installation, testing, commissioning (**excluding 16% VAT**).

3. All prices omitted from any item, section or part of the Bills of Quantities shall be deemed to have been included to another item, section or part thereof.

4. The brief description of the items given in the Bills of Quantities are for the purpose of establishing a standard to which the sub-contractor shall adhere. Otherwise alternative brands of **equal** and **approved** quality will be accepted.

5. Should the sub-contractor install any material not specified here in before receiving **written approva**l from the Project Manager, the sub-contractor shall remove the material in question and, **at his own cost**, install the proper material.

6. The grand total of prices in the price summary page must be carried forward to the **volume 1**.

7. The Bills of Quantities are divided generally into three sections:-

a. Contractual Requirement – Bill 1

The sub-contractor shall study the conditions and make provision to cover their cost in this Bill. The number of contractual items to be priced by the Tenderer have been limited to tangible items such as site office, temporary works and others. However the Tenderer is free to include and price any other items he deems necessary taking into consideration conditions he is likely to encounter on site.

b. Installation Items – Other Bills

The brief description of the items in these Bills of Quantities should in no way modify or supersede the detailed descriptions in the contract Drawings, conditions of contract in volume 1 and specifications. The unit of measurements and observations are as per those described in the contract documents.

c. Summary

The summary contains tabulation of the separate parts of the Bills of Quantities carried forward with provisional sum, and any prime cost sums included. The sub-contract shall insert his totals and enter his grand total tender sum in the space provided below the summary.

This grand total tender sum shall be carried forward to main summary of volume 1 of the main works.

PROPOSED LABOUR WARD RENOVATIONS AT NAIROBI HOSPITAL

AIR CONDITIONING & MECHANICAL VENTILATION SYSTEM

BILLS OF QUANTITIES

SECTION D.W. (I) TITLE: PRELIMINARIES & CONTRACTUAL REQUIREMENTS

Item	Description	Unit	Qty	Rate	KShs.
	PRELIMINARIES & CONTRACTUAL REQUIREMENTS				
A.	Preparation of working drawings, printing and distribution.	Sum			-
					-
B.	Preparation of 'As Installed Drawings", printing and distribution as specified. Drawings to include:				-
	(a) Blue Prints - 4 sets of each.	Sum			-
	(b) AutoCAD on Flash Drive (5 GB) – 2 No.	Sum			-
	(c) Operational Instructions, manuals and test certificates	Sum			-
C	Allow for any other preliminary stated in the conditions of contract	Sum			-
D	Any other item necessary to complete the installations in this section (please state)	Sum			-
	Carried to Main Summary Page				-

SECTION D.W 1: LABOUR WARD- AIR CONDITIONING - OUTDOOR UNITS

Item	Description	Unit	Qty	Rate KShs.	Cost KShs.
1	**OUTDOOR UNITS**				
	VRV AIR CONDITIONING SYSTEM : CORPORATE CENTER FINANCE OFFICES				
	Supply, install, test and commission the following air conditioning units. The units must be wired for automatic resetting in case of power failures.				
	'VRV/VRF System as DAIKIN, LG, TOSHIBA or an approved equivalent", inverter heat pump type air conditioning system or equal and approved comprising outdoor/indoor units including supports and all safety devices of high pressure switch, fan motor driver overload protector, inverter overload protection over current relay and PCB fuse all as described here below. Indoor units to be complete with wired remote controllers.				
	The Outdoor Units.				
A	These shall be as "DAIKIN , TOSHIBA, LG ARUM100LTES" or an approved equivalent" VRV/VRF system to have heat recovery and to be a **3 PIPE SYSTEM** for provision of simultenous heeating and cooling. **Cooling Capacity:** 28kW **Heating capacity:** 28kW Dimensions (HxWxD in mm) approx. 1690x930x760),Weight approx.215Kg. The compressor to be of the hermetically sealed scroll type with power input 3ph, 380 – 415V, 50Hz supply. Compressor to be for use with CFC FREE refrigerant. (**Note that R22 and any other ozone depleting refrigerant will not be acceptable)**. The unit shall be complete with function unit to manufacturer's specification, safety devices including HPS, fan driver overload protector, over current relay, inverter overload protector, PC Board fuse,Building Management System (BMS) interface etc.	Set	1		-
B	Supply of 3 Phase Monitor / Voltage Surge Protection Device	No.	1		-
	Sub-total carried to next page				-

SECTION D.W 1: LABOUR WARD- AIR CONDITIONING - OUTDOOR UNITS

Item	Description	Unit	Qty	Rate KShs.	Cost KShs.
	bal b/f				-
	Main Line: Refrigerant Pipe Work				
C	Supply, deliver & install of refrigeration copper pipe work complete with 25mm Armoflex Rubber Insulation for suction/liquid line including all the fittings, 'Y' Joints, Distributors etc. size19.1 mm to 41.3 mm. Rate includes the provision of 150mm cable trays	LM	120		-
	Electrical Works				
D	Inter connecting Control / Network Cables (Sheilded) to Indoor Units and / to Outdoor Units	LM	40		-
E	Allow for power connection from an isolator located approx 1 meter from the outdoor unit. (Not provision of isolator by others)	Item	1		-
	Sub-total carried to Main Collection Page				-

SECTION D.W 2: LABOUR WARD- AIR CONDITIONING- INDOOR UNITS

Item	Description	Unit	Qty	Rate KShs.	Cost KShs.
2	**INDOOR UNITS** ***Direct expansion fan coil evaporating units as "Daikin VRV IV" or equal and approved complete with all necessary multiconnection piping kits including all refigerant piping and fittings and branch connectors/controllers, evaporator fan motor, Fresh air Kit consisting of filter duct and external air grille and louvre, wired remote controller,drain up kit, and wiring to the power distribution. All refrigerant piping to be complete with 25mm Armoflex rubber insulation and including all fittings, "Y" Joints, Distributors, Branch connectors, etc. Note: Indoor Unit to match outdoor unit (3 pipe type indoor units)***				
A	5.2kW (18,000 Btu/hr.) Ceiling Concealed Air Conditioning Unit as Daikin, LG, Toshiba, or an approved equivalent, Dimensions in mm (H x W x D) 900 x 190 x 700, power input of approx. 56 watts	No.	1		-
B	3.6kW (12,000 Btu/hr.) Ceiling Concealed Air Conditioning Unit as Daikin, LG, Toshiba, or an approved equivalent, Dimensions in mm (H x W x D) 900 x 190 x 700, power input of approx. 34 watts	No.	6		-
	Sub-total carried to Main-Collection Page				-

SECTION D.W 3: LABOUR WARD- AIR CONDITIONING - ACCESSORIES

Item	Description	Unit	Qty	Rate KShs.	Cost KShs.
3	**AIR CONDITIONING ACCESSORIES**				
	Refrigerant Pipe Work				
A	Supply, deliver & install of refrigeration copper pipe work complete with 25mm Armoflex Rubber Insulation for suction/liquid line including all the fittings, 'Y' Joints, Distributors etc. size 6.5mm to 35mm. Rate includes the provision of 150mm cable trays to approval	LM	210		-
	Electrical Works				
B	Inter connecting Control / Network Cables (Sheilded) to connect VRV Indoor Units and / to Outdoor Units	LM	70		-
	Drainage Pipework				
C	Supply and install of uPVC drain pipe work to connect indoor units to drainage outlets complete with all fittings support brackets etc.	Item	1		-
					-
	Ductwork				-
D	Galvanised iron sheet metal ducting (22 SWG) complete with Armacell 22mm insulation including transformation, tees, bends, plenum, etc. manufactured to DW/144 specification with sealed joints and hangers/supports complete with all necessary accessories.	SM	30		-
	Diffusers/ Grilles				
E	Supply and install of Square Diffusers 600x600mm (Supply / Return) with Volume Control Damper as Waterloo or equal and approved. Diffuser to be constructed from extruded aluminium sections and finished in matt paint (white) and to be complete with air-supply volume control damper and supply plenum box with 200mm or 300mm diameter opening to branch.	NO	16		-
F	1200mm long One-way linear slot diffuser with at least three slots (approx. width 150mm) and with fixing accessories for gypsum (dry wall) ceiling. Diffuser to be constructed from extruded aluminium sections and finished in matt paint (white) and to be complete with air-supply volume control damper and supply plenum box with 150mm diameter opening to branch.	NO	2		-
	Sub-total carried to Main -Collection Page				-

SECTION D.W 4: LABOUR WARD- MECHANICAL VENTILATION

Item	Description	Unit	Qty	Rate	Cost KShs.
4	**FANS, DUCTING & GRILLES - GENERAL AREAS**				
	Supply fan				
A	Supply, deliver and install Supply/Extract Fan as SystemAir Capacity 2000 Cu. M/Hr at 200 Pa, complete with necessary accessories. F. Fans to come complete with brackets for mounting externally to match existing brackets on lower floors.	No.	1		-
	Diffusers/ Grilles				
B	Supply and install of Square Diffusers 600x600mm (Supply / Return) with Volume Control Damper as Waterloo or equal and approved. Diffuser to be constructed from extruded aluminium sections and finished in matt paint (white) and to be complete with air-supply volume control damper and supply plenum box with 200mm or 300mm diameter opening to branch.	NO	4		-
	Fresh Air Supply Ducts				
C	Galvanised iron sheet metal ducting (22 SWG) including transformation, tees, bends, plenum, etc. manufactured to DW/144 specification with sealed joints and hangers/supports complete with all necessary accessories.	SM	30		-
D	***Flexible Ducts- Uninsulated***				
(i)	Supply of Un-Insulated Flexible Duct 300mm Dia	LM			-
(ii)	Supply of Un-Insulated Flexible Duct 200mm Dia	LM	4		-
(iii)	Supply of Un- Insulated Flexible Duct 150mm Dia	LM	0		-
E	Supply and install Discharge Louver with Insect Screen 400 x 300mm	No	1		-
	Sub-total carried to Main Collection Page				**-**

SECTION D.W 5: LABOUR WARD- TOILET/ SLUICE EXTRACTION SYSTEM

Item	Description	Unit	Qty	Rate KShs.	Cost KShs.
5	**FANS, DUCTING & GRILLES - TOILET/SLUICE EXTRACTION**				
	Toilet/Sluice Extract Fan				
A	Supply, deliver and install Extract Air Fan as Solar Palau Silent or approved equivalent. Power input 0.29 kW, Capacity 240m3/hr @ 100 Pa complete with all necessary accessories.	No	9		-
B	"Waterloo Air Products Plc" WR/6/PPM9010/LD Disc valves of 150mm dia: for Supply/Return Air complete with adjustable damper and fixing ring able to deliver at Noise level of <50 NC	No	18		-
C	Supply and install Discharge Louver with Insect Screen 300 x 200mm	No	9		-
					-
	Toilet extract duct				-
D	Galvanised iron sheet metal ducting (22 SWG) including transformation, tees, bends, plenum, etc. manufactured to DW/144 specification with sealed joints and hangers/supports complete with all necessary accessories.	SM	130		-
E	***Flexible Ducts***				
(i)	Supply of Un-Insulated Flexible Duct 300mm Dia	LM	0		-
(ii)	Supply of Un-Insulated Flexible Duct 200mm Dia	LM	0		-
(iii)	Supply of Un- Insulated Flexible Duct 150mm Dia	LM	18		-
	Sub-total carried to Main -Collection Page				-

SECTION D.W 6: LABOUR WARD- SERVER/UPS ROOM AIR CONDITIONING

Item	Description	Unit	Qty	Rate KShs.	Cost KShs.
6	**SERVER/ UPS ROOM**				
	Split AC Unit				
A	Supply, deliver and install Wall Mount Type Split A/C Unit as Daikin or Toshiba - 24,000 BTU/ Hr Cooling, Power input of 1.9 kW / 1 Ph complete with matching condensing Unit, wall mounted AC drainage pump, and all necessary accessories	No.	1		-
	Refrigerant Pipe Work				
B	Supply, deliver & install of refrigeration copper pipe work complete with 25mm Armoflex Rubber Insulation for suction/liquid line including all the fittings, 'Y' Joints, Distributors etc. size 6.5mm to 35mm. Rate includes the provision of 150mm cable trays to approval	LM	50		-
	Electrical Works				
C	Allow for Electrical Connection for Outdoor and Indoor Units from Local Isolators / D P Switches provided by others	Item	1		-
D	Inter connecting Control / Network Cables (Sheilded) to connect Indoor Units and / to Outdoor Units	LM	25		-
E	Supply of AVS 30 Amp Voltage Surge Protection Device	No.	1		-
	Drainage Pipework				
F	Supply and install of uPVC drain pipe work to connect indoor units to drainage outlets complete with all fittings support brackets etc.	Item	1		-
	Sub-total carried to main collection page				-

MAIN COLLECTION PAGE

Item	Description				Price (KShs.)
	PROPOSED LABOUR WARD AT NAIROBI HOSPITAL **AIR CONDITIONING & MECHANICAL VENTILATION** **MAIN COLLECTION PAGE**				
(i)	Preliminaries and General Conditions				-
1	Outdoor Units				-
2	Indoor Units				-
3	Air Conditioning Accessories				-
4	Mechanical ventilation				-
5	Toilet/ Sluice Extraction				-
6	Server/ UPS Room				-
	TOTAL (VAT Inclusive)				-
	Sub-total carried to Main Summary Page				-

6 TECHNICAL SCHEDULE AND APPENDICES

6.1 TECHNICAL SCHEDULE

The tenderer must complete in full the technical schedule. Apart from the information required in the technical schedule, the tenderer **MUST SUBMIT** comprehensive manufacturer's technical brochures and performance details for all items listed in this schedule (fill forms attached).

ITEM No.	Description	Manufacturer	Country of origin	Remarks (Catalogue No. etc.)
A	GMS Duct			
B	Diffusers			
C	Volume Control Dampers			
D	Air Conditioning Units			
E	Ductwork Insulation			
F	Cold Room Evaporator			
G	Cold Room Condenser			
H	Filter Drier			
I	Control Panel			
J	Refrigerant Pipes			
K	Refrigerant Gas			
L	Refrigeration Controls			

6.2 DOCUMENTATION REQUIREMENTS

Document	With Bid	Before Manufacture	During FAT	Upon Delivery
Preliminary general arrangement drawing (with dimensions)	YES			
QA / QC Plan in accordance with ISO 9001:2008		YES		
General arrangement drawing (with dimensions)		YES		
Schematics/Line diagrams for construction	N/A	YES	N/A	N/A
Recommended Spares List	N/A	N/A	N/A	YES
Routine Test Reports / Certificates			YES	
Type Test Reports / Certificates	N/A	N/A	YES	N/A
Commissioning Procedure	N/A	N/A	N/A	YES
As-built General arrangement drawing			YES	
As-built Schematics			YES	
Site Test Reports / Certificates				YES
Special Test Reports / Certificates	N/A	N/A	YES	NO

APPENDICES

7 APPENDICES

7.1 Appendix I: Tender Evaluation Criteria

TENDER EVALUATION CRITERIA

TECHNICAL & FINANCIAL EVALUATION

SEC	REQUIREMENT SUMMARY	CRITERIA	TARGET SCORE	BIDDER'S SCORE
1	**TECHNICAL EVALUATION**			
a	Performance	Maximum of 10 as evaluated by Eng.	**10**	
b	Warranty	Maximum of 10 as per below schedule 1 year and below ---> Score of 2 1-3 years ---> Score of 6 3-10 years ---> Score of 10	**10**	
c	Product Life	Maximum of 10 as per below schedule 5-10 years ---> Score of 2 10-15 years ---> Score of 5 15 years and above ---> Score of 10	**10**	
d	Spare parts/Consumables and their availability. Local Back-up (maintenance)		**5**	
e	Technical data provided (brochures, technical specs, manuals, drawings etc)		**10**	
g	Understanding of the tender document		**5**	
3	**COSTS**			
a				
a	Price of the bid relative to the other bidders	Maximum of 25 as per below schedule Outside of 20% Range of Engineer's Estimate/Market Rate ---> Score of 0 Lowest ---> Score of 25 Second Lowest ---> Score of 20 Third Lowest ---> Score of 15 Fourth Lowest ---> Score of 10 Fifth Lowest ---> Score of 5	**25**	
b	Unit Rate Schedule (Appendix V below)	Maximum of 25 as per below schedule Lowest ---> Score of 25 Second Lowest ---> Score of 20 Third Lowest ---> Score of 15 Fourth Lowest ---> Score of 10 Fifth Lowest ---> Score of 5	**25**	
TOTAL SCORE			**100**	

The evaluation criteria provide that the bidder who scores **highest** points is technically responsive therefore, qualifies for recommendation of award of the contract unless otherwise stated.

7.2 Appendix II; Statement of Compliance

Technical Schedules shall be submitted by tenderers to facilitate and enable the Engineer to evaluate tenders but only when the fittings and accessories upon which the tenderer has based his tender sum differs in manufacture, type or performance from the description contained within this specification.

Tenderers shall submit separate leaflets and catalogues giving technical and physical details for all fittings and accessories described in the Technical Schedule at the time of tendering.

Completion of Technical Schedule shall not relieve the Contractor from complying with the requirements of the Specification except as may be approved by the Engineer.

…….. **(Signed)**

…….. **(Date)**

7.3 Appendix III; Exchange Rate Fluctuations

Adjustment will be made to the price of imported materials to compensate for variations in the foreign exchange rate. For this purpose, the tenderer is required to state the exchange rate in Kenya Shillings for the currency of the Country of origin of imported materials as applied to the actual remittance effecting payment to manufacturers of the materials.

Exchange Rate: …….

Signed (as in Tender) …….

Date ……

7.4 Appendix IV; System Warranties

The tenderer shall outline the warranties for all systems installed on this site as specified elsewhere.

These shall include but not limited, to the following:

- Air Conditioning Units (Split, VRV or any other specified)
- Mechanical Ventilation fans
- Control Panels
- Copper pipework
- Refrigerant pipework insulation
- Etc.

7.5 Appendix V; Schedule of Unit Rates

The tenderers shall provide a schedule of unit rates (under Tables (a) and (b) below) that shall be used to build up rates for variation items not specified in the bill of quantity.

This section, and the terms filled herein shall form part of the contract, and shall be considered locked for the duration of the project.

Rates filled herein shall be evaluated as part of the tender evaluation process. Attention is drawn to the tender evaluation criteria included in this tender package.

The sub-contractor shall disclose the cost of the material offered by the supplier, including or manufacturer or any other sources to the Engineer used to build up the rates in respect to schedule of table (a) and table (b) below. The engineer can reject the disclosed sources where the conflict of interest seems to prevail.

Table (a) and Table (b) shall be deemed to be exhaustive in capturing all cost components and the percentages filled herein shall be considered to be locked for the duration of the contract.

7.5.1 Locally Available Items

Unit rates for items that can be procured locally shall be generated according to table (a) below. Table (a) consists of the below items:

- Material cost – This is the supplier's unit cost for the item, i.e. the cost at the shop/supplier.
- Labor – This is to include all transportation, security, hoisting, installation, tools and consumables, testing, commissioning, costs, etc. The tenderer is to provide his/her labor cost as a percentage of material cost.
- Overheads and Profit – This is to capture all contractor's overheads, margins, profit, etc. The tenderer is to provide his/her overheads and profit as a percentage of material cost.
- Further to this, tenderers are expected to list all other cost carriers not deemed to have been captured in the table below, as a percentage of material cost.

7.5.1.1 Table (a): Locally Available Items.

Material Cost Kshs. (a)	Labour (as a percentage of material cost) (b)	Overheads and Profit (as a percentage of material cost) (c)	List any other component as necessary (as a percentage of material cost) (e)	Total Installed Cost of item Kshs. (VAT exclusive) (a+b+c+d)

7.5.2 Imported Items

Unit rates for items that will require importation shall be generated according to table (b) below. Table (b) consists of the below items:

- Material cost – This is the supplier's unit cost for the item as landed and cleared in Kenya. It includes FOB price, Carriage Insurance & Freight, Inspection Charges, Duty, Port Levies, Clearance Charges and VAT

- Labor – This is to include cost for transportation from port to site, security, hoisting, installation, tools and consumables, testing, commissioning and associated costs, etc. The tenderer is to provide his/her labor cost as a percentage of material cost.
- Overheads and Profit – This is to capture all contractor's overheads, margins, profit, etc. The tenderer is to provide his/her overheads and profit as a percentage of material cost.
- Further to this, tenderers are expected to list all other cost carriers not deemed to have been captured in the table below, as a percentage of material cost.

7.5.2.1 Table (b): Imported Items.

Material Cost Kshs. (a)	Labour (as a percentage of material cost) (b)	Overheads and Profit (as a percentage of material cost) (c)	List any other component as necessary (as a percentage of material cost) (e)	Total Installed Cost of item Kshs. (VAT exclusive) (a+b+c+d)

…….. **(Signed)**

…….. **(Date)**

…….. **(Official Stamp)**

7.6 Appendix VI; Day Work Terms for Labour

(To Be Completed By Tenderer)

Description of Artisan	Cost Per Hour
Supervisor	……..
Grade A Plumber	……..
Grade B Plumber	……..
Grade C Plumber	……..
Labour	……..
Apprentices	……..

7.7 Appendix VII; Technical Schedule

TECHNICAL SCHEDULE

The tenderer must complete in full the technical schedule. Apart from the information required in the technical schedule, the tenderer **MUST SUBMIT** comprehensive manufacturer's technical schedules details for all items listed in this schedule (fill forms attached).

Description	Manufacturer	Country of origin	Remarks (Catalogue No. etc.)
• GMS Duct • Diffusers • Volume Control Dampers • Air Conditioning Units • Ductwork Insulation • Cold Room Evaporator • Cold Room Condenser • Filter Drier • Control Panel • Refrigerant Pipes • Refrigerant Gas • Refrigeration Controls			

1. PART A: GENERAL MECHANICAL SPECIFICATION

1.1. GENERAL

This section specifies the general requirements for plant, equipment and materials forming part of the Sub-Contract Works and shall apply except where specifically stated elsewhere in the Specification or on the Sub-Contract Drawings.

1.2. QUALITY OF MATERIALS

All plant, equipment and materials supplied as part of the Sub-Contract Works shall be new and of first-class commercial quality, shall be free from defects and imperfections and where indicated shall be of grades and classifications designated herein.

All products or materials not manufactured by the Sub-Contractor shall be the products of reputable manufacturers and so far, as if they had been manufactured by the Sub-Contractor.

Materials and apparatus required for the complete installation as called for by the Specification and Sub-Contract Drawings shall be supplied by the Sub-Contractor unless mention is made otherwise.

Materials and apparatus supplied by others for installation and connection by the Sub-Contractor shall be carefully examined on receipt and stored. Should any defects be noted, the Sub-Contractor shall immediately notify the Engineer.

Defective equipment or that damaged in the course of installation or tests shall be replaced or repaired to the approval of the Engineer.

Medical gas plant supplier/constructor shall be a qualified company with relevant references for this specific type of work.

1.3. REGULATIONS AND STANDARDS

The Sub-Contract Works shall comply with the current editions of the following: -

(a) The Kenya Government Regulations.
(b) The United Kingdom Institution of Electrical Engineering Regulations for the electrical equipment of buildings.
(c) The United Kingdom Chartered Institution of Building Services' Guides.
(d) The Kenya Bureau of Standards Specifications.
(e) British Standards and Codes of Practice as published by the British Standards Institution.
(f) The Local Council By-laws.
(g) The electricity Supply Authority By-laws.
(h) The Kenya Building Regulations.
(i) The BS EN ISO 7396-1:2016 Medical gas pipeline systems. Pipeline systems for compressed medical gases and vacuum

1.4. ELECTRICAL REQUIREMENTS

Plant and equipment supplied under this Sub-Contract shall be complete with all necessary motor starters, control boards, and other control apparatus. Where control panels incorporating several starters are supplied they shall be complete with a main isolator.

The supply power up to and including local isolators will be provided and installed by the Electrical Sub-Contractor. All other wiring shall be as described in the Particular Specification.

The Sub-Contractor shall supply three copies of all schematic, cabling and wiring diagrams for the Engineer's approval.

The starting current of all electric motors and equipment shall not exceed the maximum permissible starting currents described in the Kenya Power and Lighting Company Ltd.'s By-laws.

All electrical plant and equipment supplied by the Sub-Contractor shall be rated for the supply voltage and frequency obtained in Kenya, that is 415 volts, 50HZ, 3-phase or 240 volts, 50HZ, 1-phase as specified in the particular specification.

Any equipment that is not rated for the above voltage and frequencies may be rejected by the Engineer.

1.5. TRANSPORT AND STORAGE

All plant and equipment shall, during transportation be suitably packed, crated and protected to minimise the possibility of damage, and to prevent corrosion or other deterioration.

On arrival at site all plant and equipment shall be examined and any damage to parts and protective priming coats made good before storage or installation.

Adequate measures shall be taken by the Sub-Contractor to ensure that plant and equipment do not suffer any deterioration during storage.

Prior to installation all piping, plant and equipment shall be thoroughly cleaned.

If, in the opinion of the Engineer any equipment has deteriorated or been damaged to such an extent that it is not suitable for installation, the Sub-Contractor shall replace this equipment at his own cost.

1.6. SITE SUPERVISION

The Sub-Contractor shall ensure that there is an English-speaking supervisor on the site at all times during normal working hours.

1.7. INSTALLATION

Installation of all special plant and equipment shall be carried out by the Sub-Contractor under adequate supervision form skilled staff provided by the plant and equipment manufacturer or his appointed agent, in accordance with the best standards of modern practice to the relevant regulations and standards described under clause 2.3 of this section.

1.8. TESTING

1.8.1. General

All testing shall be carried out to the entire satisfaction of the Engineer.

The following sub-clause are intended to define the Sub-Contractor's responsibilities with respect to testing and inspection.

1.8.2. Materials Tests

All materials for plant and equipment to be installed under this Sub-Contract shall be tested, unless otherwise directed, in accordance with the relevant B.S. Specification concerned.

For materials where no B.S Specification exists tests are to be made in accordance with the best modern commercial methods to the approval of the Engineer having regard to the particular type and application of materials concerned.

The Sub-Contractor shall prepare specimens and performance tests and analyses to demonstrate conformance of the various materials with the applicable standards.

If stock material, which has not been specifically manufactured for the plant and equipment specified is used, then the Sub-Contractor shall submit satisfactory evidence to the Engineer that such materials conform to the requirements stated herein in which case test of material may be partially or completed waived. Certified mill test reports of plates, piping and other materials shall be deemed acceptable.

1.8.3. Manufactured Plant and Equipment - Works Tests

The rights of the Engineer relating to the inspection, examination and testing of plant and equipment during manufacture shall be applicable to the Insurance Companies or Inspection Authorities so nominated by the Engineer.

The Sub-Contractor shall give two weeks' notice to the Engineer of the manufacturer's intention to carry out work tests and inspection.

The Engineer or his representative shall be entitled to witness such tests and inspections. The costs of such tests and inspections shall be borne by the Sub-Contractor.

Six copies of all test and inspection certificates and performance graphs shall be submitted to the Engineer for his approval as soon as possible after the completion of such tests and inspections.

Plant and equipment which is shipped before the relevant test certificate has been approved by the Engineer shall be shipped at the Sub-Contractor's own risk and should the test and inspection certificate not be approved; new tests may be ordered by the Engineer at the Sub-Contractor's expense.

1.8.4. Pressure testing

All pipework installation shall be pressure tested in accordance with the requirements of the various sections of this Specification. The installation may be tested in sections to suit the progress of the works, but all tests must be carried out before the work is buried or concealed behind building finishes. All tests must be witnessed by the Engineer or his representative, and the Sub-Contractor shall give 48 hours' notice to the Engineer of his intention to carry out such tests.

Any pipework that is buried or concealed before witnessed pressure tests have been carried out shall be exposed at the expense of the Sub-Contractor and the specified tests shall then be applied.

The Sub-Contractor shall prepare test certificates for signature by the Engineer and shall keep a progressive and up-to-date record of the sections of the work that have been tested.

1.9. COLOUR CODING

Unless stated otherwise in the Particular Specification all pipework shall be colour coded in accordance with the latest edition of B.S.1710.

1.10. Welding

1.10.1. Preparation

Joints to be made by welding shall be accurately cut to size with edges sheared, flame cut or machined to suit and the required type of joint. The prepared surfaces shall be free from all visible defects such as laminations, surface imperfections due to shearing or flame cutting operation, etc., and shall be free from rust scale, grease and other foreign matter.

1.10.2. Method

All welding shall be carried out by the electric arc process using covered electrodes in accordance with B.S. 639.

Gas welding may be employed in certain circumstances providing that prior approval is obtained from the Engineer.

1.10.3. Welding Codes and Construction

All welded joints shall be carried out in accordance with the following specification: -

1.10.4. Pipe Welding

All pipe welds shall be carried out in accordance with the requirements of B.S. 806.

1.10.5. General Welding

All welding of mild steel components other than pipework shall comply with the general requirements of B.S.5135:1974.

1.10.6. Welder's Qualifications

Any welder employed on this Sub-Contract shall have passed the trade test as laid down by the Government of Kenya.

Trade engineer may require to see the appropriate certificate obtained by any welder and should it be proved that the welder does not have the necessary qualifications the Engineer may instruct the Sub-Contractor to replace him by a qualified welder.

1.11. GENERAL MECHANICAL SPECIFICATION

1.12. INTRODUCTION

This standard specification is intended to form part of the general specification to be included in the Standard Tender document as follows:

Part (1) General Conditions of contract.
(2) Preliminary clauses (supplementary to General Conditions)
(3) Technical specification(s)
(4) Schedules of works.
(5) Appendices to specifications.

The specification comprises standard clauses, which can be used to complete specifications for Medical Gases, Air and Vacuum installations in Hospitals. The clauses are so arranged that they can be selected to suit the requirements of individual schemes and guidance notes are included to assist in the selection and completion of the clauses. All the clauses may not apply. It may also be necessary to add clauses to suit particular requirements. These should be considered for future inclusion in the specification.

Dimensions and values are given in Metric S.I. units; Imperial equivalents are quoted in brackets. Where precision in equivalent values is not important, the nearest practical or rational equivalent in Metric or Imperial units is given.

Note; - This specification does not cover the requirements for Pathology Departments, Laboratories or Workshop. These departments must be treated separately and supplied from installations independent of Medical installations. Specifications will need to be drawn up based on appropriate sections of H.T.M. 02-01.

It is intended that design guidance for Medical installations is obtained from HTM-02-01 and that the requirements arrived at are written into the specification clauses.
REFERENCES

1.13. BRITISH STANDARDS INSTITUTION

BS 4	Structural steel sections.
BS21	Pipe Threads.
BS3643	I.S.O Metric screw Threads.
BS341	Valve Fittings for compressed Gas Cylinders.
BS1319	Medical Gas Cylinders and Anaesthetic Apparatus.
BS587	Motor Starters and controllers.
BS2613	The Electrical performance of Rotating Electrical Machinery.
BS2960	Dimensions of 3 phase Electric Motors.
BS3979	Dimensions of Electric Motors, Metric Series.
BS89	Direct Acting Electrical indicating instruments.
BS559	Light Gauge copper tube, imperial sizes-inch bores.
BS2871	Part 1. Copper tubes for water, gas and sanitation – Metric outside Diam's.
BS1172	Phosphorous Deoxidised Non-arsenical copper for General Purposes.
BS1845	Filler Metals for Brazing.
BS1723	Specification for Brazing.
BS487	Part 1: Fusion welded steel air receivers (for pressures not exceeding 5001b/sq.inch).
BS1123	Safety Valves, Gauges and fittings for air receivers and compressed air installations.
BS1780	Bourdon Tube pressure and vacuum gauges.
BS1701	Air Filters for air supply for compressors, etc.
BS 2831	Methods of air filters in filters used in air conditioning and general ventilation.
BS3928	Methods for sodium flame test for air filters.
BS4001	Care and maintenance of underwater breathing apparatus. Part 1 compressed air open circuit type. Part 2 standard diving equipment.
BS4275	Selection, use and maintenance of respiratory equipment.
BS 3970	Steam sterilizers.
BS4199	Surgical suction apparatus.

	Part 1 and 2 electrically operated surgical suction apparatus.
BS3636	Methods for proving Gas Tightness of vacuum or pressurised plants.
BS1710	Identification of pipelines.
BS4099	Colours and their meanings when used for indicator lights.
CP3009	Underground piping systems.
BS4957	Hospital Medical vacuum pipe line service.
HTM	Hospital Technical Memorandum

1.14. DHSS PUBLICATIONS

Hospital Technical Memorandum No. 02-01 Piped medical gases, medical compressed air and medical vacuum installations. Data sheet EE10.11/12 colour code identification for medical gas terminal units and pipe installations.

2. STANDARD SPECIFICATIONS

2.1. GENERAL

2.1.1. Extent of Contract.

The work shall include for supplying, installing, testing, commissioning, demonstrating and leaving in proper working order a piped centralised supply system for medical gases comprising as outlined in this specification. Tenders shall comply in all respects with the specification, but the contractor may offer alternatives provided that the differences and advantages are clearly detailed by him on the schedule of alternatives attached which shall be returned with the tender.

2.1.2. Specialist Contractors.

The work shall be tendered for by approved contractors only who are specialists in the installation of medical gas systems and who have permanently employed staff experienced in this type of work. At the time of tendering the contractor shall confirm in writing that he has suitable qualified personnel who would be employed on the project.

2.1.3. Contract Drawings.

The contract drawing to be read in conjunctions with this specification are as follows
Any discrepancies between the drawings and the specification shall be clarified with the Engineer before tendering.

2.1.4. As- Installed Drawings

During the course of construction, the contractor shall correct one copy of the contract drawings daily as the work proceeds, indicating any change made from the arrangement shown in the contract drawings.

This amended drawing shall remain on site, readily available for inspection, and the amendments must ultimately be transferred to a reproducible copy of the contract drawing.Automatic manifold assembly.

The manifolds for all the specified gases (and air) shall be as far as possible identical in construction and the following clauses refer to the assemblies any of the “gases”.

2.1.4.1. Manifold Headers

Each bank of cylinders shall be located beneath a high-pressure manifold header securely mounted control panel. The headers shall carry flexible spiral tail pipes on the underside for connecting to the cylinders and each tail pipe shall incorporate a renewable non-return valve on the manifold header to allow removal and replacement of the cylinder without interrupting the supply from others in the same bank.

2.1.4.2. Non-interchange ability of cylinder connections

The screwed connections of the tail pipes to the cylinder valves shall be designed such that cross connection of the pipe for any one gas cannot be made to any cylinders for the gases, the exception being oxygen and air which to BS. 341 part 1 are identical.De-Greasing

The assembly shall be de-greased and delivered to site in a sealed polythene bag or cover and labelled to the effect that if is degreased and shall on no account be

contaminated by dirt oil or grease during erection of afterwards.Precautions against Leakages.

All parts of the control panel shall be constructed of materials, which will not deteriorate during service and lead to leakages. Diaphragm gaskets of pressure regulators shall not be of fibre but brass.

2.1.5. Service or Emergency Point.

Each gas (or air) installation shall include a service or emergency point in the manifold room on the wall near to the control panel and on the outgoing distribution pipe into which a supply can be connected manually from a standby cylinder when the control panel is to be serviced or has failed.

The service point shall be in form of a terminal unit complete with check valve and isolating valve, into which a flexible pipe with probe can be inserted. See 6.11.8 for details.

The unit shall be capable of passing 275 litres/min. minimum at a nominal gauge pressure of 4.1 bar (60 p.s.i.) with a pressure loss not exceeding 0.55 bar (8 p.s.i.).

The unit shall be rigidly piped up to the distribution main and the height of the unit above floor level shall be such that the flexible pipe probe can inserted easily by a person of average height standing on floor level.

The service point shall be identified indelibly with the name of the gas and by colour code to B.S. 1710 (1971), schedule No. 13 of this specification.

2.2. DISTRIBUTION PIPEWORK SYSTEM

2.2.1. Extent of Pipework

The Specialist contractor shall supply, install, connect up and test all the pipework and valves required from the supply source to the distribution terminals for each gas, air and vacuum.

The pipe sizes and valve positions shall be as given on the Contract Drawings and test procedure as described later.

2.2.2. Pipe Installation

2.2.2.1. Fixing

All pipework shall be fixed without any springing or forcing. A clearance of 150mm (6”) shall be maintained between the pipework and other services. Where pipework crosses other services a clearance of 25mm (1”) minimum shall be maintained.

2.2.2.2. Gradients

Gradients are not required on gas, air or vacuum pipelines.

2.2.2.3. Drainage

A full way drain lock is to be provided at the bottom of each main vertical run on the air and vacuum pipework.

Branches on horizontal air pipe work shall be taken from the topside of mains to avoid pockets of moisture.

2.2.2.4. Diversion Sets

The use of fittings for the diversion sets shall not be permitted and the sets shall be formed from a long length in one piece and cold drawn or hot drawn in a neat manner without bucking or thinning.

2.2.2.5. Routing to avoid Fire Risk Areas

The routes of the pipework shall avoid fire risk areas including laundries boiler houses, generator rooms, incinerator rooms, storage rooms for combustible materials (unless the pipes are to be cased), lift shafts and kitchens.

2.2.2.6. Pipework Supports

Pipework shall be supported at not greater than the intervals shown in the table below:

SPACING OF SUPPORTS FOR COPPER PIPES

Nominal Pipe outside diameter mm BS 2871
Part 1 Table X Maximum Intervals

For Vertical Runs	Maximum Intervals For Horizontal Runs
Metres	Metres
10	1.2	-
12	1.2	1
15	1.8	1.2
18	2	1.5
22	2.4	1.8
28	2.4	1.8
35	3	2.4
42	3	2.4
54	3	2.7
76.1	3.6	3

Where valves are fitted the pipe shall be supported at both sides of the valve to facilitate valve operation without valve movement.

Fixing brackets or supports shall be of a suitable non-ferrous material or suitability treated to minimize corrosion and prevent electronic action.

The specialist contractor shall drill and plug walls and ceilings as required fastening the supports. Where roof decking is encountered the specialist, contractor shall provide cavity fixing devices to fasten the supports.

2.2.2.7. Pipework in Floors, Walls, Ceilings

Pipework in rooms and corridors shall be concealed either behind ceiling panels, or in walls, ducts or trucking. Removable covers or panels shall be provided to allow access to pipework.

Pipework shall not be buried solidly in floors, walls or ceiling except with the approval of the Engineer. Approval will normally be given only for tail pipes in one piece from Terminal unit to service duct or ceiling void and for unjointed pipes from control value to void. The route of the buried pipe should be clearly and continuously marked by

chalk, coloured adhesive tape or otherwise, during construction, to discourage the driving of nails into or near the pipe. Where pipes are to be installed in partition walls the tail pipes of terminal unit shall be in one piece (without joint) form the terminal unit to the service doctor ceiling void.

Service ducts or voids should have adequate ventilation to prevent gas concentration in the event of a leak.

Where pipes pass through floors, walls or partitions, copper sleeves shall project between 1.5 and 3mm (1/16" and 1/18") beyond finished surfaces and plates shall be fitted. All joints shall be accessible, and no joint shall be made so that it's inside the pipe sleeve.

Where pipework is to be concealed it shall not be covered over until it has satisfactory passed all pressure tests.

Pipework in service ducts, or voids or in rooms or in corridors where the pipework is not required to be concealed shall be surface run.

2.2.2.8. Special Precautions against Corrosion.

Where pipework is supported by or is liable to come into contact with timber that has been treated with compounds likely to cause corrosion of copper, the pipe shall be protected locally by impermeable materials such as p.v.c. tape or spacers.

2.2.2.9. Cleanliness during installation

Great care shall be taken during installation to ensure that no extraneous materials are allowed to enter the pipework. Where any section of the pipework is left incomplete during erection the open end of the pipe shall be sealed immediately with plastic cap.

2.2.2.10. Bonding and Earthing

Wherever possible, pipeline shall be physically separated from the metal sheath and amour of electric cables and from metal conduits, trunking and bare earth continuity conductor s associated with any cables which operate at low voltage or above.

Where physical separation is impossible or when pipeline is in metal trucking and bed head units the pipeline shall be bonded to the I.E.E Regulations B. 53 and D.10.

The above work shall be carried out by specialist contractor or other.

2.2.3. Pipework Material and Size

2.2.3.1. Material

Pipework material for gases, air and vacuum shall be phosphorous de-oxidized non-arsenical copper to B.S 1172

2.2.3.2. Sizes

Pipework sizes shall be to metric outside diameters in accordance with B.S. 2871, Part 1, Table X.

2.2.4. Fittings and Joints

2.2.4.1. Capillary Fittings

All fittings shall be “high Duty” Capillary Type suitable for a “steam” working pressure of 17bar (250p.s.i.) gauge.

The fittings shall have integral rings of silver brazing alloy complying with composition to B.S 1845 (1966) Table 2, Type AG.11 Brazing by the end-feed method shall not be permitted.

The fitting shall be non-ferrous and capable of withstanding corrosion and dezincification.

2.2.4.2. Flux

Because of the high temperatures required for their effective use borax or borax-based fluxes shall NOT be used.

The flux shall be provided by the Fitting Manufacture to suit the work. Fluxes shall be free from grease and agents which promote corrosion or deposits of chlorides. Care shall be taken to avoid any excess of flux which might enter the pipe bore and when the joint is cool excess flux shall be washed and wire brushed off. A visual inspection of each brazed joint shall be made to confirm that the hardened flux has not formed a temporary seal which holds test pressure.

2.2.4.3. Fittings

Fittings on moisture eliminators and trap sets for vacuum and compressed air shall be brass competition type fittings, or flanged fittings as appropriate.

2.2.4.4. Valve Joints. Capillary or Screwed

Joining of valves to the pipelines shall preferably be made with a capillary joint similar to 6.5.1. but the end feed method may have to be used in this case. *(57). If, however, the valve connection is screwed a capillary to screwed adaptor shall be used but in this case the joint shall be made by tinning the male thread with soft solder. Litharge and Glycerin or an approved oxygen lung or scaling compound are also acceptable. See also 6.7.1.

The screwed joint shall be factory made using silver alloy as specified for capillary fittings and the adaptor screwed up while the “tining” is molten. This shall be done with valves dismantled to avoid damage to internal parts and the same care shall be taken when making the capillary to the damage diaphragms, seating etc.

The parts of the valves shall be maintained in a degreased condition. Screw threads shall be tampered either to B.S. 3643 or BS. 21. Parallel threads shall not be used.

2.2.5. Degreasing of Pipes and Fittings

2.2.5.1. Extent. Protection Labelling

All pipework and fittings for medical Gas, air and vacuum shall be degreased at the manufacturer’s works, the pipes to be individually fitted with purpose made tightly fitting plastic caps or plugs to protect the bores before dispatch to site. Pipes shall be delivered in bundles in protective wrappings and fittings in sealed polythene bags, no capping required.

The bundles and bags shall be securely and clearly labelled: - “Degreased Materials”. For use on Medical Gas Installations. Do not allow to come into contact with oil or grease”.

The specialist Contractor shall take great care in storing these materials and any materials contaminated while on site shall be returned to the manufacturer for degreasing, all at the expense of the Specialist Contractor.

2.2.5.2. Degreasing Processes

The pipes shall be degreased internally by steam, then dried, shot blasted and blown through with medical quality bottled air. After a visual inspection each pipe shall be capped individually at both ends.

If steam cleaning is not economical, pipes above 54mm outside diameter may be alternatively cleaned using an approved solvent such as such as methyl chloride, which will leave no poisonous or explosive residues and the fittings shall be dried out, inspected and capped or sealed as specified in 6.6.1.

While the degreasing process is primarily concerned with the bore of pipes care shall be taken to avoid oil or grease on the outside, as being a possible source for bore contamination t occur from.

Degreasing of values is dealt with under 6.7.4.

2.2.6. Valves on Distribution Pipework

The Specialist Contractor Shall supply and fit valves at the positions shown on the Contract Drawings and any deviations from these positions shall be agreed in writing by the Engineer.

The height of valves is to be stated under “Valve Boxes”, (6.8.3.) but in plant or manifold rooms valves may be arranged differently providing they are easily accessible for emergency or maintenance use.

2.2.6.1. *(59) Valve Materials and Types

All valves shall be of non-ferrous material and of the non-lubricated type, to the following details. If screwed, threads shall be tampered either to BS.3643 or BS.21 (see 6.5.4.) Parallel threads shall not be allowed.

a) Medical Gas Valves (specify)

Type
Bores
End Connections
Manufacture

b) Compressed Air valves (specify)

Type
Bores
End Connections
Manufacture

c) Vacuum Valves (specify)

Type
Bores

End connections
Manufacture

2.2.6.2. Direction of Valve Closure

Wheel screw valves shall close in a clockwise direction. Lever Ball Valves shall have the direction of closing indelibly cast or engraved on the wheel by means of an arrow and the word “CLOSE”.

Lever ball valves shall have “ON” / “OFF” cast or engraved on to show when the valve is open or closed.

2.2.6.3. Maker’s Identification

Each valve shall carry the manufacturer’s serial numbers or identification and valve size.

2.2.6.4. Pressure Testing and Degreasing

All valves shall be pneumatically tested by the manufacturers to twice the working pressure and afterwards de-greased for medical gas services using a suitable method as given as at 6.6.2 before being individually sealed in polythene bags, capping not required.

The valves shall be securely and clearly labelled: -

“Degreased Valve. For use on Medical Gas installations. Do not allow to come into contact with oil or grease”.

2.2.6.5. Certificates

A certificate shall be supplied by the manufacturer for each valve or batch stating that pressure tests and degreasing has been carried out and that any solvents have been completely removed.

2.2.6.6. Valves for System Testing Purposes

The Specialist Contractor Shall Supply and fit at the position(s) shown on the Contract Drawings (s), a three-valve arrangement to facilitate providing and testing of the installation(s).

The Principle of the method is shown on schedule No.6 and the procedure laid down under Testing and Commissioning Requirements. The valves shall be of non-ferrous material, de-greased and comply with relevant requirements, as previously specified and to be to following details: -

Type
Bores
End Connections
Manufacture

The valves shall be suitably labelled as described under 6.10

2.2.6.7. Extended. Phased. Modified, Installations

New work during installation shall be physically separated from the existing system and final joining up left to the last after completing all tests in section 10.

2.2.7. Valve Boxes

2.2.7.1. Location

The Specialist Contractor shall supply and install lockable valve boxes for all the medical gas, air and vacuum valves located outside manifold and plant rooms and not contained in ducts or cupboards etc.

2.2.7.2. Purpose

The boxes shall render the valves tamper proof and shall have a transparent breakable panel to facilitate emergency operation of the valve.

2.2.7.3. Mounting Height

The valves shall serve for the both emergency and maintenance purposes and because of the former requirement the box and valve shall be mounted at the centre height of 1.22metres (4 feet) above floor level in a position not obstructed in a anyway by other equipment. Boxes for the different gases grouped together may be fixed one above another in which case the mean height is to be 1.22m.

2.2.7.4. Mounting Depth

The boxes shall be set into the wall with any projection being kept to a minimum and surface mounted boxes shall be avoided if at all possible. The Specialist Contractor shall ascertain from the Architect or Site the nature of the wall into which the boxes will fit.

2.2.7.5. Standardised Type Boxes

The design of box offered shall be of a standardized pattern throughout the installation and have the following features:

(a) Ease of access for fitting valve and maintenance
(b) Designed so that the pipework can be fitted easily, either by having a split box or other suitable means
(c) Ventilation to obviate a possible build-up of gas in case of a leak,
(d) Non-interchangeable keys so that a maintained permit – to – work system can be operated
(e) Keys in duplicate
(f) Keys and locks with numbers engraved on
(g) Breakable transparent panel
(h) Non-interchangeability box covers if this could wrongly identify – covers to be hinged on.
(i) Boxes shall accommodate one valve only, ganging not permitted.

2.2.7.6. Box Material

The boxes shall not be of wooden construction but of robust plastic or metallic material and capable of withstanding hazards from blows, abrasions and fire.

The finished appearance of the boxes shall be such that they match the décor of the rooms and are not unsightly.

2.2.8. Valves in Ducts or Cupboards

The valves shown on the Construct Drawings in ducts or cupboards are intended for maintenance purpose only and are not required to be in valve boxes, providing the valves are lockable in the open and closed position. Suitable locking arrangements and duplicate non-interchangeable keys shall be provided so that such valves can be included in any permit to work scheme. (See 6.8.5.d.).

Care shall be taken not to install valves in cupboards or ducts which are poorly ventilated or in cupboards used for other materials which could be affected by leakages. Any pipe runs so situated shall be drawn to the attention of the Engineer before proceeding on site.

2.2.9. Identification of Valves

An engraved label of white "Traffolyte" or similar material shall be permanently fixed adjacent to each valve box to indicate the service and give the following information:

a) In Red Letter — Engraving Required

1. Service — e.g. "OXYGEN"
2. Area Served — e.g. 'WARD 1"
3. Emergency Instruction e.g. "IN EMERGENCY BREAK PANEL AND CLOSE VALVE"

b) In Black letters:

1. Valve number — e.g. "VALVE 6"

This number is for maintenance purpose and is to be agreed later on site.

Valves in ducts or cupboards shall be similarly identified except for emergency instructions.

The titles of areas served shall be finally agreed on site and the labels shall be installed before the systems are tested and commission in order to prove their correctness.

2.2.10. Terminal Units

2.2.10.1. Extent of Works

The Specialist Contractor shall supply, install and connect to the distribution pipework all the terminal, install and connect to the distribution pipe work all the terminal units required at the positions shown approximately on the Contract Drawings and as listed on the Schedule of Terminal Units.

2.2.10.2. Definition

A terminal unit shall be defined as a single outlet point for a specific gas shall be a separate unit for that one gas only.

2.2.10.3. Fascia Plate

Terminal Units for different gases at one location may be house under a common fascia plate but it shall not be possible to amount the fascia plate incorrectly and reverse or alter the identification of the services. The Units should be mounted on a common back plate to ensure accurate centering of the units and allow precise fitting of the fascia plate so that the probes enter freely.

2.2.10.4. Mounting Order

The Terminal Unit when viewed facing the units shall be mounted in the following order horizontally from left to right: -

Oxygen. Nit: Oxide. Nit Oxide/Oxy: Mixture Carbon Dioxide. Compressed Air. Vacuum.

2.2.10.5. Type (select either as required)

The terminal units shall be of the flush mounted type set into the wall. Or the Terminal units shall be of the raised surface mounted type with probe connection made vertically underneath.

2.2.10.6. Mounting Height

The mounting height of the terminal units above floor level shall be as follows: -

a)	For Flush Mounted Units	1.3m (4'- 4") to centre of Unit
b)	For Raised Surface Mounted Units	1.6m (5'- 2") to centre of unit
c)	For "Rail" Systems areas	1.5m (5'-0") to centre of unit.*(65a)

2.2.10.7. Exact Positioning of Terminal Unit

The exact position of the terminal units relative to the beds, operating tables, etc. shall be finally agreed between the Medical Officers and Architect/Engineer, and the Architect/Engineer shall provide the Specialist contractor with suitable drawings.

Due regard shall be given to ensure that nursing stall can couple up equipment easily, the short for flexible pipes to apparatus can be achieved without obstruction movement to staff or equipment round the patient and the access to the units for maintenance is easy without disruption to patients or other services.

2.2.10.8. Essential Design Features of Units

Terminal Units shall be designed to incorporate the following features: -

(a) The ability to accept, retain ad release the inserted probe by means of a quick release mechanism designed for single handed operation.
(b) A secondary locking mechanism to prevent accidental ejection of the probe which is to be finally removed by hand.
(c) Two Valves: -
    i. A valve on the inlet to the unit which can be closed to isolate the unit only, without the need to isolate a complete section when maintenance is carried out.
    ii. A self-sealing check valve which is opened by the probe and or withdrawal closes before secondary lock engages.
(d) Non-swivel type terminal socket to probe connection so that secondary equipment such as a flow meter is not titled during use.
(e) The terminal socket and check valve shall only accept the correct probe for the specified "gas" and not allow intern-changeability with or partial operation by probes for any other service.
(f) It shall not be possible to interchange the parts of a unit for one gas with those for a different gas and so enable a probe to be connected to the wrong position.

(g) Fascia plates which is such that interchangeability of fascia plates between the different gas terminal units is impossible.
(h) The front face around the terminal socket to be exposed and to carry "gas" name and colour identification, unless incorporated as at 6.11.8(7).
(i) Identification by shape incorporated on the problem is not an essential feature but if adopted by a manufacturer the following shapes shall be used:

Service	Shape
Oxygen	Hexagonal
Nitrous Oxide	Round
Nitrous Oxide /Oxygen Mixture	Round with two opposing flats
Carbon Dioxide	Triangular with radiuses corners
Medical Air	Round with one flat
Medical Vacuum	Square

2.2.10.9. Identification Colours and Wording on Units

The following names and colours shall apply:

Service	Colour	Wording
Oxygen	White	Oxygen
Nitrous Oxide	French Blue	Nitrous Oxide
Nitrous Oxide/Oxygen Mixture	French Blue and white quarters	N2O+O2 (50/50)
Carbon dioxide	French Grey	Carbon dioxide
Medical Air	White and Black Quarters	Medical Air
Medical Vacuum	Prim Rose	Vacuum

The name and colour shall be permanent, and it shall not be possible to transfer either to a different terminal.

Painting on of colour or wording is not permissible.

2.2.10.10. Pressure Loss across Terminal Units

The terminal units shall be capable of passing the following flow rates without exceeding the stated pressure losses across the terminal units.

Nominal Gauge Pressure at back of Service Terminal Unit	Maximum permissible		Maximum Rate of floor required at this pressure		Maximum permissible loss across terminal unit	
	Bar	p.s.i.	Litre/min.at STP		bar	p.s.i.
Medical Gases	3.93	57	40		0.034	0.5
NitorousOxide/Oxygen Mixture	3.93	57	275		0.55	8
Medical Air	6.9	100	250		0.34	5
Medical Vacuum	Minus 400mm Hg (360 mmHg absolute)		40		100mm Hg	

The figures relate to the performance required of the terminal units.

The actual design flow rates for purposes of sizing the installation and determining pipeline diameters should be taken from Section V of HTM 22.

2.3. SPECIAL FITTINGS FOR OPERATING THEATRES

2.3.1. Location and Type

The Specialist Contractors shall supply, install and connect to the distribution pipework in each operating Theatre. These fittings are in additional to the wall mounted terminal units specified earlier.

2.3.2. Gases to be dispensed

The fittings(s) shall supply the following “gases”:-
Oxygen, AGSS, nitrous oxide and medical air.

2.3.3. Design of fittings

2.3.3.1. Boom Assembly, Open Type A

The boom shall be designed to carry flexible pipes connected into standard type flush fitting terminal units mounted at a height of 1.8M (5’-11”) above floor level.

2.3.3.2. Boom Assembly, Enclosed Type B

The boom shall be designed to carry concealed pipes of nylon connected to the distribution Pipework in a suitable wall unit.

2.3.3.3. Ceiling Pendant, Multipoint, Type C.

The pendant shall comprise a heavily chromed or stainless steel removable ceiling rose thought which flexible hoses with terminal end connections are suspended.

The connections to the distribution pipework shall be within the ceiling rose space and the design shall be such that all strain is taken off the hose connections

The hose to distribution pipe connections shall not be interchangeable between the different services.

2.3.3.4. Ceiling Pendant, Single Point, Type D

The Pedant shall comprise a heavily chromed or stainless steel removable ceiling rose through which a flexible hose with terminal end connection is suspended.

The connection to the distribution pipe shall be within the ceiling rose space and the design shall be such be that all strain is taken off the hose connection.

2.3.3.5. Terminal Connections

The terminal connection on all fittings shall only accept standard type probes and shall incorporate all the necessary features of the wall mounted terminal units as regards non-interchangeability, self-sealing check valves, isolating valves, identification.

2.3.3.6. Valves

Where the design of the terminal connection on the fitting or hose does not include an isolating valve, this shall be provided elsewhere weather within or near to the fittings on the incoming distribution pipe work, in any easily assessable position for maintenance purposes.

2.3.3.7. Special Precautions

The design of all special fittings and hoses shall ensure that during use and movement of the fitting the pipework or hose cannot be twisted, kinked, uncoupled at either end, overstrained or otherwise damaged.

2.3.3.8. Anti-static Precautions

All fittings and hoses shall be of anti-static construction.

2.3.3.9. Cleanliness

All fittings shall be designed to present minimum lodgement of dirt, dust. etc. and be easy to keep clean . The materials of construction shall have complete freedom from rusting, scaling or deterioration and may be enamelled finish, stainless steel, or heavily chromed finish.

2.3.3.10. Order of Arrangement of Terminal Connections

On multi-point fittings the order arrangement of the terminal connections shall be as follows: - Oxygen. Nit: Oxide. Nit: Oxide/ Oxy: Mixture. Carbon Dioxide. Comp.Air. Vacuum

For pendants and columns, the above order clockwise nearest to the hinge.

2.3.3.11. Headroom Clearance

All fittings shall provide a minimum clearance of 1.8m (5'-11") above floor level and on telescopic fittings when in the retracted position.

2.3.3.12. Dimensions of Fittings

The terminal outlet connections of fittings shall not be more than 1.9m (6'-3") above floor level on booms, pedant hoses and columns.

The depth of fittings and pendant hose length shall suit the height of the room.

These dimensions shall be verified on site by the specialist Contractor.

2.3.3.13. Structural Requirements for fittings

The specialist contractor shall state in his tender the requirements for structural strength of walls or ceilings to which the special fittings are to be fastened.

2.3.3.14. Positioning of Special Fittings

The exact positioning of special fittings shall be agreed between the Medical Officers and Architect, and the Architect shall provide layout drawings for the Specialist Contractor.

2.3.3.15. Electrical Services in Fittings

The bedhead unit shall carry electrical services which shall be in solid drawn rust-proof conduit separate from the medical service pipes.

The electrical fittings shall be arranged in a neat manner to fit in with the medical terminal outlets and shall afford easy access for coupling up equipment.

2.4. IDENTIFICATION OF PIPELINES

2.4.1. Permanent Identification

The Specialist Contract shall carry out identification of the installations(s) by colour coding in accordance with Data Sheet EE 10.11/12 and B.S. 1710 (1971).

The identification shall comprise: -

a) Colour handing applied at valves, junctions; either side of walls, floors and at intervals of about 2m (6 feet) on short runs up to 4m (13 feet) on long straight runs).
b) The name of the service printed on the colour hand in a contrasting colour.
c) An arrow at each colour band showing direction of flow.

Letters to be a minimum of 6mm (¼") high.
Self-adhesive plastic labels or tapes of approved manufacture may be used as an alternative to painting. Where valves are in a valve boxes and identified by "Traffolyte" labels, colour handing is not required.

2.4.2. Temporary identification

During installation of piping, individual pipes, valves junctions and ends shall be identified as the work progresses. This identification shall be at intervals similar to final identification

requirements and may be made with removable labels. These temporary identification labels must be subsequently replaced by the permanent ones at an appropriate stage.

2.5. WARNING AND ALARM SYSTEMS

2.5.1. Extent of Works

The specialist Contractor shall supply, install and commission the following warning and Alarm systems comprising a combination of (select) flashing/steady lights and audible alarms, for the appropriate services.

2.5.2. Master and Slave indicating Units

A Master indicating Units shall be installed in nurse stations to monitor all the services in one combined unit.

The Master Unit shall relay to slave Units installed in the following rooms in all other nurse station as will be shown in the drawings.

2.5.3. Electrical Power

The systems shall work on low voltage D.C. current stepped down from a 250 volt single phase supply via a double earth screened transformer. The power pack may be incorporated in the Master Unit.

2.5.4. *(76) Essential Features of Flashing Light Units

The Master Unit and Slave Units shall be of similar construction and embody the following features:-

1. On the Master Unit, solid state flasher unit to operate the lamps thought the system.
2. On Master and slave Units, translucent coloured panels for each service engraved with the “fault”conditions.
3. Two under-run low voltage white lamps in parallel behind each panel.
4. A green panel to indicate that the unit is operational.
5. A Standardized size and type of lamp throughout the system.
6. Lamps suitable for rapid on/off flashing operation with long life.
7. Lamp test button on each unit to test all lamps on the unit simultaneously.
8. Audible alarms as indicated in Schedule No. 4
9. On the Master Unit, A Key operated muting switch:-
   a) Make flashing lights steady on Master Unit and Slave Units
   b) Mute Audible alarms on Master Unit only.
10. One each Slave Unit, a key operated muting switch to mute audible alarms.
11. The muting switches to deal with only one alarm signal at a time and to re-set automatically.
12. On the Master Unit a System Alarm Circuit run from a dry battery to indicate: -
    a) Failure of flasher unit.
    b) Failure to low voltage supply.

These faults to be indicated by a coloured orange engraved panel with steady twin lights and audible alarm with key operated muting switch and automatic =-re-set.

A test button shall be provided to simulate “a” ad “b” to test the above circuit.

2.5.5. *(76) Essential Features of Steady Light Units

The Master Unit and Slave Units shall be of similar construction and embody the following features: -

1. Translucent coloured panels for each service engraved with the “fault” condition.
2. A translucent green panel to each service to indicate that low voltage supply is on and services are operating normally.
3. Two under-run low voltage while lamps in parallel being each panel.
4. A standardized size and type off lamp thought the system.
5. Lamp suitable for long life.
6. A lamp test bottom on each unit to test all lamps on the unit simultaneously.
7. Audible alarms as indicated in Schedule No.5
8. On the Master Unit, key Operated muting switch to mute audible alarms on the Master Unit only.
9. On each Slave Unit, a Key operated muting switch to mute audible alarms on the Unit.
10. The muting switches to deal with only one alarm signal at a time and to re-set automatically.
11. On the Master Unit, a System Alarm Circuit run from a dry battery to indicate failed of low voltage supply.

This fault to be indicated by a coloured orange engraved panel with steady twin lights and an audible alarm with key operated muting switch and automatic re-set.

A test button shall be provided to simulate low voltage supply failure to test the above circuit.

2.5.6. Working of Master and Slave Units – “Flashing” System

The units shall indicate the condition of all the monitored services simultaneously and for each service more than one panel may be indicating at a time as outlined in Schedule No. 4.

The audible alarm on each unit shall be common to all the services and be arranged to re-set automatically after being mute d, or if muting is not carried out, after the fault is rectified.

2.5.7. Working of master and Slave Units – “Steady” System

The units shall indicate the conditions of all the monitored services simultaneously and for each service only one panel will be indicating at a time as outlined in Schedule No.5.
The audible alarm on each unit shall be common to all the services and be arranged to re-set automatically after being muted, or if muting is not carried out, after the fault is rectified.

2.5.8. Arrangement of Panels on Units

The order in which the services shall be arranged on the Master and Slave Units shall be that adopted for terminal unit: -

When facing the panels the service shall be in the following order reading left to right: -
OXY. NIT.OXIDE. NIT OXIDE. CABRBON DIOXIDE COMPRESSED AIR VACUUM OXY.MIXTURE

2.5.9. Engraving of Fascia Panels of Units

The fascia panels of the Units shall be engraved with the name of the service, either at the top or bottom of each column of translucent panels.

The function of the various press buttons and switches shall also be engraved on the fascia panels.

All engraving shall be picked out in contrasting indelible colour.

2.5.10. Monitoring Equipment

The Specialist Contractor shall include for supply and fixing all necessary sensing Devices, Operating switches and Relays on the plant for the initiation of the Warning and Alarms signals. The Sensing devices, etc. on the Liquid Oxygen Plant and Standby manifold shall be supplied and installed by the Specialist Oxygen Supplier.

Absolute reliability and long life of contracts in relay units shall be as essential feature of the equipment.

The relays shall be energized under normal operating conditions and the alarm contracts shall “break” under “fault” conditions.

The alarm terminal block shall be remote from the electrically isolated from all other terminals and energized from a separate source.

The monitored unit alarm contracts shall be rated at 250 volts 3Amp, 50 Hz and the alarm system contacts at 50 volts, 0.5 Amp, D.C.

On a “Flashing” system the alarm circuit conductors to the slave units shall be suitable so that when the green, white and orange panels on every slave unit are illuminated simultaneously the pressure loss does not exceed 5% of the rated operating voltage.

On a “Steady” System the alarm circuit conductors to the slave units shall be suitable so that when any signal is illuminated simultaneously on all slaves the pressure loss does not exceed 5% of the rated operating voltage.

(Delete the system not required)

2.5.11. Setting of Sensing Devices

The sensing devices shall be set so that the conditions are indicated as soon as the following limits are reached: -

Conditions on Schedule

*(81) Manual manifolds

1. When duty bank falls to approximately: -

    (a) 10% of full capacity on oxygen systems
    (b) 8% of full capacity on N2 0/02 systems
    (c) 6% of full capacity on N20 systems

Automatic Manifold

2. When duty bank becomes “exhausted” and change-over to reserve bank made.

3. When with one bank empty, duty bank falls to approximately: -
    (a) 10% of full capacity on oxygen systems
    (b) 8% of full capacity on N2 0/0 2 systems
    (c) 6% of full capacity on N20 systems

    Liquid Oxygen Installations

4. When change-over to standby manifold made.

5. When one standby bank becomes exhausted and changeover to reserve bank made.

Medical Compressed Air Plant

6. When “standby compressor cuts in to back up “duty” compressor.
7. When change-over to standby air manifold made (denoting fault on compressors or air temperature too high).
8. When dew point of air from dryers is rising above 0°C (32°F) at 7.3 bar (105 p.s.i.) gauge.

Medical Vacuum Plant

9. When “standby” vacuum pump cuts in to back up “duty” vacuum pump.

All PMG &V Plant Installations

10. When either one or both pumps fail to operate
11. When pressure in distribution pipe work falls to:-
    a) 10% below normal on medical gas lines
    b) 15% below normal on air and vacuum lines

2.5.12. Electrical Wiring

The interconnecting wiring shall be carried out by others, but the specialist Contractor shall supply all necessary wiring diagrams, induplicate, within……weeks of being awarded the contract.

PART B:

PARTICULAR SPECIFICATION FOR MEDICAL GASES

3. PART B: PARTICULAR SPECIFICATION FOR MEDICAL GASES

3.1. MEDICAL GASES

To be tapped off from existing lines

3.2. PLANT ALARMS

Supply and installation of a plant alarm to supervise all the medical gas plant. This plant alarm panel shall display gas pressure, normal and alarm conditions of all gases; panel shall contain audible and visual alarm indicators. Each gas service shall consist of a bank of five dual-circuit LED indicators, one green (for "normal" indication), three yellow and one red (for four output conditions).

3.2.1. Terminal Units

Medical gas terminal units shall be as Medaes Gem 10 or approved equivalent and shall conform to BS 5682: 1984 and International Standard 9170.

Terminal units shall be gas specific and accept only the correct medical gas probe.

Gas specific components shall be pin-indexed to ensure that a correct gas specific assembly is achieved such that in the normal course of dismantling for repair or maintenance, parts from other gases cannot inadvertently be used.

Terminal units shall be designed to allow easy and accurate installation and shall be supplied with installation instructions and a comprehensive Operating and Maintenance Manual.

Terminal units shall be capable of single handed insertion and removal of the correct BS 5682: 1984 medical gas probe and shall have a minimum 3 year warranty. All terminal unit installations can be achieved the use of Double Arm Pendants, Ceiling fixed Pendants, Bedhead Units, Wall Terminal units etc. depending on the application.

3.12.2 Isolating Valves

Medical gas line ball valves shall be as Medaes Limited or approved equal and shall be constructed of a nickel plated brass body, PTFE seats/seals and a brass chrome plated ball. The valve shall operate by a manual operating lever selected through 90˚. All medical gas line ball valves shall provide a full bore flow and shall be cleaned for oxygen service and fully tested prior to dispatch. Smaller Type V valve assemblies (15 to 42mm inclusive) shall incorporate stainless steel “Dowty” bonded seals and mechanically sealed connectors. Larger Type VF valve assemblies (54 to 108mm inclusive) shall be flanged, installed with stainless steel bolts, nuts and spring washers, with 3mm Viton sealing gaskets. In all cases, the use of PTFE tape or any other thread sealing medium shall not be used during installation.

Each medical gas line ball valve assembly shall terminate in copper stub pipes to enable brazing direct into the distribution system, using the fluxless brazing technique. A lockable device shall be provided and enable the valve to be locked in either the fully open or fully closed position.
Medical gas ball valve assemblies shall comply with, and fully satisfy, the pressure drop requirements of the United Kingdom Health Technical Memorandum No. 2022 and Model Specification C11.

3.1 DISTRIBUTION PIPEWORK

3.1.1 Introduction

Distribution pipework shall be manufactured, installed and commissioned in accordance with the United Kingdom Health Technical Memorandum No. 02-01 (where specified), and the National Health Service – Model Engineering Specification C11.

3.1.2 Pipework Materials

Pipework materials are manufactured by a licensee of the BS 5750 quality assurance certification scheme and all pipes and fittings are marked with the BSI kitemark.

3.1.3 Component Cleanliness and Protection

Component cleanliness and protection procedures are carried out on all pipes, fittings, components and equipment for use with all Medical gas services. Final residual contamination level does not exceed 100mg/m² when tested by the method specified in ASTM B280 Clause 12. All equipment and items supplied to site are fully protected against the ingress of dirt and contamination by:

(a) Sealing small components in polythene bags or boxes.

(b) Individual end capping of pipes.

(c) Bundling and sleeving pipework in polythene bags.

(d) Wrapping or boxing

3.1.4 Cleaning and Degreasing

Copper pipes are cleaned and degreased by oxygen service in accordance with BOC Specification 399394. Fittings are cleaned, flux removed, dryed and degreased for oxygen service in accordance with BOC Specification 399856. All packaging is labeled “Degreased for Medical gas service”.

3.1.5 Pipework Supports

3.1.6 Spacing

Distribution system pipework is normally supported at intervals specified in table below:

Metric sizes outside diameter Mm	Maximum internals for vertical runs Metres	Maximum intervals for horizontal runs Metres
6	1.0	1.0
12	1.2	1.0
15	1.8	1.2
22	2.4	1.8
28	2.4	1.8
35	3.0	2.4
42	3.0	2.4
54	3.0	2.7
76	3.6	3.0

3.1.7 Secondary Fixing Brackets

Except for vertical drops to terminal units, secondary fixing brackets comprise a suitable metallic, non-ferrous material or a ferrous material suitably treated to prevent corrosion and electrolyte action. For vertical drops to terminal units, secondary fixing brackets comprise a suitable metallic, non-ferrous material or a non-metallic material.

3.1.8 Brazed Pipework Jointing

Copper to copper joints made on-site, utilize a copper phosphorous brazing alloy type CP1 or CP4 to BS 1845 and an inert gas shield and no flux. Copper or brass or gunmetal joints made off-site, utilize a silver brazing material type AG13 to AG18 to BS 1845, with a flux, and the joint is subsequently cleaned and degreased for oxygen service.

3.1.9 Pipe Preparation

Pipe ends are cut clean and square with the pipe axis using wheel cutters.

Cut ends and the inside of fittings are thoroughly cleaned. Expanded tube joints are formed with the correct pipe expanding tools and are only used for straight tube to tube joints on pipe sizes 28mm and below.

3.1.10 Inert Gas Shielding

Inert gas shielding is provided internally for all on-site fluxless jointing and hot forming of bends. Inert gas is Nitrogen to BS 4105.

PART C

BILLS OF QUANTITIES

4 PRICE SCHEDULES

4.1 GENERAL NOTES TO TENDERERS

1. The Bills of Quantities form part of the contract documents and are to be read in conjunction with the contract drawings and general specifications of materials and works.

2. The prices quoted shall be deemed to include for all obligations under the sub-contract including but not limited to supply of materials, labour, delivery to site, storage on site, installation, testing, commissioning (**excluding VAT**).

3. All prices omitted from any item, section or part of the Bills of Quantities shall be deemed to have been included to another item, section or part thereof.

4. The brief description of the items given in the Bills of Quantities are for the purpose of establishing a standard to which the sub-contractor shall adhere. Otherwise alternative brands of **equal** and **approved** quality will be accepted.

5. Should the sub-contractor install any material not specified here in before receiving **written approva**l from the Project Manager, the sub-contractor shall remove the material in question and, **at his own cost**, install the proper material.

6. The grand total of prices in the Summary page must be carried forward to the **volume 1**.

7. The Bills of Quantities are divided generally into three sections:-

   a. Contractual Requirements – Bill 1

   These captured under main works specification document.

   b. Installation Items – Other Bills

   The brief description of the items in these Bills of Quantities should in no way modify or supersede the detailed descriptions in the contract Drawings, conditions of contract in Volume 1 and specifications. The unit of measurements and observations are as per those described in the contract documents.

   c. Summary

   The summary contains tabulation of the separate parts of the Bills of Quantities carried forward with provisional sum, summary volume included. The sub-contractor shall insert his totals and enter his grand total tender sum in the summary.

   This grand total tender sum shall be carried forward to main summary of volume 1 of the main works

PROPOSED LABOR WARD RENOVATIONS AT THE NAIROBI HOSPITAL

MEDICAL GASES INSTALLATIONS

BILLS OF QUANTITIES

SECTION D.W. (I) TITLE: PRELIMINARIES & CONTRACTUAL REQUIREMENTS

Item	Description	Unit	Qty	Rate	Cost KShs.
	PRELIMINARIES & CONTRACTUAL REQUIREMENTS				
A.	Preparation of working drawings, printing and distribution.	Sum			-
					-
B.	Preparation of 'As Installed Drawings", printing and distribution as specified. Drawings to include:				-
	(a) Blue Prints - 4 sets of each.	Sum			-
	(b) AutoCAD on Flash Drive (5 GB) – 2 No.	Sum			-
	(c) Operational Instructions, manuals and test certificates - 4 Sets	Sum			-
					-
C	Allow for any other preliminary stated in the conditions of contract	Sum			-
D	Any other item necessary to complete the installations in this section (please state)	Sum			-
	Carried to Main Summary Page				-

SECTION D.W. 1 - - EXTERNAL MEDICAL GASES PIPEWORK

Item	Description	Unit	Qty	Rate	Cost KShs.
1.1	**EXTERNAL MEDICAL GASES PIPEWORK** **Supply , Install, Test and Commission the following materials, equipment, apparatus, fittings etc. including erection, testing and commissioning as described below and shown on the drawings-** The distribution pipe work shall be manufactured, installed, tested and commissioned in accordance with UK Health Technical Memorandum 02-01 and the Nation Health Service – Model Engineering Specification C11. Pipework materials shall be manufactured by a licensee of the BS 5760 quality assurance certification scheme and all pipes and fittings are marked with the BSI Kitemark. Pipes to be phosphorous de-oxidised non-arsenical copper to BS 6017 and BS 2871 and marked to BS 2871. Tenderers to allow for brazing, reducers supports, flux, clippings, cleaning, bending, forming and degreasing as necessary for the proper functioning of the installations as specified:				
A	15mm dia. copper pipe.	LM	0		-
B	22mm dia. ditto.	LM	120		-
	Fittings to BS 6017 Grade C106 of sizes and manufacture to BS 864 Part 2.				
C	15mm dia. copper bend.	No.	0		-
D	22mm dia. ditto.	No.	33		-
E	15mm dia. tee.	No.	0		-
F	22mm dia. ditto.	No.	9		-
G	22mm dia. Medical gas line ball valve assemblies	No.	6		-
	Carried to main collection page				-

SECTION D.W. 2 - - MEDICAL GASES PIPEWORK

Item	Description	Unit	Qty	Rate	Cost KShs.
2.1	**INTERNAL MEDICAL GASES PIPEWORK** **Supply , Install, Test and Commission the following materials, equipment, apparatus, fittings etc. including erection, testing and commissioning as described below and shown on the drawings-** The distribution pipe work shall be manufactured, installed, tested and commissioned in accordance with UK Health Technical Memorandum 02-01 and the Nation Health Service – Model Engineering Specification C11. Pipework materials shall be manufactured by a licensee of the BS 5760 quality assurance certification scheme and all pipes and fittings are marked with the BSI Kitemark. Pipes to be phosphorous de-oxidised non-arsenical copper to BS 6017 and BS 2871 and marked to BS 2871. Tenderers to allow for brazing, reducers supports, flux, clippings, cleaning, bending, forming and degreasing as necessary for the proper functioning of the installations as specified:				
A	15mm dia. copper pipe.	LM	180		-
B	22mm dia. ditto.	LM	90		-
	Fittings to BS 6017 Grade C106 of sizes and manufacture to BS 864 Part 2.				
C	15mm dia. copper bend.	No.	60		-
D	22mm dia. ditto.	No.	30		-
E	15mm dia. tee.	No.	16		-
F	22mm dia. ditto.	No.	8		-
G	22mm dia. Medical gas line ball valve assemblies	No.	6		-
	Carried to main collection page				-

SECTION D.W. 3- - MEDICAL GASES ACCESSORIES

Item	Description	Unit	Qty	Rate	Cost KShs.
3.1	**Bedheads, Medical Gases accessories, ZSU's, Alarm Panel etc** **Supply , Install, Test and Commission the following materials, equipment, apparatus, fittings etc. including erection, testing and commissioning as described below and shown on the drawings-**				
A	Medical Bedhead Unit with 3 No. Medical gases terminals, (1No. Oxygen, 1 No. Medical Air, 1 No. vacuum), 1 No. nurse call system, 2No. Raw power twin sockets, 4No. Clean power twin non-standard socket, 3 Gang switch, equipotential earth socket, telephone point, 4No. data points room, reading and examination lights, and a top rail for other fixings as Beacon Medaes or equal and approved.	No.	8		-
B	Medical Gas Terminal unit (wall mounted) complete with all accessories as Medaes GEM 10 or equal and approved. Medical gas outlets:				
	(i) Vacuum Outlets	No.	8		-
	(ii) Medical Gases Outlets	No.	8		-
	(iii) Oxygen outlets	No.	8		-
C	Zone service unit for 1 No. gases in valve boxes 22mm dia. with pressure switch mounting as Beacon Medaes ZSU or approved equivalent.	No.	3		-
D	Allow for careful removal of all existing bedhead units and handover to the client. Rate to include cart away of materials that will not required.	item	1		-
		Carried to next page			-

SECTION D.W. 3 - - MEDICAL GASES ACCESSORIES

Item	Description	Unit	Qty	Rate	Cost KShs.
	bal b/f				-
	Local/Area Alarm system				
E	The LCD Alarm shall be capable of displaying all alarms includes pressure high, low, or normal, flow and report to main control centre or computer screen via the facility's ethernet or internet complete. Alarm Panel to be as Medipoint 26 by Beacon Medaes and to be capable of monitoring 3 No. Gases, and complete with all associated accessories, including all high and low pressure sensors, cabling, etc	No.	1		-
	Testing & Commissioning				
F	Allow for flushing of the existing pipework, pressure testing, repairs, testing and commissioning of the entire system (including already installed copper pipework) in the . Rates to capture all neccesary accessories and tools required for testing and commissioning of the installation.	No.	1		-
				Carried to Main-Collection	-

MAIN COLLECTION PAGE

Item	Description				Price (KShs.)
	PROPOSED LABOR WARD AT THE NAIROBI HOSPITAL **MEDICAL GASES INSTALLATIONS** **MAIN COLLECTION PAGE**				
(i)	Preliminaries and General Conditions				-
1	External pipework				-
2	Internal pipework				-
3	Medical Gases Accessories				-
	Sub-Total (Inclusive of VAT)				-
	Total				-
	TOTAL FOR MEDICAL GASES CARRIED TO MAIN SUMMARY PAGE				-

APPENDICES

1.2 Appendix II; Statement of Compliance

Technical Schedules shall be submitted by tenderers to facilitate and enable the Engineer to evaluate tenders. Failure on the part of the tenderer to submit said schedules shall constitute an affirmation by the tenderer that the tenderer shall provide the equipment and brands as specified in the bill of quantity.

Tenderers shall submit separate leaflets and catalogues giving technical and physical details for all fittings and accessories described in the Technical Schedule at the time of tendering.

Completion of Technical Schedule shall not relieve the Contractor from complying with the requirements of the Specification except as may be approved by the Engineer in writing. Award of contract to the tenderer shall not constitute approval of any proposed equipment to be supplied, as detailed in the tenderers submitted technical schedules.

…….. **(Signed)**

…….. **(Date)**

1.4 Appendix IV; System Warranties

The tenderer shall outline the warranties for all systems installed on this site as specified elsewhere.

These shall include but not limited, to the following:

- Bedheads
- Head Walls
- ZSU's
- Alarm Panels
- Terminal Units

Etc.

Appendix V
Schedule of Unit Rates

1.5 Appendix V; Schedule of Unit Rates

The tenderers shall provide a schedule of unit rates (under Tables (a) and (b) below) that shall be used to build up rates for variation items not specified in the bill of quantity. This section, and the terms filled herein shall form part of the contract, and shall be considered locked for the duration of the project.

Rates filled herein shall be evaluated as part of the tender evaluation process.

The sub-contractor shall disclose the cost of the material offered by the supplier, including or manufacturer or any other sources to the Engineer used to build up the rates in respect to schedule of table (a) and table (b) below. The engineer can reject the disclosed sources where the conflict of interest seems to prevail.

Table (a) and Table (b) shall be deemed to be exhaustive in capturing all cost components and the percentages filled herein shall be considered to be locked for the duration of the contract.

- **Locally Available Items**

Unit rates for items that can be procured locally shall be generated according to table (a) below. Table (a) consists of the below items:

- Material cost – This is the supplier's unit cost for the item, i.e. the cost at the shop/supplier.
- Labor – This is to include all transportation, security, hoisting, installation, tools and consumables, testing, commissioning, costs, etc. The tenderer is to provide his/her labor cost as a percentage of material cost.
- Overheads and Profit – This is to capture all Contractor's overheads, margins, profit, etc. The tenderer is to provide his/her overheads and profit as a percentage of material cost.
- Further to this, tenderers are expected to list all other cost carriers not deemed to have been captured in the table below, as a percentage of material cost.

- *Table (a): Locally Available Items.*

Material Cost Kshs. (a)	Labour (as a percentage of material cost) (b)	Overheads and Profit (as a percentage of material cost) (c)	List any other component as necessary (as a percentage of material cost) (d)	Total Installed Cost of item shall Kshs. a + (axb%) + (axc%) + (axd%) (VAT exclusive)
	……..%	……..%	……..%	

- **Imported Items**

Unit rates for items that will require importation shall be generated according to table (b) below. Table (b) consists of the below items:

- Material cost – This is the supplier's unit cost for the item as landed and cleared in Kenya. It includes FOB price, Carriage Insurance & Freight, Inspection Charges, Duty, Port Levies, Clearance Charges and VAT

- Labor – This is to include cost for transportation from port to site, security, hoisting, installation, tools and consumables, testing, commissioning and associated costs, etc. The tenderer is to provide his/her labor cost as a percentage of material cost.
- Overheads and Profit – This is to capture all Sub-contractor's overheads, margins, profit, etc. The tenderer is to provide his/her overheads and profit as a percentage of material cost.
- Further to this, tenderers are expected to list all other cost carriers not deemed to have been captured in the table below, as a percentage of material cost.

- *Table (b): Imported Items.*

Material Cost Kshs. (a)	Labour (as a percentage of material cost) (b)	Overheads and Profit (as a percentage of material cost) (c)	List any other component as necessary (as a percentage of material cost) (d)	Total Installed Cost of item shall Kshs. a + (axb%) + (axc%) + (axd%) (VAT exclusive)
	……..%	……..%	……..%	

1.6 Appendix VI; Day Work Terms for Labour

(To Be Completed By Tenderer)

Description of Artisan	Cost Per Hour
Supervisor	……
Technician 1	……
Technician 2	……
Technician 3	……
Labour	……
Apprentices	……

1.7 Appendix IV; Technical Schedule

TECHNICAL SCHEDULE

The tenderer must complete in full the technical schedule. Apart from the information required in the technical schedule, the tenderer **MUST SUBMIT** comprehensive manufacturer's technical schedules details for all items listed in this schedule (fill forms attached).

ITEM No.	Description	Remarks
A	Copper pipe	
B	Bedhead	
C	ZSU's	
D	Terminal units	

THE NAIROBI HOSPITAL

PROPOSED IMPROVEMENT OF THE LABOUR WARD

BOOK OF DRAWINGS

1. Architectural
2. Civil/Structural
3. Mechanical Services
4. Electrical Services

January 2024

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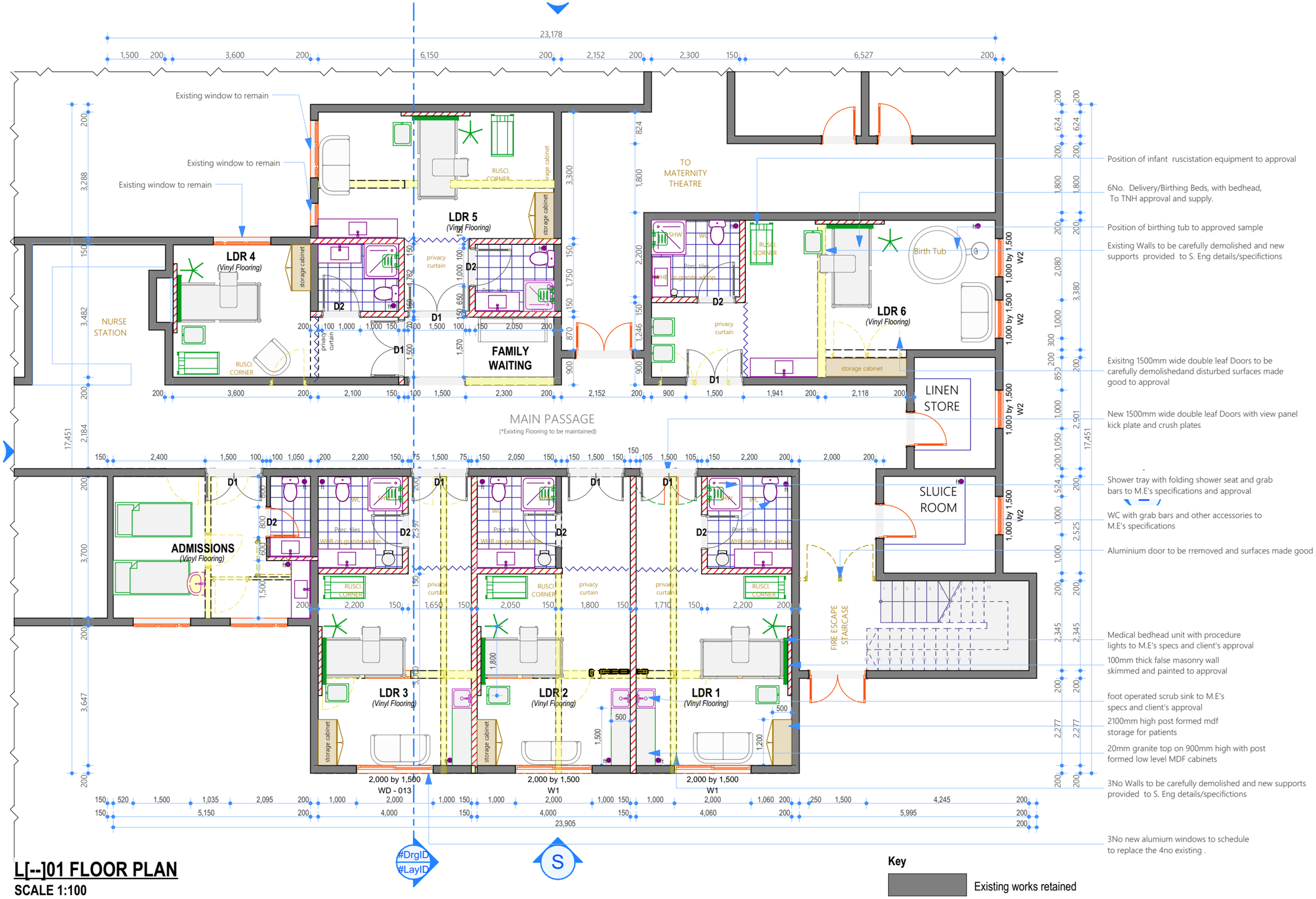

L[--]01 FLOOR PLAN

SCALE 1:100

Key

- Existing works retained
- Demolition works
- New works

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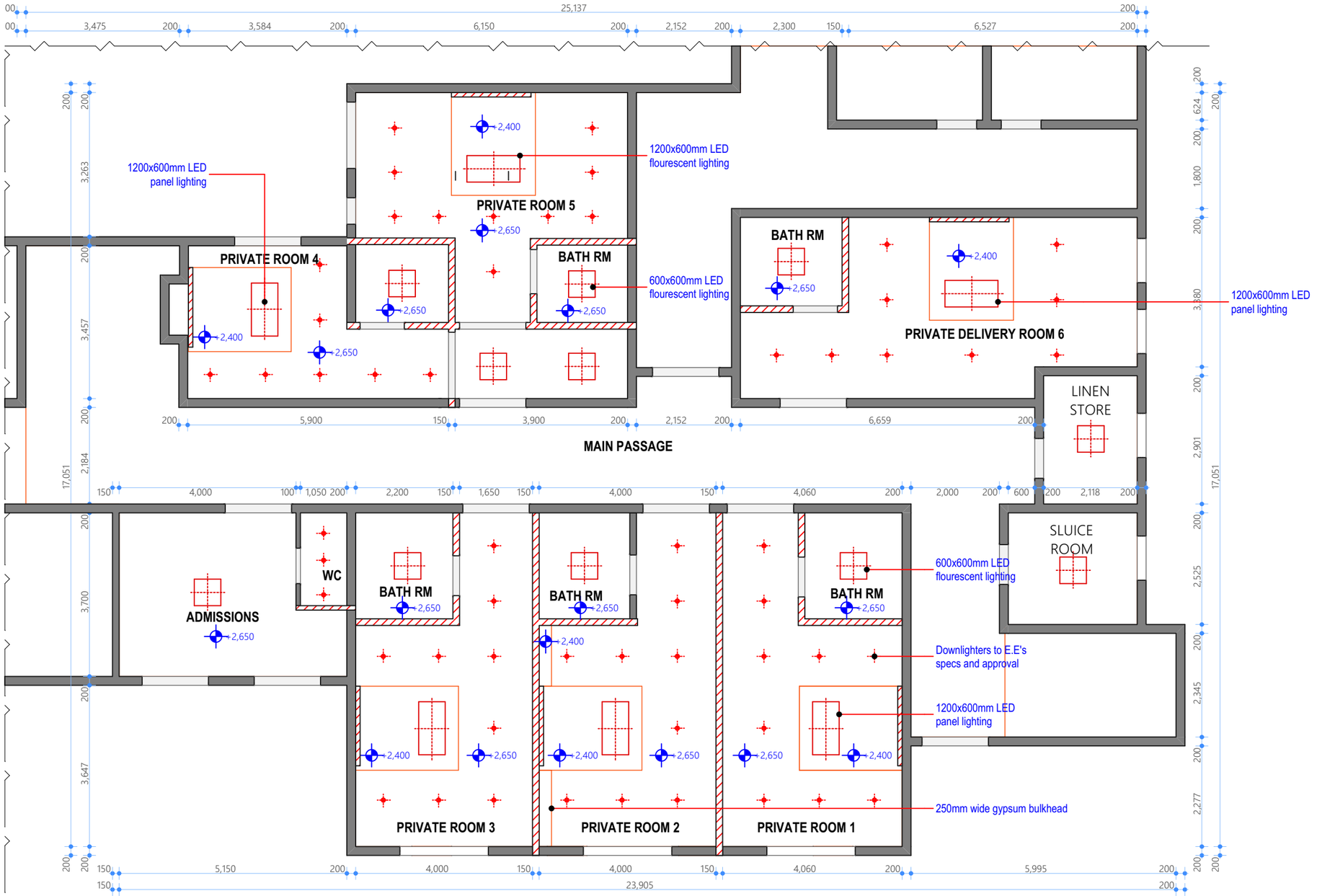
DRAWING TITLE
WORKING DRAWINGS

JOB NO.	
2515 - 16	

DRAWING NO.	REV
2515 - 15/1	**00**

DATE	06/1 /2024	DRAWN	Arch. M. L
SCALE	1:75	CHECKED	ARCH.E . KIGAI



L[--]02 REFLECTED CEILING PLAN

SCALE 1:100

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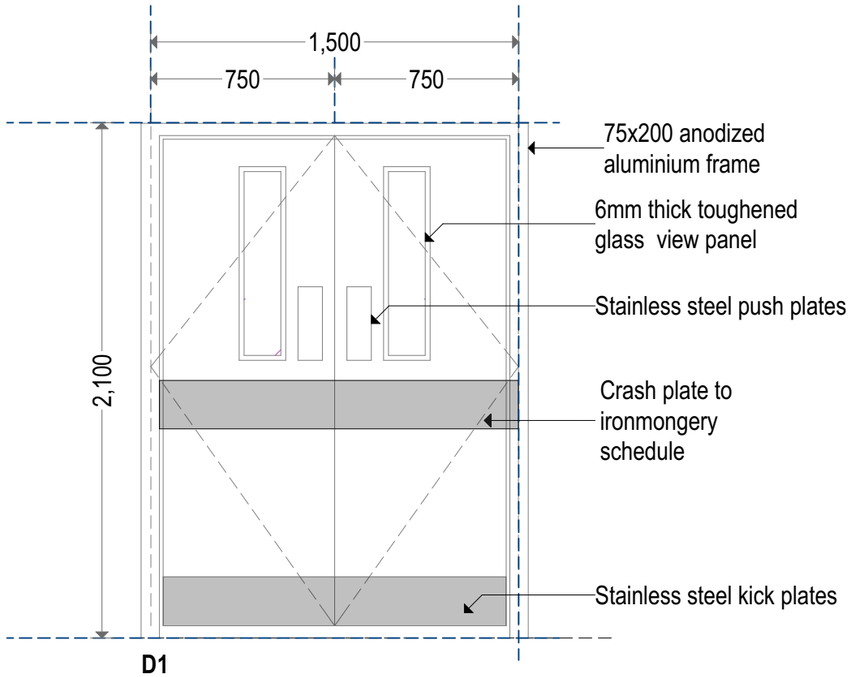
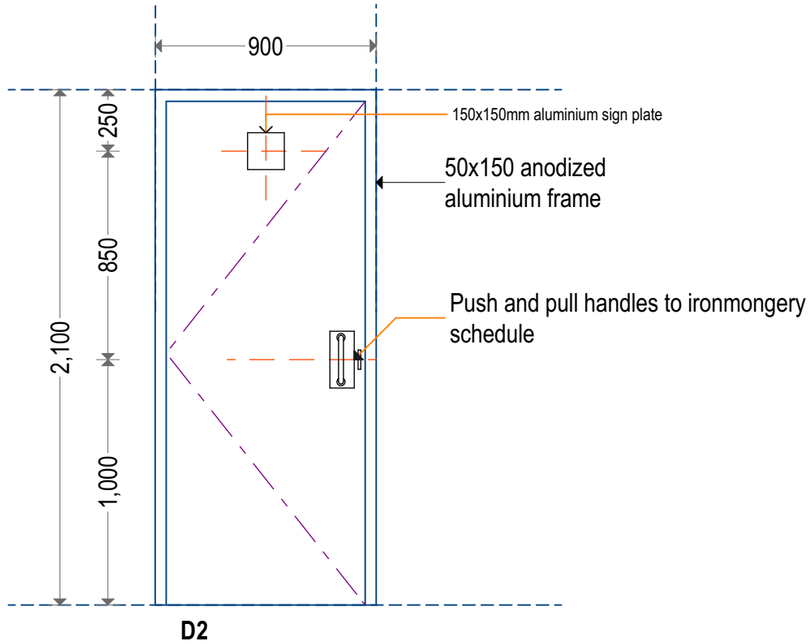


D1

Description;

45mm thick post formed door with concealed lipping

IRONMONGERY:
-6 nos.S.S ball bearing hinges 'HN 2BB-403030'
-1 pair 200mm stainless steel pull handles mounted on S.S plate engraved
-2 lever lock 2 wayaction
-Cylinder stainless steel floor mounted door stop 'DH005 SS'
-Door closer,power 2-6 STD ARM 9shenfei) '7836 SIL'
-



D2

Description;

45mm thick post formed door with concelaed lipping

IRONMONGERY:
-3no. 100mm steel butt hinges as Union 'HN 2BB-403030'
-Steel door lock as 'Union 05-22931'
-Stainless steel door stop as 'Union DH005'
-Stainless steel heavy duty door closer as 'Union 8247 SS'
-Stainless steel euro cylinder lock case, 72 centres with gull on plate handle as 'UNION QDS001047-72'

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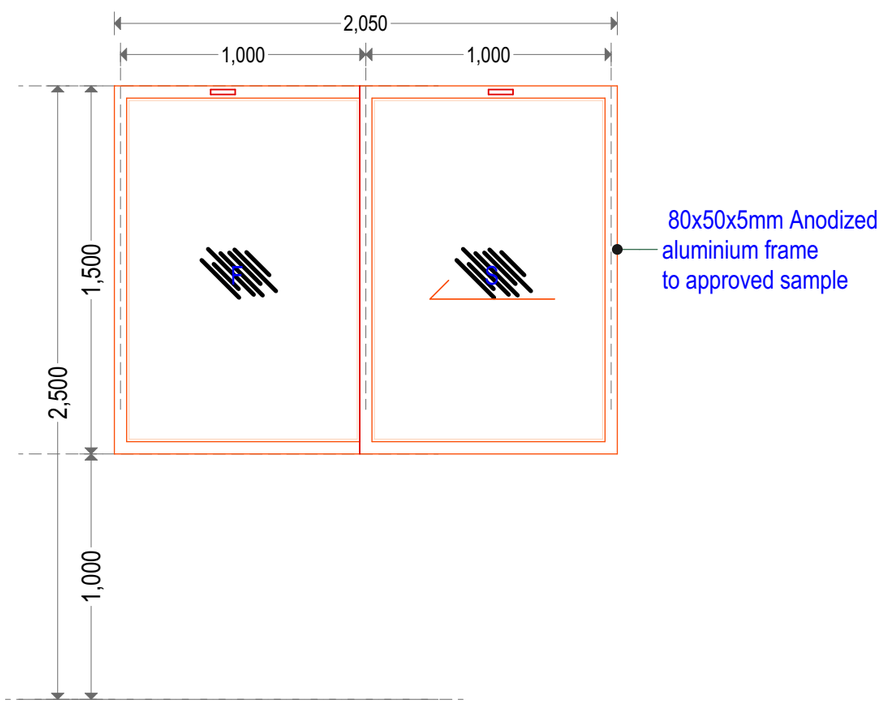


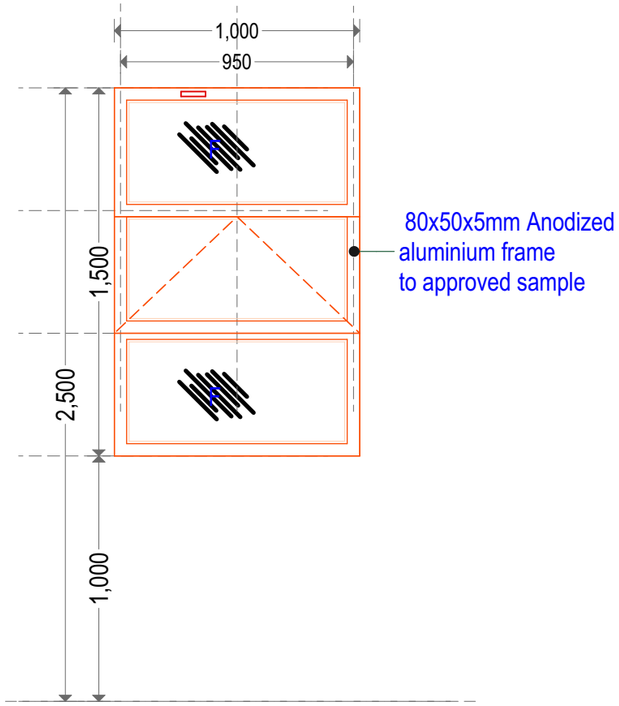
W1

Description;

Purpose made anodized aluminium glazed sliding window, with 8mm one way glass, with 150x20mm thick galaxy black granite in window board to sample to approval.

Iron Mongery;

fasterners,stays,hinges and sliding rails to manufacturers specs.



W2

Description;

Purpose made anodized aluminium glazed window, with 8mm one way glass, with 150x20mm thick galaxy black granite in window board to sample to approval.

Iron Mongery;

fasterners,stays,hinges and sliding rails to manufacturers specs.

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PROPOSED MATERNITY ROOMS IMPROVEMENT NAIROBI HOSPITAL -

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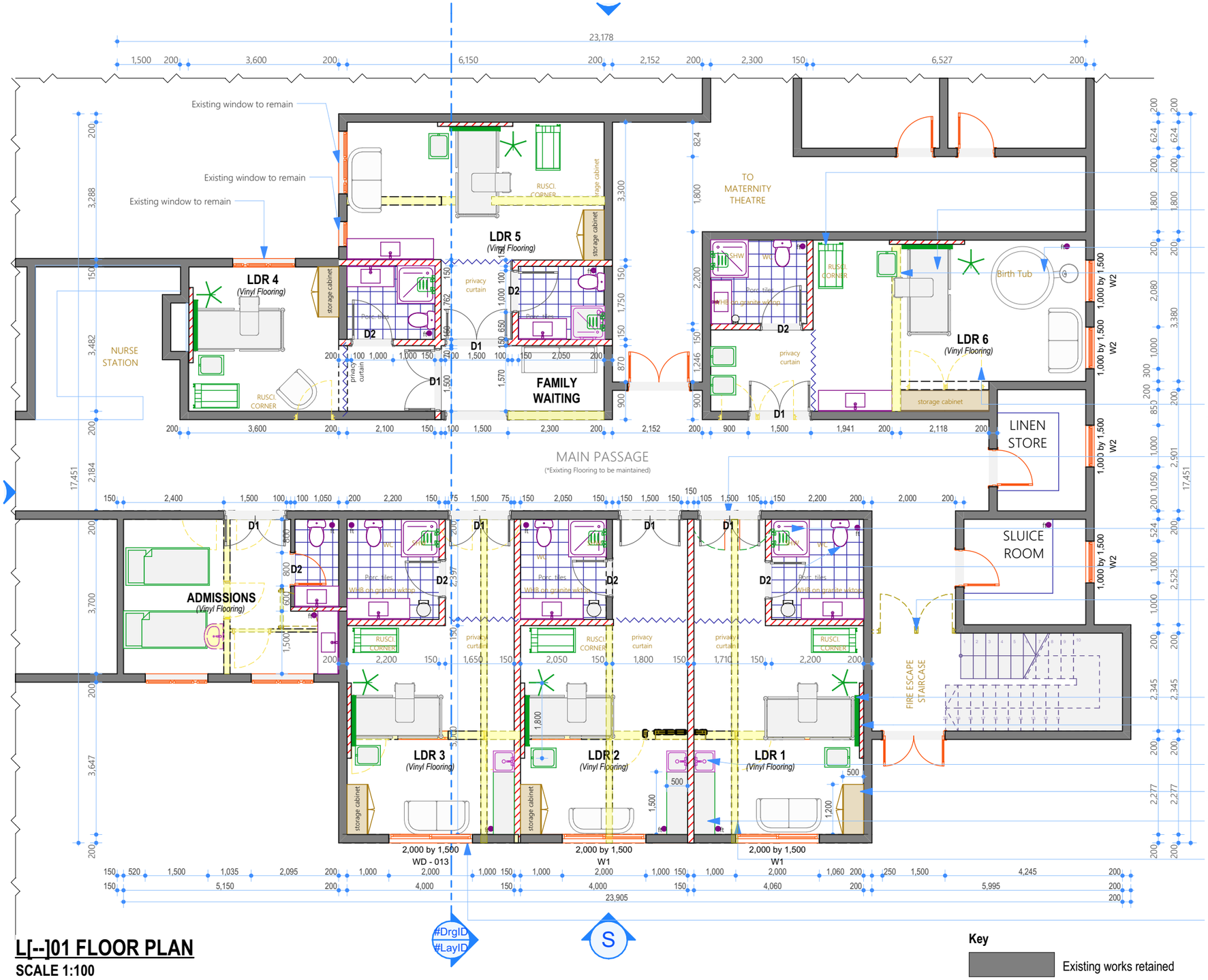

L[--]01 FLOOR PLAN

SCALE 1:100

#DrgID
#LayID

S

Key

- Existing works retained
- Demolition works
- New works

Position of infant ruscistation equipment to approval

6No. Delivery/Birthing Beds, with bedhead, To TNH approval and supply.

Position of birthing tub to approved sample

Existing Walls to be carefully demolished and new supports provided to S. Eng details/specifictions

Exisitng 1500mm wide double leaf Doors to be carefully demolishedand disturbed surfaces made good to approval

New 1500mm wide double leaf Doors with view panel kick plate and crush plates

Shower tray with folding shower seat and grab bars to M.E's specifications and approval

WC with grab bars and other accessories to M.E's specifications

Aluminium door to be rremoved and surfaces made good

Medical bedhead unit with procedure lights to M.E's specs and client's approval

100mm thick false masonry wall skimmed and painted to approval

foot operated scrub sink to M.E's specs and client's approval

2100mm high post formed mdf storage for patients

20mm granite top on 900mm high with post formed low level MDF cabinets

3No Walls to be carefully demolished and new supports provided to S. Eng details/specifictions

3No new alumium windows to schedule to replace the 4no existing .

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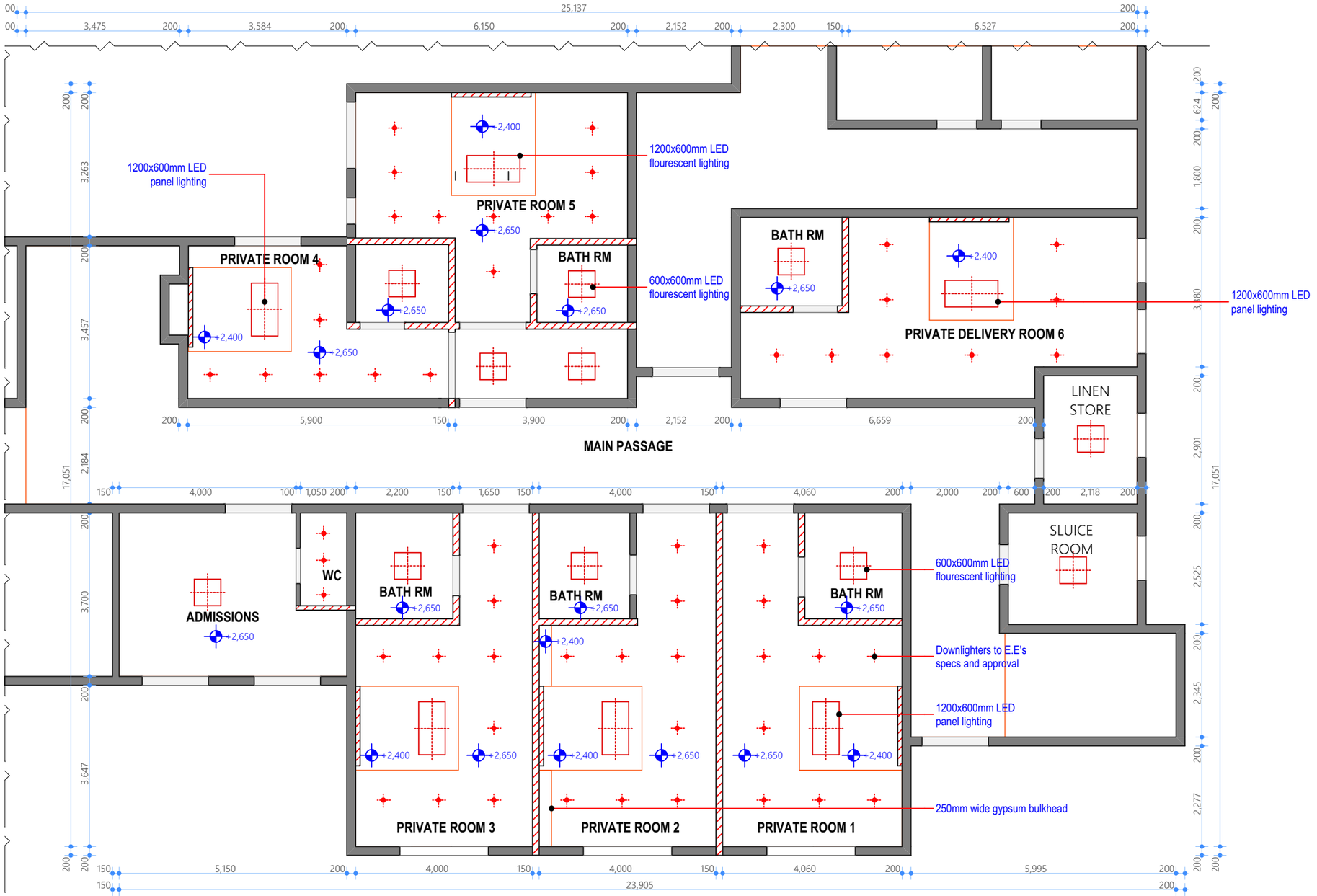

L[--]02 REFLECTED CEILING PLAN

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BOOK OF DRAWINGS

FOR

CIVIL & STRUCTURAL DRAWINGS

PROPOSED FIY OUTS AND REORGANIZATION FOR THE NAIROBI HOSPITAL

LABOR WARDS

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JOB NO.

DRAWING NO. REV

DATE	SCALE	DRAWN	CHECKED

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PROPOSED REDEVELOPMENT AT NAIROBI HOSPITAL CENTRAL CORE RECEPTION ALTERATION & REHABILITATION WORKS

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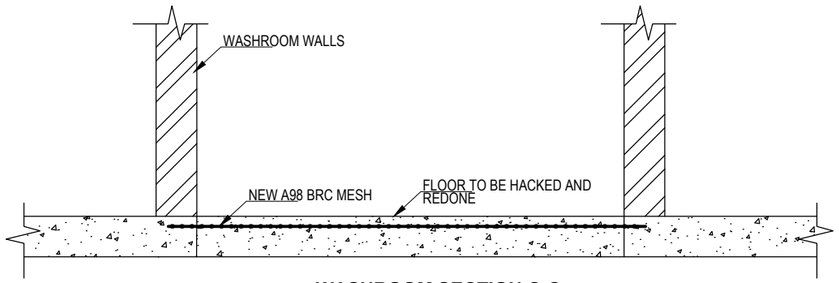

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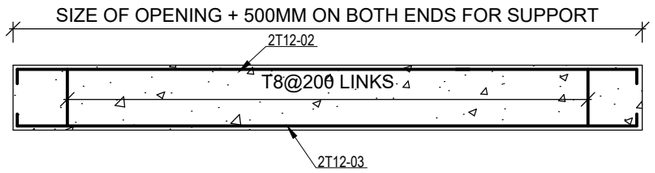

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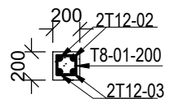

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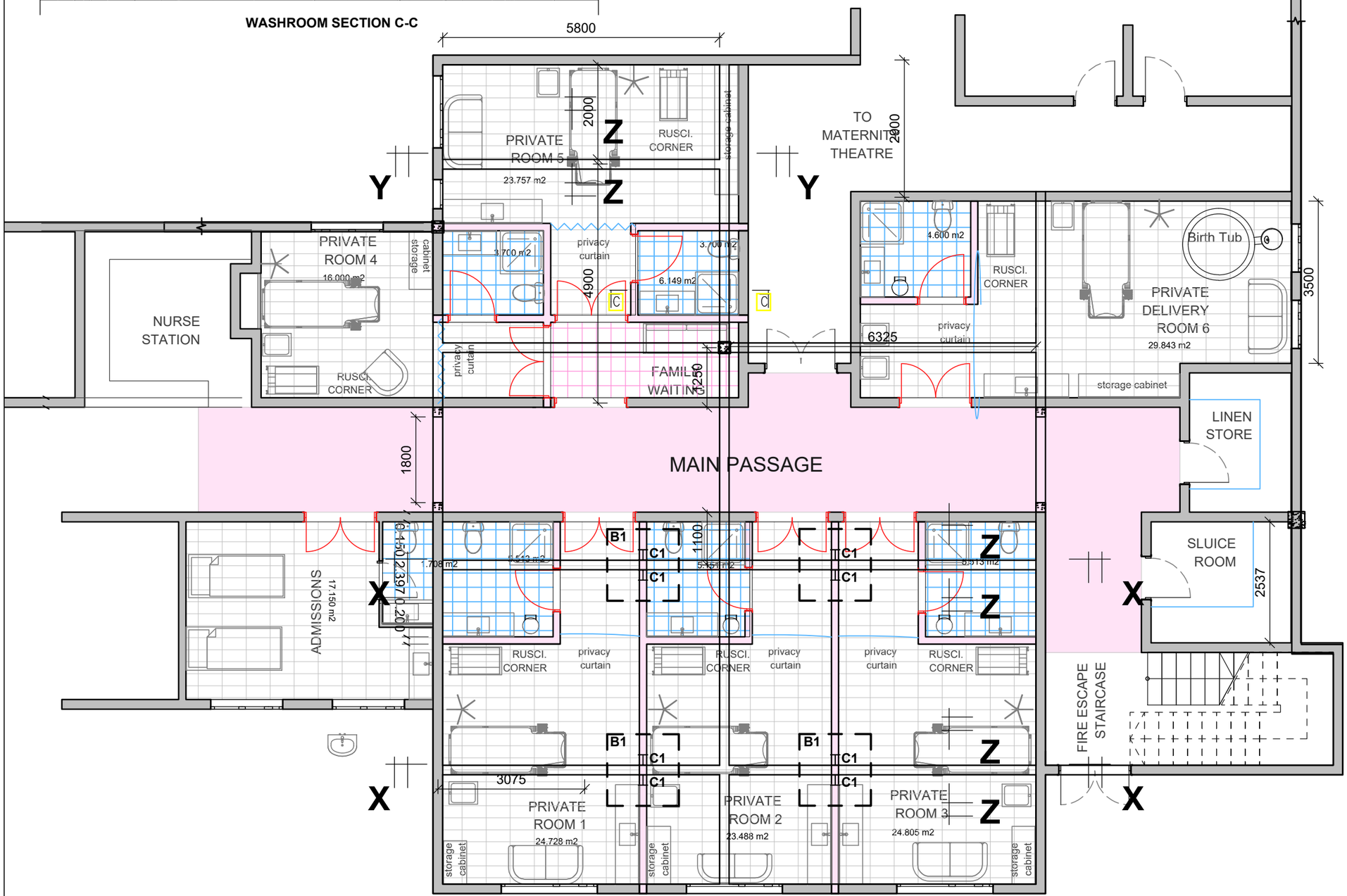

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REVISIONS

NO.	REVISION/ISSUE	INSTRUCTION BY.	DATE

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PROJECT
PROPOSED FIT-OUTS AND RE-ORGANIZATION FOR THE NAIROBI HOSPITAL

SITE
Plot L. R. No. 209/6442/1,
NAIROBI COUNTY.

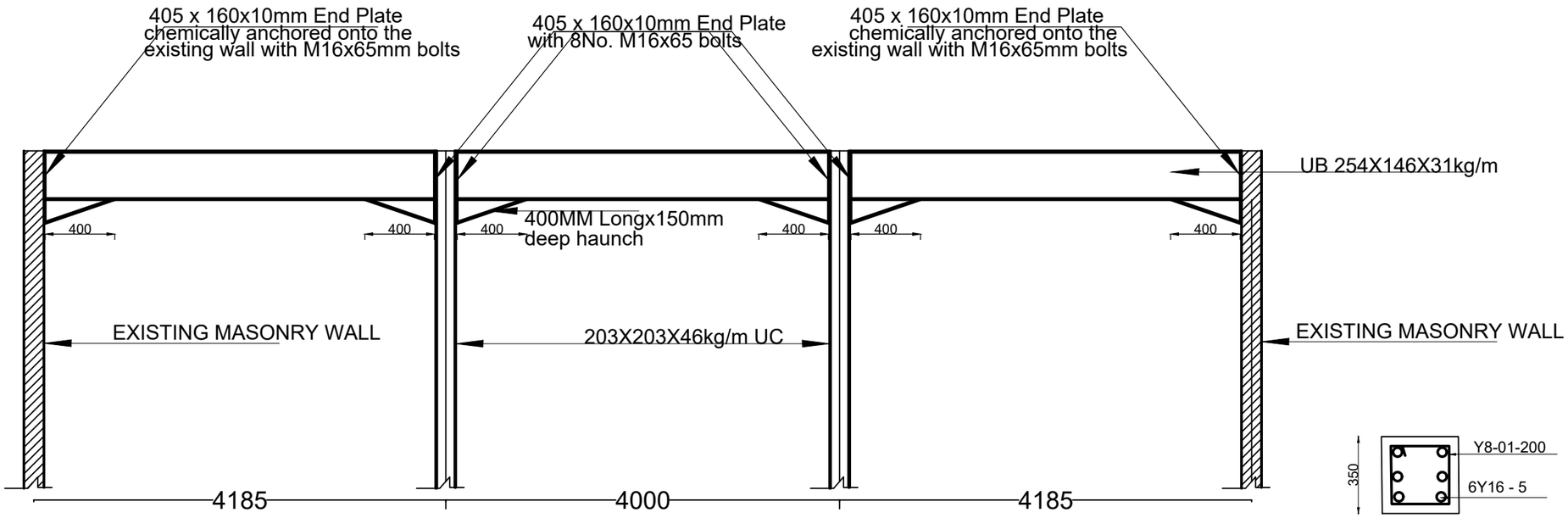
DRAWING TITLE
TNH MATERNITY IMPROVEMENT WORKS
Layout

JOB NO.

DRAWING NO. Nat24_TNH_labour_01

REV

DATE	SCALE	DRAWN	CHECKED
07-Jan-24		P.N.N	Eng. P.N.M



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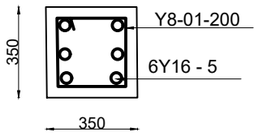

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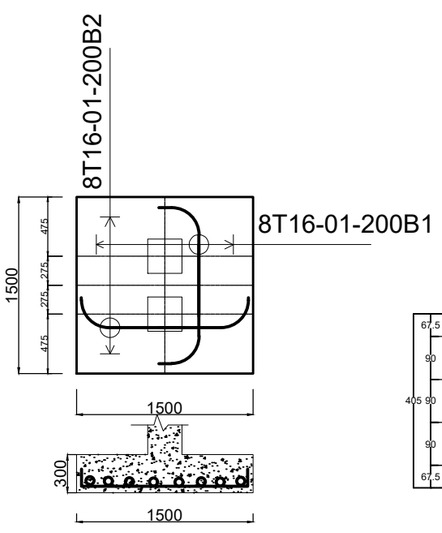

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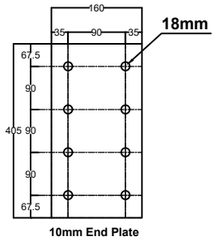
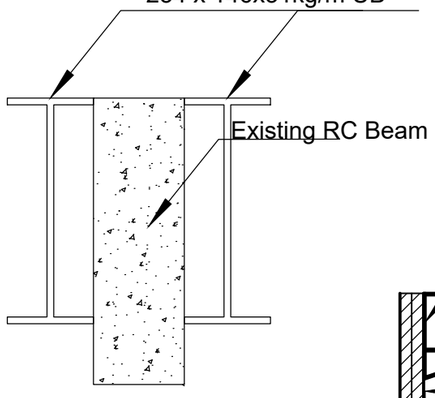
SCALE 1:10





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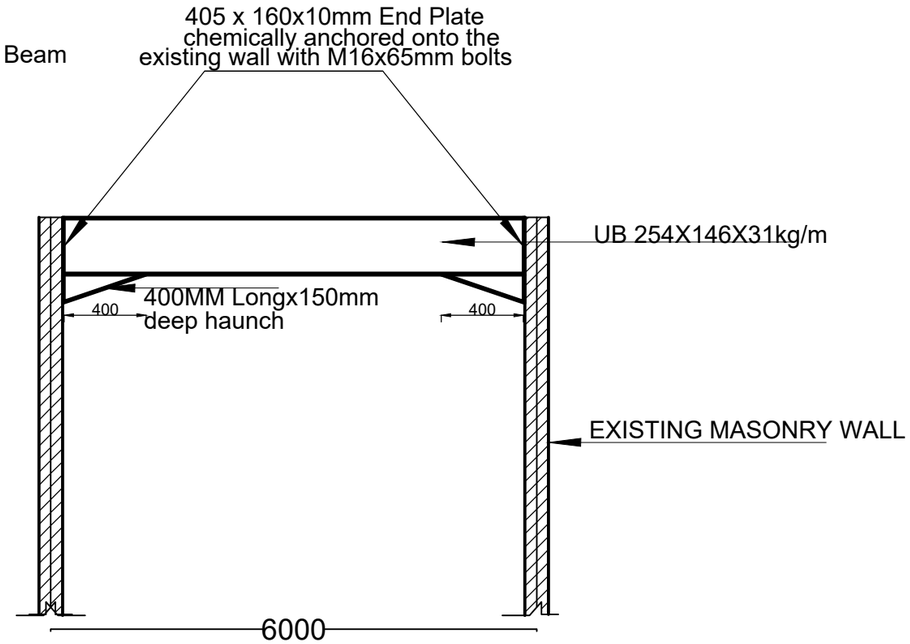

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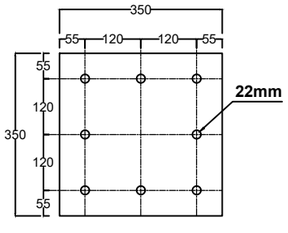

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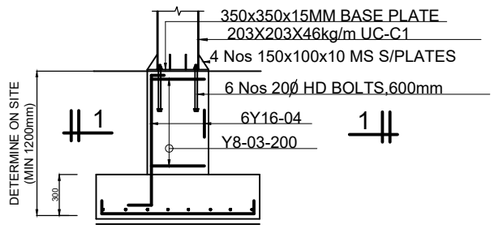
SCALE 1:10



350x350 COL C1-2 Nos
SCALE 1:25

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CLIENT

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PROJECT
PROPOSED FIT-OUTS AND RE-ORGANIZATION FOR THE NAIROBI HOSPITAL

SITE
Plot L. R. No. 209/6442/1,
NAIROBI COUNTY.

DRAWING TITLE
TNH MATERNITY IMPROVEMENT WORKS
Beam Details

JOB NO.

DRAWING NO. Nat24_TNH_labour_02
REV

DATE	SCALE	DRAWN	CHECKED
07-Jan-24		P.N.N	Eng. P.N.M

THE NAIROBI HOSPITAL

PROPOSED RE-ORGANIZATION AT THE NAIROBI HOSPITAL

PROPOSED MATERNITY LABOR WARDS IMPROVEMENT

MECHANICAL SERVICES BOOK OF DRAWINGS

PREPARED BY

GEOMAX CONSULTING ENGINEERS

GEOMAX CONSULTING | DESIGN|MANAGEMENT

DRAWING REFERENCE AND CODING KEY

L (- -)01 ← DRAWING NUMBER
↑ ↑ SERVICES CODE
LAYOUT CODE

L(50) - MECHANICAL SCHEDULE OF DRGS.
L(52) - DRAINAGE SERVICES
L(53) - PLUMBING & FIRE PROTECTION
L(57) - AIR CONDITIONING & MECHANICAL VENTILATION

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REVISIONS

NO.	REVISION/ISSUE	DONE BY;	INSTRUCTION BY;	DATE

CLIENT

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PSRM CONSULTANTS
projects : strategy : risk : management.

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PROJECT

PROPOSED MATERNITY LABOR WARDS IMPROVEMENTS

FOR THE NAIROBI HOSPITAL

SITE
Argwings Kodhek Road, Nairobi

DRAWING TITLE:
COVER PAGE

JOB NO.
J2106.27

DRAWING NO. REV

DATE	SCALE	DRAWN	CHECKED
JAN-2024	N.T.S	SKK	SKK

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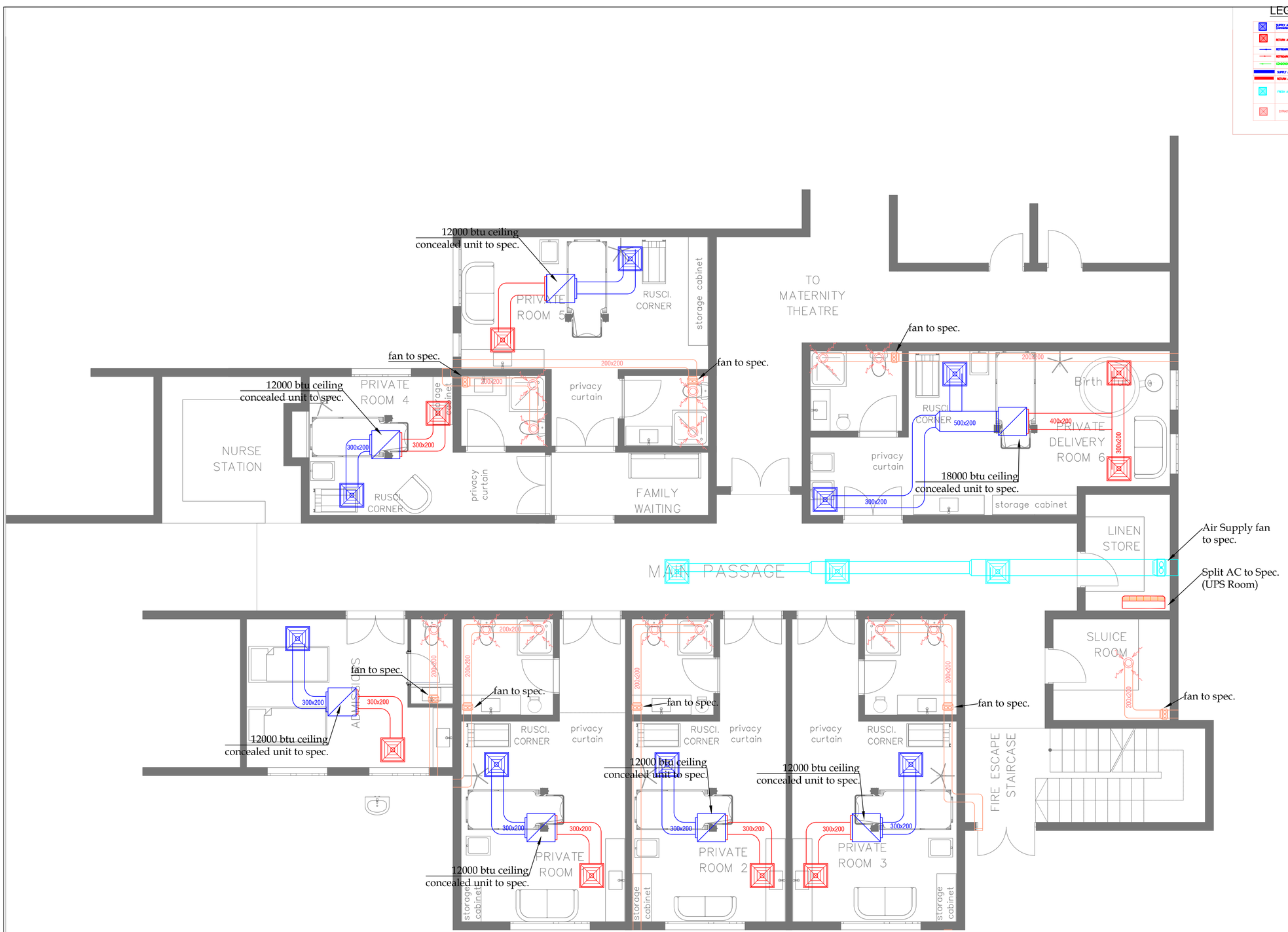

LEGEND

- SUPPLY AIR DIFFUSER SIZE 600x600mm (Perforated To AC Units)
- RETURN AIR DIFFUSER SIZE 600x600mm
- REFRIGERANT SUCTION LINE PIPE
- REFRIGERANT DISCHARGE LINE PIPE
- CONDENSATE DRAIN PIPE
- SUPPLY AIR SLOT DIFFUSER SIZE 1200x200mm
- RETURN AIR SLOT DIFFUSER SIZE 1200x200mm
- FRESH AIR SUPPLY DIFFUSER SIZE 600x600mm
- EXTRACT AIR DIFFUSER SIZE 600x600mm

DRAWING REFERENCE AND CODING KEY

L (- -)01
- 01 ← DRAWING NUMBER
- (- -) ← SERVICES CODE
- L ← LAYOUT CODE

L(50) - MECHANICAL SCHEDULE OF DRGS.
L(52) - DRAINAGE SERVICES
L(53) - PLUMBING & FIRE PROTECTION
L(57) - AIR CONDITIONING & - MECHANICAL VENTILATION

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CLIENT

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PSRM CONSULTANTS projects : strategy : risk : management.

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PROJECT

PROPOSED MATERNITY LABOR WARDS IMPROVEMENTS

FOR THE NAIROBI HOSPITAL

SITE

Argwings Kodhek Road, Nairobi

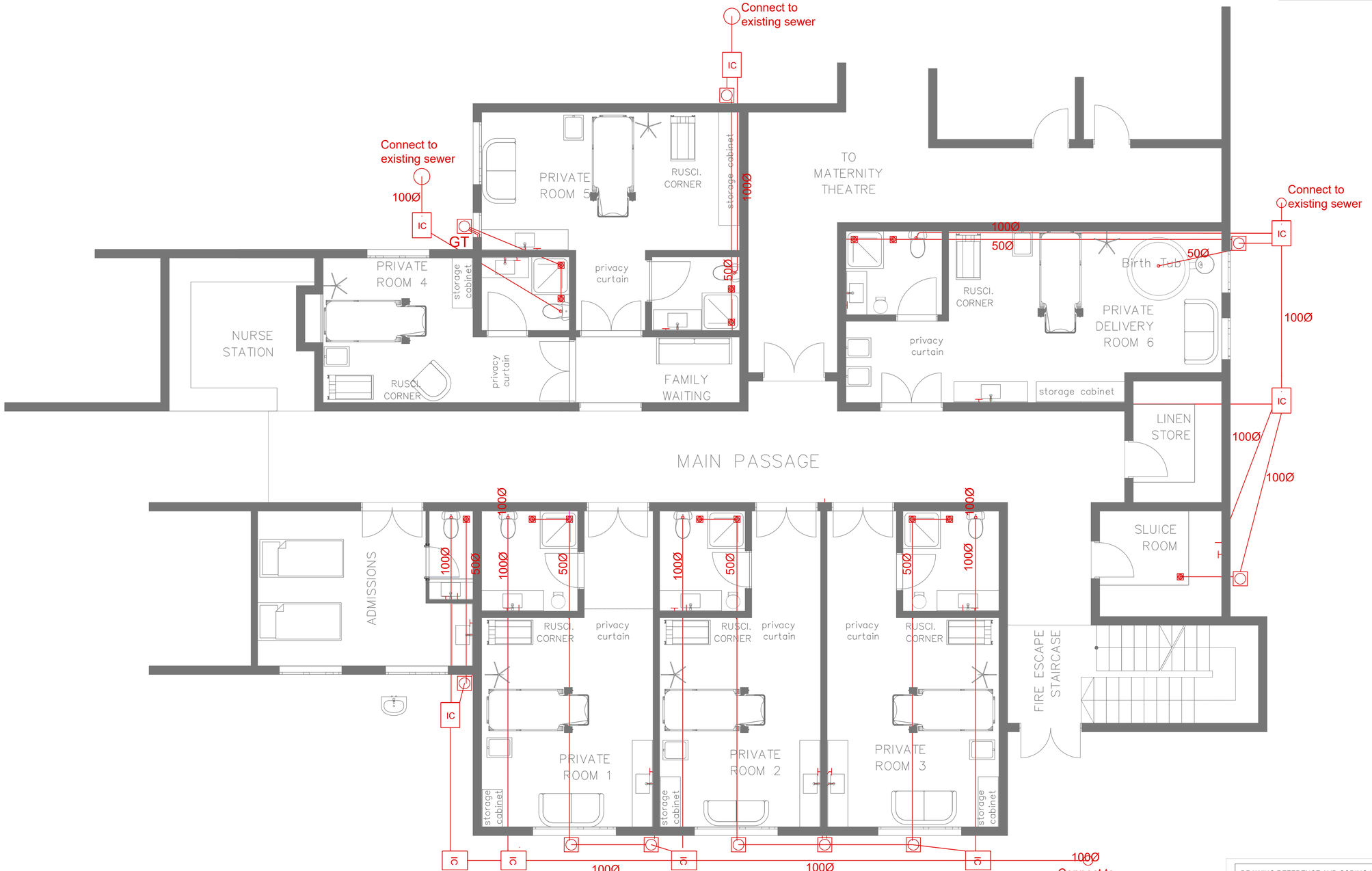
DRAWING TITLE: MATERNITY LABOR WARD IMPROVEMENTS

AIR CONDITIONING & MECHANICAL VENTILATION LAYOUT

JOB NO. J2106.27

DRAWING NO. J2106.27 - L(57) - 01 REV 0

DATE	SCALE	DRAWN	CHECKED
JAN – 2024	1:50(A1)	SKK	SKK



LEGEND

- CWS- COLD WATER SUPPLY PIPE
- HWS- HOT WATER SUPPLY PIPE
- HWR - HOT WATER RETURN LINE
- RM ..... RISING MAIN
- FA ..... FROM ABOVE
- TB ..... TO BELOW
- HR 90m HOSEREEL
- FE 9ltr. WATER CO2 FIRE EXTINGUISHER
- FE 9kg ABC DRY POWDER FIRE EXTINGUISHER

DRAWING REFERENCE AND CODING KEY

L (- -)01
- 01 ← DRAWING NUMBER
- SERVICES CODE
- LAYOUT CODE

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P.O. Box 30026 - 00100 NAIROBI

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PSRM CONSULTANTS projects : strategy : risk : management.

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PROJECT

PROPOSED MATERNITY LABOR WARDS IMPROVEMENTS FOR THE NAIROBI HOSPITAL

SITE

Argwings Kodhek Road, Nairobi

DRAWING TITLE: MATERNITY LABOR WARD IMPROVEMENTS

DRAINAGE LAYOUT

JOB NO. J2106.27

DRAWING NO. J2106.27 - L(52) - 02 REV 0

DATE	SCALE	DRAWN	CHECKED
JAN–2024	1:50(A1)	SKK	SKK

LEGEND

- CWS- COLD WATER SUPPLY PIPE
- HWS- HOT WATER SUPPLY PIPE
- HWR - HOT WATER RETURN LINE

RM ..... RISING MAIN
FA ..... FROM ABOVE
TB ..... TO BELOW
HR ..... 90m HOSEREEL
FE ..... 9KL WATER CO2 FIRE EXTINGUISHER
FE ..... 9kg ABC DRY POWDER FIRE EXTINGUISHER

DRAWING REFERENCE AND CODING KEY

L (- -)01 ← DRAWING NUMBER
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NO.	REVISION/ISSUE	DONE BY;	INSTRU-CTION BY;	DATE

CLIENT

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CONSULTING | DESIGN| MANAGEMENT

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PROJECT

PROPOSED MATERNITY LABOR WARDS IMPROVEMENTS

FOR THE NAIROBI HOSPITAL

SITE
Argwings Kodhek Road, Nairobi

DRAWING TITLE: MATERNITY LABOR WARD IMPROVEMENTS
PLUMBING LAYOUT

JOB NO.
J2106.27

DRAWING NO. J2106.27 - L(53) - 03
REV 0

DATE	SCALE	DRAWN	CHECKED
JAN-2024	1:50(A1)	SKK	SKK

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FE ..... 9KL WATER CO2 FIRE EXTINGUISHER
FE ..... 9kg ABC DRY POWDER FIRE EXTINGUISHER

DRAWING REFERENCE AND CODING KEY

L (- -)01
- 01 — DRAWING NUMBER
- (- -) — SERVICES CODE
- L — LAYOUT CODE

L(50) - MECHANICAL SCHEDULE OF DRGS.
L(52) - DRAINAGE SERVICES
L(53) - PLUMBING & FIRE PROTECTION
L(57) - AIR CONDITIONING & - MECHANICAL VENTILATION

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NOTES

1. All dimensions are in millimetres unless otherwise stated.
2. Work to figured dimensions only.
3. All works to be carried out in accordance with Council regulations and Specifications.
4. Architectural drawings must be used in conjunction with Structural, Mechanical and any other relevant consultants' drawings.
5. Any discrepancies in this drawing must be reported to the Engineer before construction commences
6. All drainage pipes passing under buildings and drive ways to be pvc pipes and encased in concrete.
7. All inspection chambers on driveways to have heavy duty covers.
8. All sanitary fittings to be in accordance with MoH rules, regulations and specifications.
9. All final services connections to existing to be agreed with the client and approved by the Engineer
10. Existing services disconnections shall be effected with explicit approval from the client and the Engineer

REVISIONS

NO.	REVISION/ISSUE	DONE BY;	INSTRUCTION BY;	DATE

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THE NAIROBI HOSPITAL
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projects : strategy : risk : management.

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PROJECT

PROPOSED MATERNITY LABOR WARDS IMPROVEMENTS

FOR THE NAIROBI HOSPITAL

SITE
Argwings Kodhek Road, Nairobi

DRAWING TITLE: MATERNITY LABOR WARD IMPROVEMENTS
PLUMBING LAYOUT

JOB NO.
J2106.27

DRAWING NO. J2106.27 - L(53) - 04 REV 0

DATE	SCALE	DRAWN	CHECKED
JAN-2024	1:50(A1)	SKK	SKK

THE NAIROBI HOSPITAL

PROPOSED RE-ORGANIZATION AT THE NAIROBI HOSPITAL

PROPOSED MATERNITY ROOMS IMPROVEMENT

ELECTRICAL SERVICES
BOOK OF DRAWINGS

PREPARED BY

GEOMAX CONSULTING ENGINEERS

GEOMAX
CONSULTING | DESIGN|MANAGEMENT

TENDER ISSUE

DRAWING REFERENCE AND CODING KEY

L(--)01 ← DRAWING NUMBER
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LAYOUT CODE

L(60) - ELECTRICAL SCHEDULES
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L(64) - COMMUNICATIONS LAYOUT
L(67) - LIGHTNING PROTECTION LAYOUT
L(68) - FIRE ALARM/SECURITY LAYOUT

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PROJECT

PROPOSED FIT-OUTS AND REORGANIZATION FOR THE NAIROBI HOSPITAL LABOUR WARDS

SITE
Argwings Kodhek Road, Nairobi

DRAWING TITLE: LABOUR WARDS COVER PAGE

JOB NO.
J2106.27

DRAWING NO. J2106.27 - L(00) - 00
REV 0

DATE	SCALE	DRAWN	CHECKED
JAN-24	NTS(A2)	VKM	GMN

SCHEDULE OF ELECTRICAL SERVICES CONTRACT DRAWINGS

2024								YEAR
01								MONTH
								DAY

DRAWING NO.	DESCRIPTION	ISSUE/REVISION						SIZE	SCALE
J2106.27 L(60)00	SCHEDULE OF ELECTRICAL DRAWINGS	0						A2	NTS
J2106.27 L(61)01	RAW POWER SINGLE LINE WIRING DIAGRAM	0						A2	NTS
J2106.27 L(61)02	CLEAN POWER SINGLE LINE WIRING DIAGRAM	0						A2	NTS
J2106.27 L(62,64)03	POWER AND COMMUNICATION LAYOUT	0						A2	1:75
J2106.27 L(63)04	LIGHTING LAYOUT	0						A2	1:75
J2106.27 L(65)05	SECURITY SYSTEMS LAYOUT	0						A2	1:75
J2106.27 L(68)06	FIRE DETECTION AND ALARM SYSTEM LAYOUT	0						A2	1:75
J2106.27 L(64)07	NURSE CALL LAYOUT	0						A2	1:75

TENDER ISSUE

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PROJECT

PROPOSED FIT-OUTS AND REORGANIZATION FOR THE NAIROBI HOSPITAL LABOUR WARDS

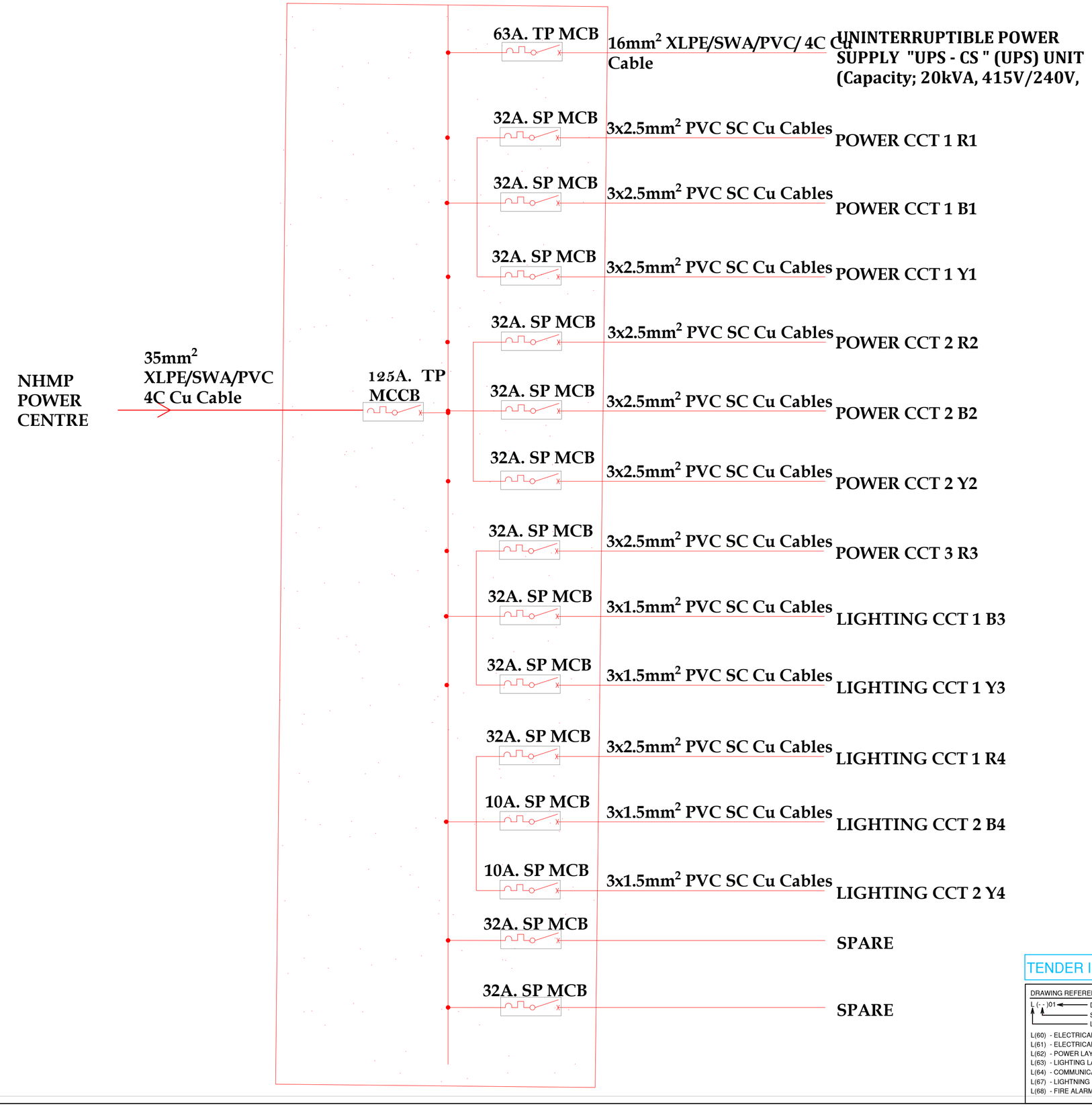
SITE
Argwings Kodhek Road, Nairobi

DRAWING TITLE: LABOUR WARDS
SCHEDULE OF ELECTRICAL DRAWINGS

JOB NO.
J2106.27

DRAWING NO. REV
J2106.27 - L(64,68) - 03 0

DATE	SCALE	DRAWN	CHECKED
JAN-24	1:75(A2)	VKM	GMN



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NOTES

1. ALL DIMENSIONS ARE IN MILLIMETERS (MM) UNLESS OTHERWISE SPECIFIED.
2. ALL BUSBARS AND CABLES IN THE SWITCHBOARD SHALL BE COPPER.
3. ALL MAIN BUSBARS MUST BE THE SAME SIZE INCLUDING THE NEUTRAL BUSBAR.
4. ALL BUSBARS MUST BE ADEQUATELY BRACED.
5. INTERCONNECTIONS BETWEEN BUSBAR DROPPERS AND DEVICES SHALL COMPRISE COPPER BARS. CABLES SHALL NOT BE PERMITTED.
6. FIXING OF CABLES TO BUSBARS SHALL BE BY HIGH TENSILE 8.8 GRADE MILD STEEL BOLTS AND NUTS.
7. ALL TERMINALS AND BUSBARS SHALL BE ADEQUATELY SHROUDED TO AVOID IMMEDIATE ACCESS TO LIVE PARTS.
8. THE SWITCHBOARD SHALL INCORPORATE WARNING LABELS AS APPROPRIATE TO EXPOSURE OF LIVE PARTS.

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PROJECT

PROPOSED FIT-OUTS AND REORGANIZATION FOR THE NAIROBI HOSPITAL LABOUR WARDS

SITE

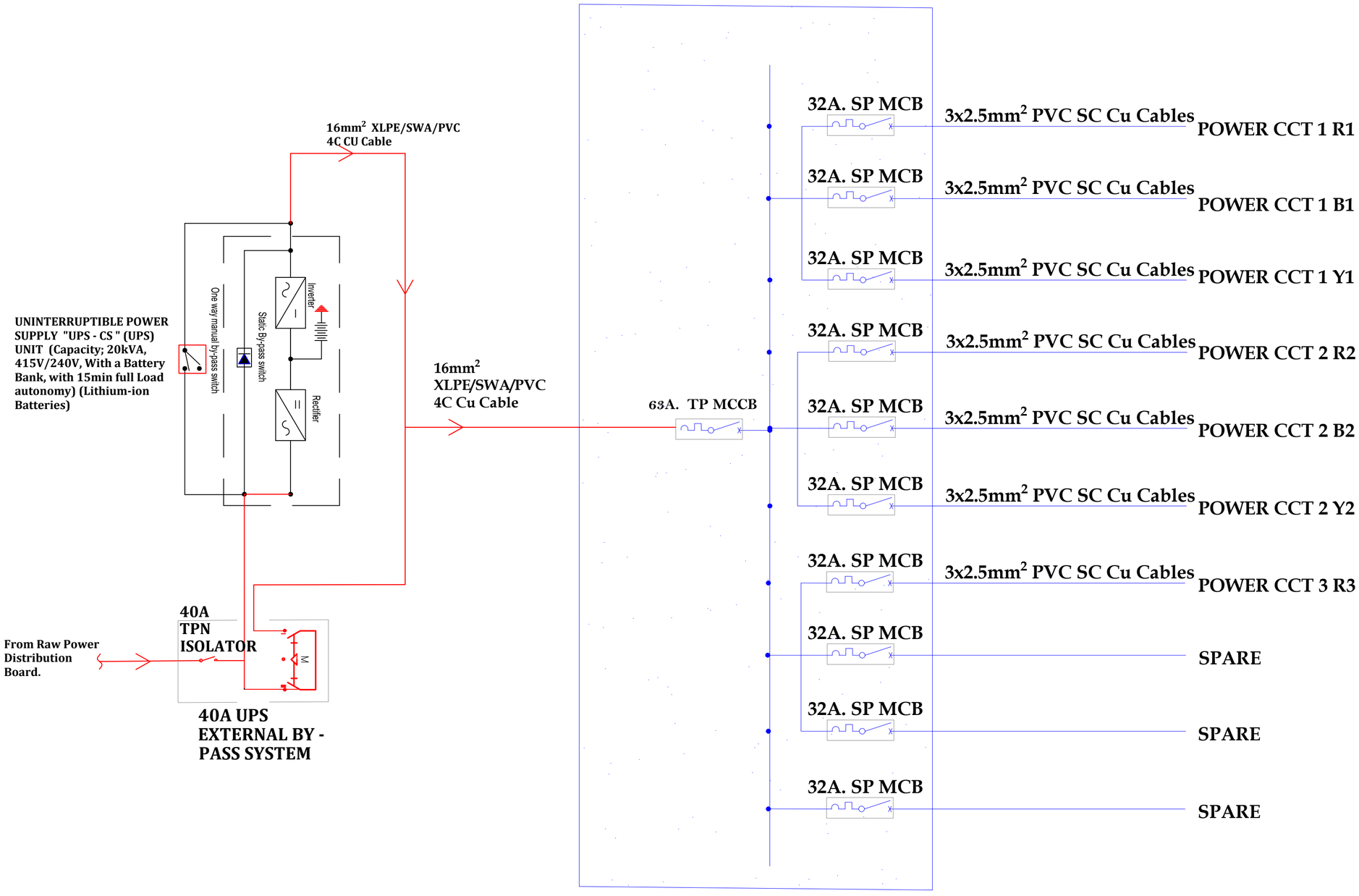
Argwings Kodhek Road, Nairobi

DRAWING TITLE: LABOUR WARDS
RAW POWER DISTRIBUTION BOARD

JOB NO. J2106.27

DRAWING NO. J2106.27 - L(61) - 01 REV 0

DATE	SCALE	DRAWN	CHECKED
JAN-24	NTS,A2)	VKM	GMN



LABOR WARD CLEAN POWER DB

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8. THE SWITCHBOARD SHALL INCORPORATE WARNING LABELS AS APPROPRIATE TO EXPOSURE OF LIVE PARTS.

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PROJECT

PROPOSED FIT-OUTS AND REORGANIZATION FOR THE NAIROBI HOSPITAL LABOUR WARDS

SITE

Argwings Kodhek Road, Nairobi

DRAWING TITLE: LABOUR WARDS CLEAN POWER DISTRIBUTION BOARD

TENDER ISSUE

DRAWING REFERENCE AND CODING KEY

L(--)01 ← DRAWING NUMBER
SERVICES CODE
LAYOUT CODE

L(60) - ELECTRICAL SCHEDULES
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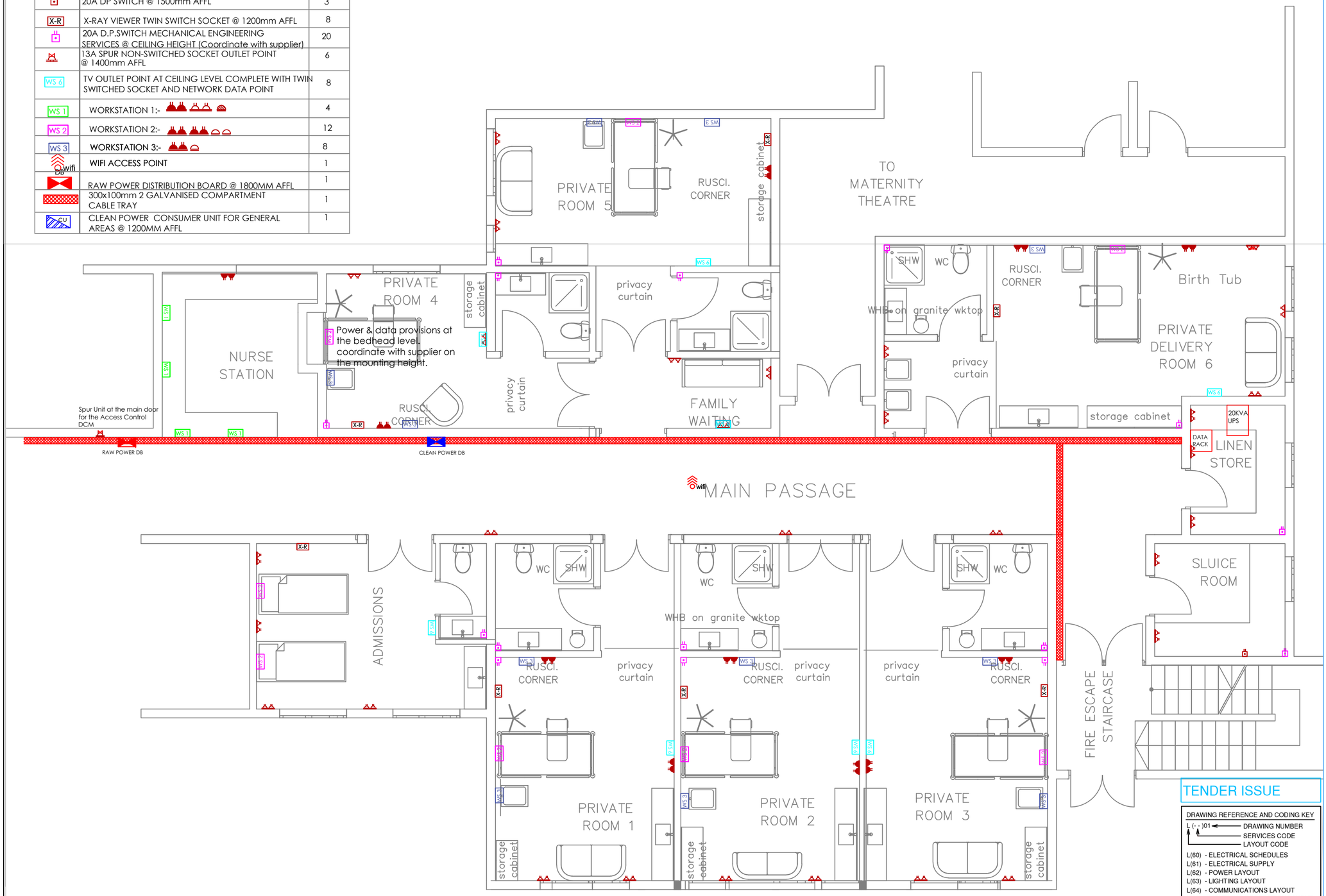
L(68) - FIRE ALARM/SECURITY LAYOUT

JOB NO. J2106.27

DRAWING NO. J2106.27 - L(61) - 02 REV 0

DATE	SCALE	DRAWN	CHECKED
JAN-24	NTS,A2)	VKM	GMN

LEGEND		
SYMBOL	DESCRIPTION	QTY
	DUAL DATA/TELEPHONE POINT	0
	13A TWIN SWITCHED SOCKET - WATER PROOF	2
	13A TWIN SWITCHED SOCKET	20
	13A TWIN(UPS - CONTINUITY) SWITCHED SOCKET	14
	ISOLATOR SWITCH TO SPEC@ 1500mm AFFL	2
	20A DP SWITCH @ 1500mm AFFL	3
X-R	X-RAY VIEWER TWIN SWITCH SOCKET @ 1200mm AFFL	8
	20A D.P.SWITCH MECHANICAL ENGINEERING SERVICES @ CEILING HEIGHT (Coordinate with supplier)	20
	13A SPUR NON-SWITCHED SOCKET OUTLET POINT @ 1400mm AFFL	6
WS 6	TV OUTLET POINT AT CEILING LEVEL COMPLETE WITH TWIN SWITCHED SOCKET AND NETWORK DATA POINT	8
WS 1	WORKSTATION 1:-	4
WS 2	WORKSTATION 2:-	12
WS 3	WORKSTATION 3:-	8
wifi	WIFI ACCESS POINT	1
DB	RAW POWER DISTRIBUTION BOARD @ 1800MM AFFL	1
	300x100mm 2 GALVANISED COMPARTMENT CABLE TRAY	1
CU	CLEAN POWER CONSUMER UNIT FOR GENERAL AREAS @ 1200MM AFFL	1



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NOTES

1. Work to figured dimensions only.
2. All dimensions are in millimetres unless otherwise stated.
3. All lighting switches shall be mounted at a height of 1100mm a.f.f.l. unless otherwise stated.
4. All lighting circuit cables shall be not less than 2x1.5mm^2 pvc sc + 1.5mm^2 e.c.c cables unless otherwise specified.
5. All lighting circuits conduits shall be not less 20mm dia. minimum unless otherwise specified.
6. All distribution boards and or consumer units shall be mounted at a height of 1800mm a.f.f.l. unless otherwise stated.
7. All ring circuits shall have 4x2.5mm^2 pvc sc + 2x2.5mm^2 e.c.c cables unless otherwise specified.
8. All radial circuits shall have 2x2.5mm^2 pvc sc + 2.5mm^2 e.c.c cables unless otherwise specified.
9. All Specialized works conduits provision shall be not less than 25mm dia. minimum unless otherwise specified.
10. Specialized systems shall be by others, however, the Electrical Sub - Contractor shall provide the necessary infrastructure in way of raceways i.e Conduits, trunking and Cable trays.
11. Specialized Sub - Contractors shall provide all cabling, termination outlets and any other accessories to complete the installation as called for.
12. All Systems shall comply and conform to the cause and effects matrix that will be generated by Engineer in respect to the installed systems.
13. All sub-contractors shall provide working drawings outlining the entire or and part of the system on site at all time.

REVISIONS

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PROPOSED FIT-OUTS AND REORGANIZATION FOR THE NAIROBI HOSPITAL LABOUR WARDS

SITE
Argwings Kodhek Road, Nairobi

DRAWING TITLE: LABOUR WARDS POWER & COMMUNICATION LAYOUT

TENDER ISSUE

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JOB NO. J2106.27

DRAWING NO. J2106.27 - L(64,68) - 03 REV 0

DATE	SCALE	DRAWN	CHECKED
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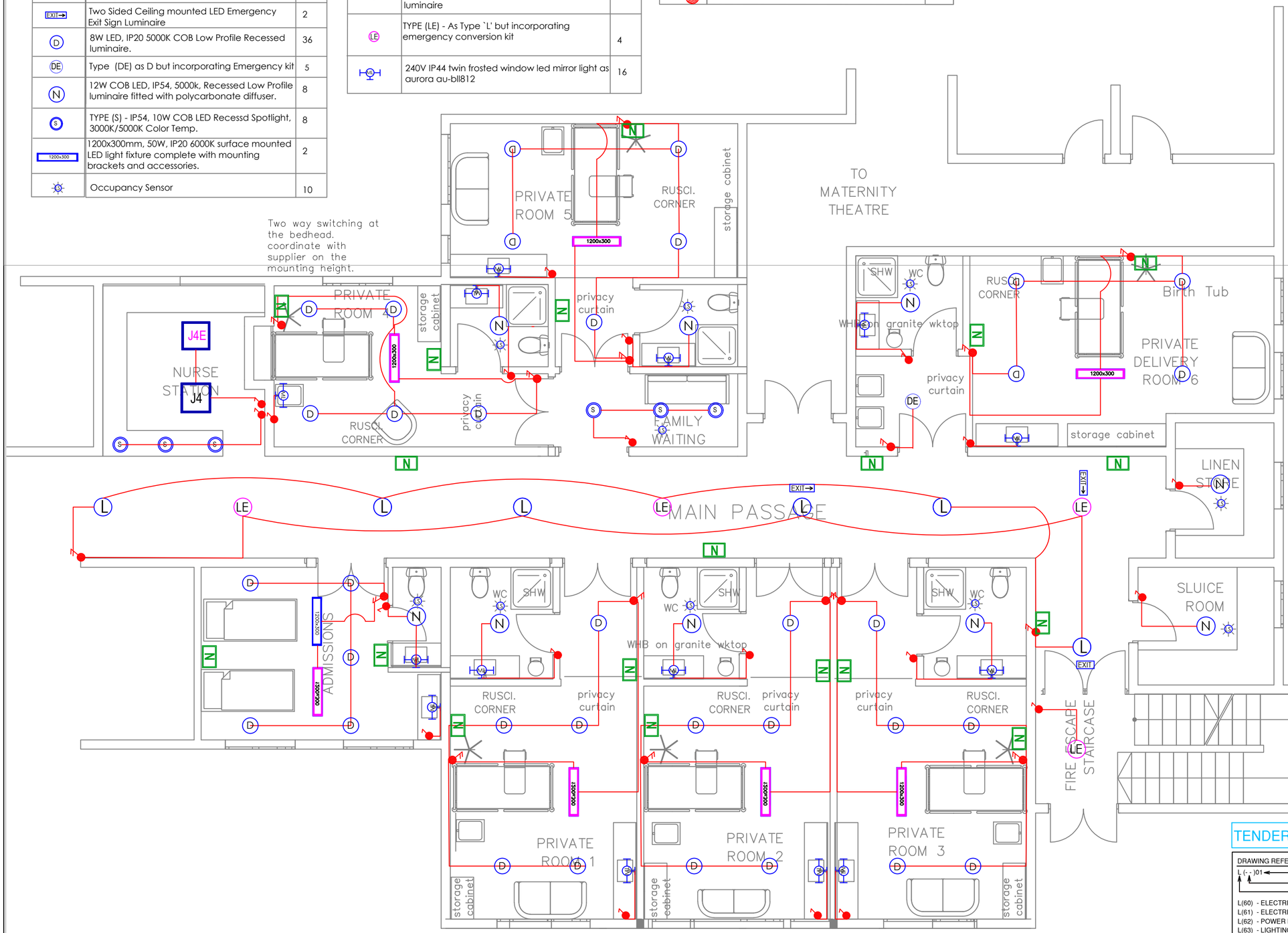
L E G E N D		
SYMBOL	DESCRIPTION	QTY
J4	TYPE (J4) - 600X600mm, IP20, 36W, 5000K SMD LED Dimmable Panel Luminaire.	1
J4E	Type (J4E) as J4 but incorporating Emergency kit	1
EXIT	One Sided Wall mounted LED Emergency Exit Sign Luminaire	1
EXIT→	Two Sided Ceiling mounted LED Emergency Exit Sign Luminaire	2
D	8W LED, IP20 5000K COB Low Profile Recessed luminaire.	36
DE	Type (DE) as D but incorporating Emergency kit	5
N	12W COB LED, IP54, 5000k, Recessed Low Profile luminaire fitted with polycarbonate diffuser.	8
S	TYPE (S) - IP54, 10W COB LED Recessd Spotlight, 3000K/5000K Color Temp.	8
1200x300	1200x300mm, 50W, IP20 6000K surface mounted LED light fixture complete with mounting brackets and accessories.	2
	Occupancy Sensor	10

L E G E N D		
1200x300	1200x300mm, 50W, IP20 6000K surface mounted LED light fixture complete with mounting brackets and accessories and incorporating emergency conversion Kit	9
N	3W, IP66, 3000K SMD LED Rectangular recessed Night Light at 300mm AFFL	20
L	TYPE (L) - 16W IP65 rated, Surface mounted polycarbonate bulkhead luminaire	6
LE	TYPE (LE) - As Type `L' but incorporating emergency conversion kit	4
W	240V IP44 twin frosted window led mirror light as aurora au-bll812	16

L E G E N D		
Symbol	Description	
	10A 1Gang 1Way Lighting Switch @ 1400mm AFFL	10
	10A 1Gang 2Way Lighting Switch @ 1400mm AFFL	5
	10A 2Gang 2Way Lighting Switch @ 1400mm AFFL	16
	10A 3Gang 2Way Lighting Switch @ 1400mm AFFL	0

Two way switching at the bedhead. coordinate with supplier on the mounting height.



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PROJECT
PROPOSED FIT-OUTS AND REORGANIZATION FOR THE NAIROBI HOSPITAL LABOUR WARDS

SITE
Argwings Kodhek Road, Nairobi

DRAWING TITLE: LABOUR WARDS LIGHTING LAYOUT

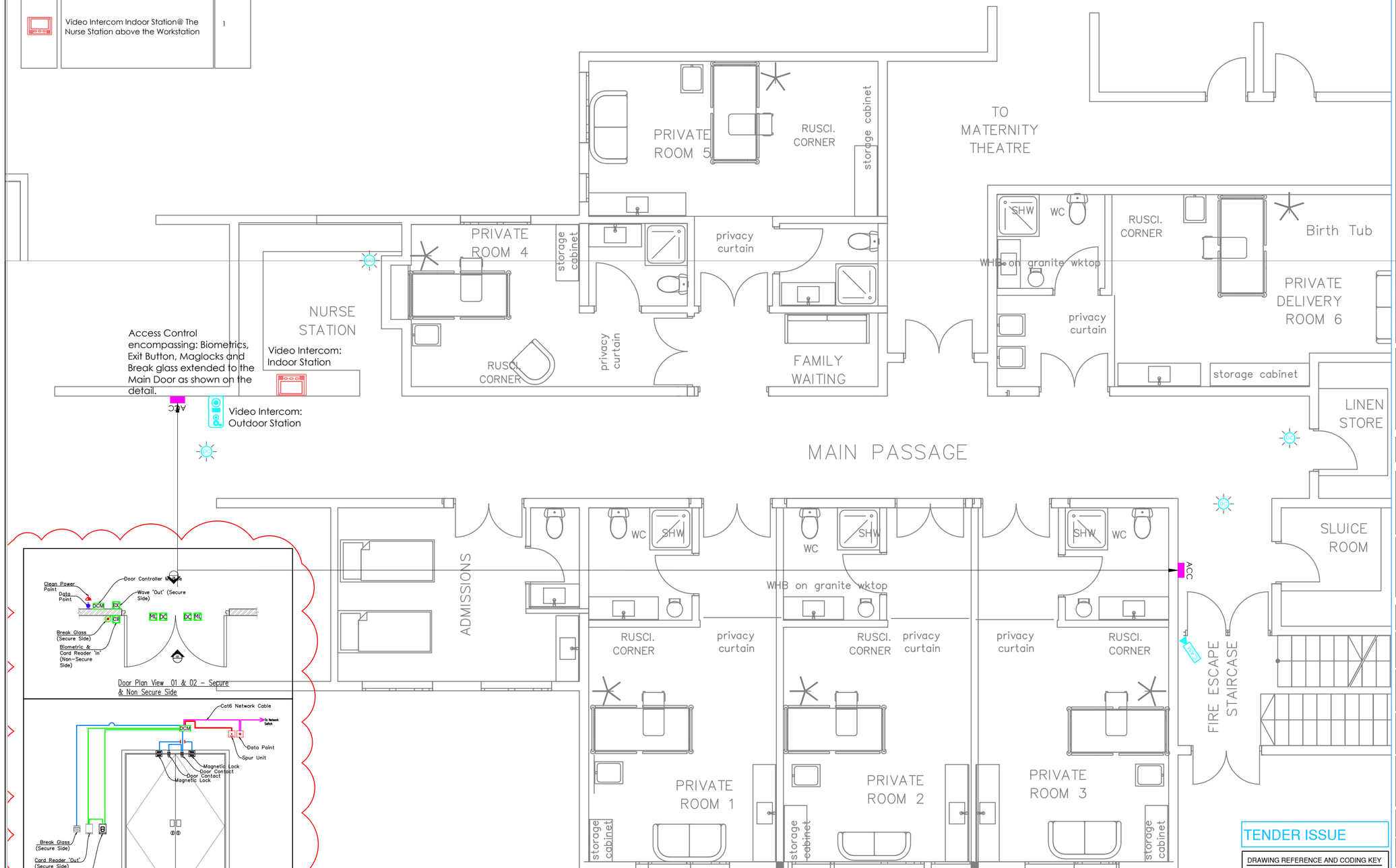
JOB NO. J2106.27

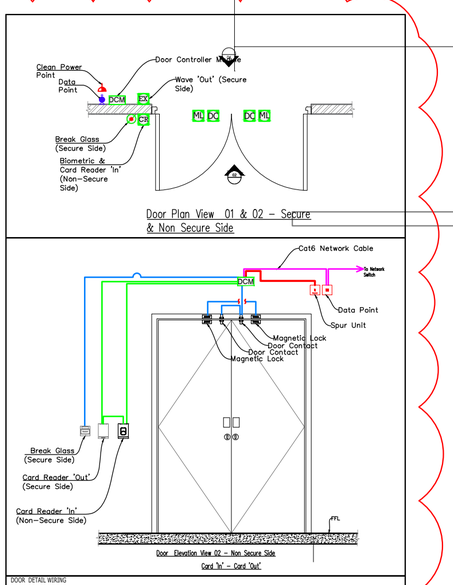
DRAWING NO. J2106.27 - L(63) - 04 REV 0

DATE	SCALE	DRAWN	CHECKED
JAN-24	1:75(A2)	VKM	GMN

LEGEND

CAM	IP BASED BULLET CAMERA	1
	IP BASED DOME CAMERA	4
ACC	IP BASED ACCESS CONTROL UNIT @ 1350mm AFFFL	2
	Video Intercom Outdoor Station@ 1400MM AFFL	1
	Video Intercom Indoor Station@ The Nurse Station above the Workstation	1





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PROJECT

PROPOSED FIT-OUTS AND REORGANIZATION FOR THE NAIROBI HOSPITAL LABOUR WARDS

SITE

Argwings Kodhek Road, Nairobi

DRAWING TITLE: LABOUR WARDS SECURITY SYSTEM LAYOUT

TENDER ISSUE

DRAWING REFERENCE AND CODING KEY

L(--)01 ← DRAWING NUMBER; SERVICES CODE; LAYOUT CODE

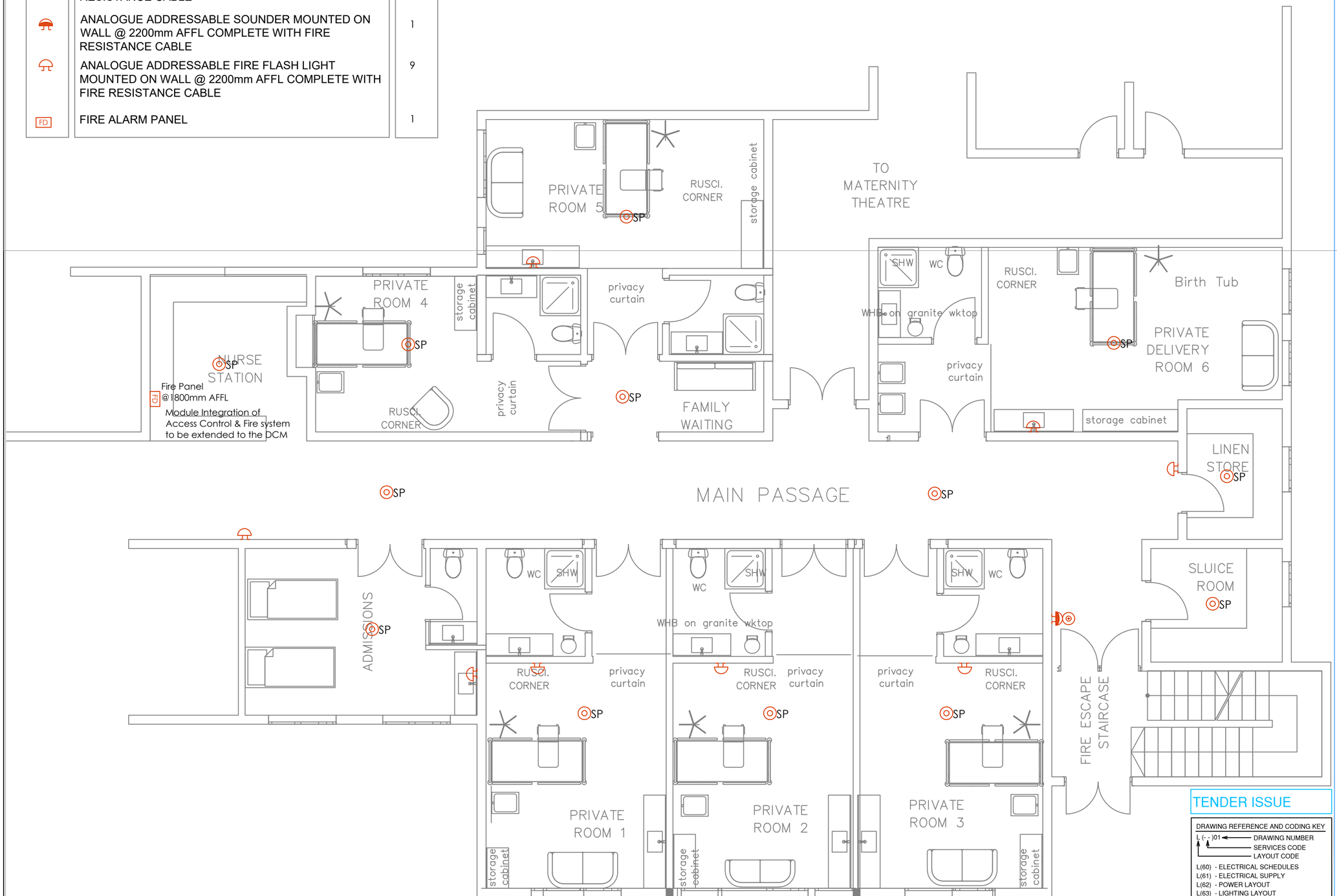
L(60) - ELECTRICAL SCHEDULES
L(61) - ELECTRICAL SUPPLY
L(62) - POWER LAYOUT
L(63) - LIGHTING LAYOUT
L(64) - COMMUNICATIONS LAYOUT
L(67) - LIGHTNING PROTECTION LAYOUT
L(68) - FIRE ALARM/SECURITY LAYOUT

JOB NO. J2106.27

DRAWING NO. J2106.27 - L(65) - 05 REV 0

DATE	SCALE	DRAWN	CHECKED
JAN-24	1: 75(A2)	VKM	GMN

LEGEND		
SP	ANALOGUE ADDRESSABLE SMOKE DETECTOR MOUNTED ON CEILING/WALL COMPLETE WITH FIRE RESISTANCE CABLE	14
	ANALOGUE ADDRESSABLE PUSH BUTTON MOUNTED ON WALL @ 1450mm AFFL COMPLETE WITH FIRE RESISTANCE CABLE	2
	ANALOGUE ADDRESSABLE SOUNDER MOUNTED ON WALL @ 2200mm AFFL COMPLETE WITH FIRE RESISTANCE CABLE	1
	ANALOGUE ADDRESSABLE FIRE FLASH LIGHT MOUNTED ON WALL @ 2200mm AFFL COMPLETE WITH FIRE RESISTANCE CABLE	9
FD	FIRE ALARM PANEL	1



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PROJECT

PROPOSED FIT-OUTS AND REORGANIZATION FOR THE NAIROBI HOSPITAL LABOUR WARDS

SITE

Argwings Kodhek Road, Nairobi

DRAWING TITLE: LABOUR WARDS
FIRE DETECTION & ALARM SYSTEM LAYOUT

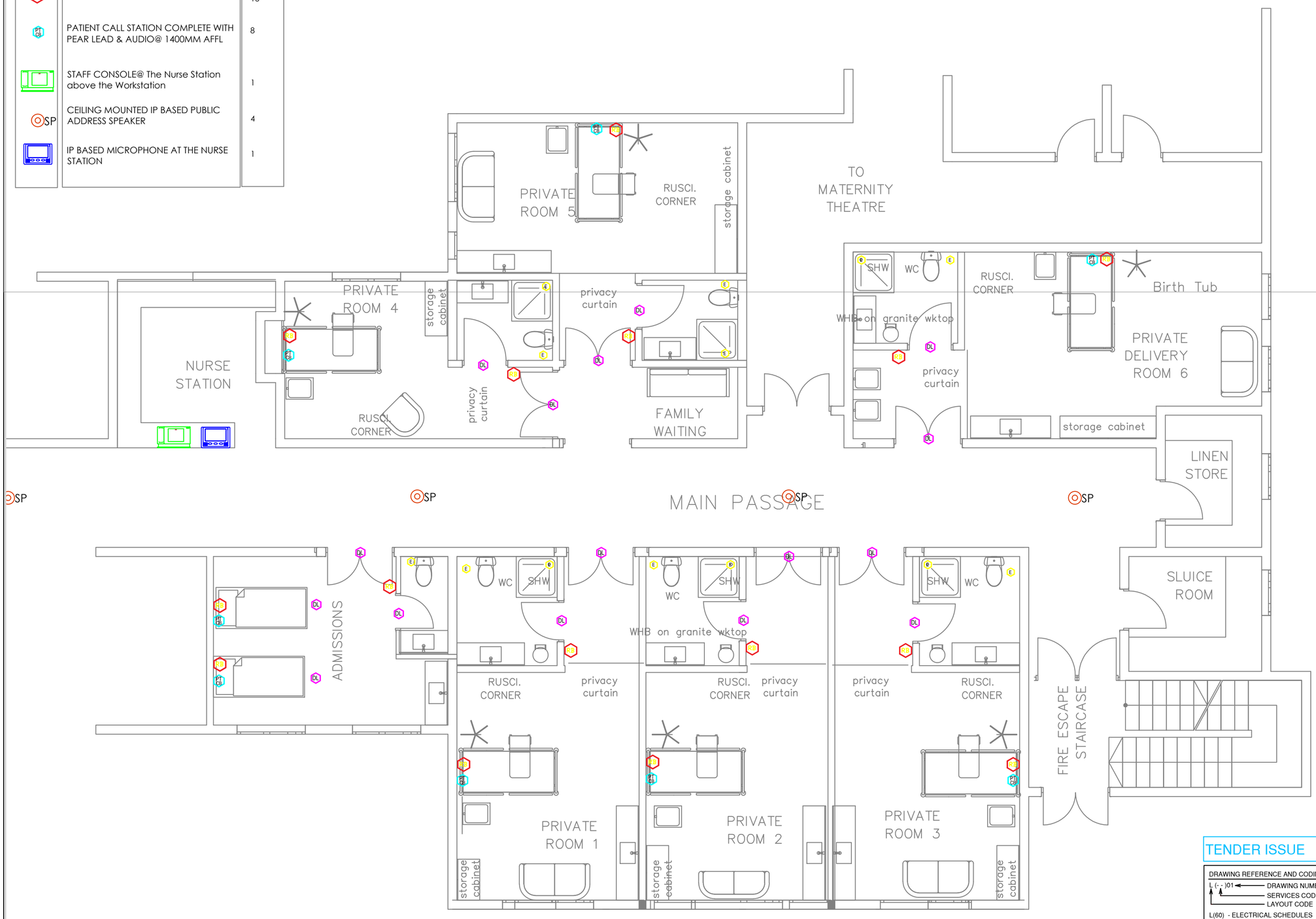
JOB NO. J2106.27

DRAWING NO. J2106.27 - L(68) - 06 REV 0

DATE	SCALE	DRAWN	CHECKED
JAN-24	1: 75(A2)	VKM	GMN

LEGEND

E	CEILING MOUNTED EMERGENCY PULL CORD	13
DL	DOME LIGHT WALL MOUNTED ABOVE THE DOOR	14
RB	RESET BUTTON @ 1400mm AFFFL	15
PT CB	PATIENT CALL STATION COMPLETE WITH PEAR LEAD & AUDIO@ 1400MM AFFL	8
	STAFF CONSOLE@ The Nurse Station above the Workstation	1
SP	CEILING MOUNTED IP BASED PUBLIC ADDRESS SPEAKER	4
	IP BASED MICROPHONE AT THE NURSE STATION	1



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SITE
Argwings Kodhek Road, Nairobi

DRAWING TITLE: LABOUR WARDS
NURSE CALL & PUBLIC ADDRESS SYSTEM

JOB NO.
J2106.27

DRAWING NO. J2106.27 - L(64) - 07 REV 0

DATE	SCALE	DRAWN	CHECKED
JAN-24	1: 75(A2)	VKM	GMN

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SECTION 2.1

Building and Civil Work Specifications

2.1 BUILDING AND CIVIL WORK SPECIFICATIONS

2.1.1 GENERAL REQUIREMENTS

2.1.1.1 General

2.1.1.1.1 Definitions

(a) '**Architect'** means the person or other entity engaged by the Employer to perform architectural, engineering, design and other services related to the works as provided for in the contract. Where the specifications refer to the 'Engineer', the terms **'Architect'** and

'Engineer' shall be synonymous. The Architect shall serve as a technical representative of the Employer.

2.1.1.1.2 Standards

(a) All materials, equipment and testing apparatus etc. to be furnished and Works to be executed by the Contractor in this Contract shall conform to the requirements of the latest Kenya Standards, International Standards Organisation (ISO) Standards, British Standards, European Standards, or other approved applicable Standard in Kenya, unless otherwise specifically stated.

(b) All materials and equipment to be purchased shall be from well-recognised manufacturers whose products are standardised and controlled by any recognised Standard Organisation. All dimensions and measurement units shall be S.I. units.

(c) The Contractor may propose to the Engineer an alternative Standard other than specified, in which case he shall submit six (6) copies of English translation of the proposed Standard and all other information for the materials, equipment and testing, together with the written proof that the proposed Standard is equivalent in all significant respects to the Standard specified.

2.1.1.1.3 Equipment

(a) The equipment to be employed by the Contractor shall have sufficient performance capacity and durability as to secure the completion of the Works within the construction period stipulated under the Contract.

(b) All materials and equipment shall be subject to inspections or tests by the Engineer at any time and in any state of completion both off-site and on-site, as he deems necessary.

(c) The Contractor shall furnish promptly, without additional charge, all facilities, labour and materials reasonably needed for performing such inspections and tests as may be required by the Engineer.

2.1.1.1.4 Substitutes

(a) The Contractor shall make diligent efforts to procure the specified materials, but when the materials specified are unavailable, for reasons beyond the control of the Contractor, substitutes may be used with prior written approval of the Engineer.

2.1.1.2 Supervision and Labour

The Contractor will be required to maintain a competent Site Agent and staff on site throughout the construction period until the completion of the Works, and thereafter as may be required during the period of maintenance. The Engineer shall give prior authority to the appointment of the Site Agent and reserves the right to call for his withdrawal. The Site Agent must speak English.

2.1.1.3 Specialist Sub-Contractors

Where sub-contractors are not nominated, the Contractor shall appoint approved specialist sub-contractors for any sections of the works described herein for which he is not himself an experienced and approved operator. The Contractor shall co-ordinate his programmes with those of the sub-contractors.

2.1.1.4 Site

2.1.1.4.1 Definition of the site

The Site shall include all those areas of land which, being public or private:

- Are being provided by the Employer for the purposes of constructing the permanent Works;
- Are being provided by the Employer for Temporary Works, including camps, offices and stores;

2.1.1.4.2 Use of the Site

(a) The lands and other places outside the Site, which are the property or under the control of the Employer, shall not be used except with the approval of the Engineer.

i. The Contractor shall at any time remove any vehicle or vessel or any other obstruction under his control that may be required to be removed by the Engineer for any purpose. The Contractor shall move such obstruction promptly on being given instruction to do so.

ii. The Contractor shall maintain access for the inspection, operation and maintenance of any of the Employer's plant or works, which lies within the site or elsewhere.

iii. The Contractor shall not use any portion of the Site for any purpose not connected with the Works without the written consent of the Engineer.

iv. Except with the written consent of the Employer, to be given when necessary for the execution of the Works, the Contractor's employees will not be permitted to enter any of the Employer's buildings or lands or sites under the control of other contractors or the Engineer. The Contractor shall warn his employees that any person found within such buildings or sites without authority is liable to be removed from the Works in accordance with the Conditions of Contract.

2.1.1.5 Possession of Site

The Contractor shall restrict his activities to areas for which possession has been given and shall avoid any encroachment upon lands outside these areas. Any trespass or damage arising from such encroachment shall be the Contractor's sole responsibility and he shall hold the Employer indemnified against all claims arising from such trespass or damage.

2.1.1.6 Interference with the Works

The Contractor shall not interfere in any way with any existing works, whether the property of the Employer or of a third party, whether or not the position of such works is indicated to the Contractor by the Engineer, except where such interference is specifically described as part of the Works, either in the Contract or in an instruction from the Engineer.

2.1.1.7 Security

The Contractor at his own expense shall provide watching of the Works. If the Engineer considers it necessary, he will order in writing that additional watchmen be provided all at the Contractor's expense. Watch dogs shall be confined to the Site, be kept under control and properly inoculated and licenced (if necessary).

2.1.1.8 Material for the Works

2.1.1.8.1 Materials and equipment provided by the Employer

(a) Materials and equipment which are to be provided by the Employer will be as stated in the Contract.

(b) Materials and equipment provided by the Employer shall be collected by the Contractor from the locations stated in Contract and delivered by the Contractor to the Site. The Contractor shall inspect the materials and equipment before taking receipt and shall immediately inform the Engineer of any shortage or damage.

(c) Materials or equipment provided by the Employer which are damaged after collection shall be repaired by the Contractor and submitted to the Engineer for approval. Materials or equipment which are lost or which in the opinion of the Engineer are not capable of being or have not been repaired satisfactorily shall be replaced by the Contractor.

(d) Crates and containers for materials or equipment provided by the Employer shall be disposed of by the Contractor.

(e) Equipment and materials provided by the Employer which are surplus to the requirements of the Works shall be returned to the locations stated in the Contract.

(f) The Contractor shall protect and maintain equipment provided by the Employer while it is on the Site and shall provide operatives, fuel and other consumables required to operate the equipment.

2.1.1.8.2 Materials

(a) Materials for inclusion in the permanent work shall be new or other material as stated in the Contract or approved by the Engineer.

(b) Certificates of tests by manufacturers which are submitted to the Engineer shall relate to the material delivered to the Site. Certified true copies of certificates may be submitted if the original certificates cannot be obtained from the manufacturer. A letter from the supplier stating that the certificates relate to the material delivered to the Site shall be submitted with the certificates.

(c) Materials which are specified by means of trade or proprietary names may be substituted by materials from a different manufacturer approved by the Engineer provided that the materials are of the same or better quality and comply with the specified requirements.

(d) Samples of materials submitted to the Engineer for information or approval shall be kept on the Site and shall not be returned to the Contractor or used in the permanent work unless permitted by the Engineer.

2.1.1.9 Inspection by Engineer during Defects Liability Period

The Engineer will give the Contractor 7 days' notice of his intention to carry out any inspection during the defect's liability period. The Contractor shall, upon receipt of such notice, arrange for a responsible representative to be present at the times and dates named by the Engineer.

2.1.1.10 Pollution

The Contractor shall take all reasonable steps to protect the environment on and off the site and to avoid damage or nuisance to persons or to property of the republic or others resulting from pollution, noise or other causes arising as a consequence of his methods of operation.

2.1.1.11 Fences

2.1.1.11.1 Fences

The Contractor shall not interfere with existing fences and should give prior notice to the Engineer whenever the Works necessitate breaching of fences. In such instances, the Contractor will make good the fence on completion of that section of the Works at his own expense.

Hoardings, fences, gates and signs on the Site shall be maintained in a clean, stable and secure condition.

Project signboards stated in the Contract shall be erected not more than 2 weeks, or such other period agreed by the Engineer, after the date for commencement of the Works. Other advertising signs shall not be erected on the Site unless permitted by the Engineer.

The permission of the Engineer shall be obtained before hoardings, fences, gates or signs are removed. Hoardings, fences, gates and signs which are to be left in position after completion of the Works shall be repaired and repainted as instructed by the Engineer.

2.1.1.12 Contractor's Activities in Respect of Property outside the Site of the Works and of Services Moved, Damaged or Altered

2.1.1.12.1 Location of Services

(a) The Contractor shall acquaint themselves with the position of all existing services, such as drains, underground and overhead telephone and electricity lines, ducts, poles, water mains, fittings, railway lines, etc. before any excavation or other work likely to affect the existing services is commenced.

(b) The Contractor shall check and determine on the site the position of any services shown on the Drawings. This shall be done by consultation with owners of services, visual inspections, using detecting apparatus and by making excavations as required to expose the position of the services. The positions of all services so detected shall be marked carefully and then drawn in on the Drawings. These services will then be defined as known services.

2.1.1.12.2 Damage to Services

(a) The Contractor shall take all reasonable precautions to protect existing services during construction and during the relocation of such services. Where protective measures involve the construction of permanent work, the Contractor shall execute the work in accordance with the Engineer's instructions.

(b) All pipes, cables, conduits or other known services of any nature whatsoever damaged as a result of the Contractor's operations shall be repaired and reinstated forthwith by the Contractor or by the Authority concerned, to the satisfaction of the Engineer, all at the expense of the Contractor.

(c) The Contractor shall inform the Engineer immediately if any existing works or services are exposed, located or damaged. All costs which may be incurred by the Contractor as a result of programming and coordinating work to enable any alterations to the services to be carried out and the cost of any safety precautions which shall be deemed necessary shall be at the Contractor's expense.

2.1.1.12.3 Safety by Overhead Power Lines

(a) Where work is to be carried out in the vicinity of overhead power lines, the Contractor shall ensure that all persons working in such areas are aware of the relatively large distance that high voltage electricity can "short" to earth when cranes, or other large masses of steel, are in the vicinity of power lines. The Contractor shall be required to work outside the clearances stated in **BS END 61439:1-2, BS END 62271-200:2012** and **BS 7354** which give safe clearance for the various voltages.

2.1.1.12.4 Relocation of Services

(a) It shall be clearly understood that, in certain instances, existing services can be relocated only after the Contractor has advanced sufficiently on or has completed certain sections of earthworks or certain structures. Whenever services are encountered which interfere with the execution of the Works and which require to be moved and relocated, the Contractor shall advise the Engineer, who will determine the extent of work, if any, to be undertaken by the Contractor in moving, relocating and reinstating or protecting such services. The Contractor shall be responsible for arranging the removal or alteration of such services in conjunction with and to the specifications of the relevant statutory authority subject to the prior agreement of the Engineer and were necessitated by the Works.

(b) A Provisional Sum for this work has been included in the Bill of Quantities. Subject to prior agreement of the Engineer, and upon production of receipts, the Contractor will be reimbursed the net cost of such work plus the percentage inserted by the Contractor in the Bill of Quantities for his overheads and costs, in making the arrangement, for co-ordinating the work and effecting payment.

2.1.1.12.5 Negotiations with Owners of Services

(a) The Contractor shall work in close co-operation with private owners or public authorities controlling services, which have to be protected, moved or relocated. Details regarding the state of negotiations concluded between the Employer and the owner at the time of bidding in respect of the time when either the owner is prepared to start moving such services or

when the Contractor is required to or will be allowed to start moving the services, and the duration of such operations, will either be stated in the bid documents or be made available to bidders.

(b) Further such consultations and negotiations with private owners or public authorities shall be carried out as required by the Contractor. Should the owners of services refuse to co-operate with the Contractor in a reasonable manner in connection with the protection or moving of services belonging to them, the Contractor shall refer the matter to the Engineer.

2.1.1.12.6 Use of Land outside Provided Area

(a) Should the Contractor wish to use land outside the area provided by the Employer for storing or keeping material or equipment required for the construction of the permanent works, it will be subject to the following:
- That the Engineer approves any area selected for this purpose;
- That such land be physically separated from any production plant or activities and suitably fenced in;
- That the area used for the aforesaid purpose be surveyed, and, where the land does not belong to the Contractor, he shall enter into a contract of lease with the owner of such land in respect of the full period for which such land shall be used for such purpose;
- That the contract shall stipulate that the owner shall not have any right whatsoever to any material stockpiled on such land during the currency of the contract of lease;
- That suitable, permanent reference beacons, approved by the Engineer, be placed next to the area, at the cost of the Contractor, for use by the Engineer with a view to, if applicable, taking cross-sections for determining quantities;
- That only material intended for use on this contract shall be stored on such land.

2.1.1.13 Programme of Works and Temporary Works

2.1.1.13.1 Programme of Works

(a) In accordance with relevant clauses of the Conditions of Contract and the Particular Conditions of Contract and prior to commencement of permanent works, the Contractor shall submit a fully detailed and time related programme showing the order of procedure and method in which the Contractor proposes to carry out the Works.

(b) The programme shall be in form of a gant chart only and show clearly the anticipated quantities of work to be performed each month, as well as the anticipated earnings for the various sections of work. Further it shall show the critical path of activities. The Contractor shall supply together with his programme an expenditure chart superimposed on it showing his monthly anticipated expenditure.

(c) The breakdown of the work to be shown for each Section of the Works on the programme submitted in accordance with Clauses 2.1.1.13.1(1) shall be comprehensive.

- work to be carried out, including testing and commissioning,
- fabrication, delivery and installation of materials to be fabricated off the Site,
- Delivery of critical materials originating from outside Kenya.
- activities for which the Employer or Engineer is responsible, including the issue of critical drawings and other information,
- provision of materials by the Employer, nomination and approval of Nominated Sub-contractors and consideration and approval of drawings and proposals, and

- Work to be carried out by Government departments, utility undertakings and other contractors.

(d) The Contractor shall be responsible for arranging, co-ordinating and agreeing with the utility undertakings a programme for their works. The Contractor shall make full allowance for time and provision of facilities for the utility undertakings in the preparation of his programmes.

(e) The Works shall be carried out so as to achieve a continuous and consecutive output of fully completed elements of construction. The order of execution of the Works shall be subject to reasonable adjustment as requested by the Engineer.

(f) Should the Contractor fall behind with the programme submitted by him in terms of the relevant clause of the Conditions of Contract, which programme has been approved by the Engineer, or if the sequence of operations is altered, or if the programme is deviated from in any other way, the Engineer may, without prejudice to the Employer's rights in terms of the relevant clause of the Conditions of Contract, require the Contractor to submit, within seven days of the date on which he has received a notice to this effect, a revised programme in terms of this Clause, which indicates the manner in which the Contractor undertakes to complete the Works within the required time.

(g) Any proposal in the revised programme to accelerate the rate of progress shall be accompanied by positive steps to increase production by more and / or better labour and equipment being provided on the site or by the available labour and equipment being utilised more effectively. Failure on the part of Contractor to work according to the programme or revised programmes shall be sufficient reason for the Employer to take steps as provided in the Conditions of Contract and shall be construed, as not executing the Works in accordance with the Contract.

(h) The approval by the Engineer of any programme shall have no contractual significance other than that the Engineer would be satisfied if the work is carried out in accordance with such programme and that the Contractor undertakes to carry out the work in accordance with the programme.

2.1.1.13.2 Temporary Works

(a) The Contractor shall supply the Engineer with drawings for approval showing the layout and general arrangement of all Temporary Works he proposes to construct for the purpose of the Contract including, but not limited to:

- Site Offices
- Stores
- Concrete batching plants
- Temporary access roads

2.1.1.14 Workmanship and Quality Control

2.1.1.14.1 Workmanship and quality control

(a) The onus rests with the Contractor to produce work which conforms in quality and accuracy of detail to all the requirements of the Specifications and Drawings, and the Contractor shall, at his own expense, institute a quality control system and provide experienced engineers, foremen, surveyors, materials technicians, other technicians and

other technical staff, together with all transport, instruments and equipment, to ensure adequate supervision and positive control of the Works at all times.

(b) The Contractor shall provide chainmen and labourers as necessary for the Engineer to carry out checks on the Works. The Contractor shall conduct tests or have them conducted continually on a regular basis, to check the properties of natural materials and processed natural materials and of products manufactured on the site, such as concrete.

(c) Although not a requirement for the Contractor to conduct regular tests on any commercially manufactured products such as cement, bitumen, steel and pipes, the Contractor shall remain fully responsible for any defective material or equipment provided by him. Similarly, the quality of all elements of the Works shall be checked on a regular basis so as to ensure compliance with the specified requirements.

(d) The intensity of control and of tests to be conducted by the Contractor in terms of these obligations is not specified but shall be adequate to ensure that proper control is being exercised. Where any natural materials or products made from natural materials are supplied, and upon completion of each element of the construction work, the Contractor shall test and check such materials, products and / or elements for compliance with the specified requirements and shall submit his results to the Engineer for approval. Such submission shall include all his measurements and test results and shall furnish adequate proof of compliance with the specified requirements.

(e) The Contractor's attention is also drawn to the provisions of the various sections of the Specifications regarding the minimum frequency of testing that will be required to undertake process control. The Contractor shall at his own discretion increase this frequency where necessary to ensure adequate control. The Contractor shall submit to the Engineer for examination, the results of all relevant tests, measurements and levels indicating compliance with the Specifications on completion of every part of the Work.

2.1.1.15 The Setting Out of Work and Protection of Beacons

2.1.1.15.1 Setting out

(a) The Contractor’s attention is drawn to the requirements of the relevant clauses of the Conditions of Contract, and he shall also comply with all legal provisions in regard to surveying and setting out work. The Contractor shall be responsible for the proper and accurate setting out of the works as required in the Contract documents. The Contractor shall provide all survey and measuring equipment and instruments necessary for his use in the execution of the scheduled Works.

(b) The Engineer will provide sufficient basic survey information to enable the contractor to set out the Works and the Contractor shall be responsible for setting out all necessary reference points and for the maintenance thereof.

(c) The Contractor shall satisfy himself as to the accuracy in line, level and dimension of the basic survey and setting out details provided and should the Contractor discover any error in the information provided by the Engineer, he should at once notify the Engineer. If the information is confirmed to be in error the Engineer will issue amended drawings or instructions regarding the correction of the error.

2.1.1.15.2 Beacons

(d) The Contractor shall not remove, damage, alter or destroy in any way plot beacons or survey beacons of the Kenya Government. Should the Contractor consider that any beacon

will be interfered with by the Works he shall notify the Engineer who, if he considers necessary, will make arrangements for the removal and replacement of the beacon.

(e) If the Contractor removes or disturbs a beacon without permission of the Engineer, he shall be liable for the full cost of its replacement.

(f) The Contractor shall allow in his bid rates for being unable to use up to 30% of the Engineer's control points where such are provided in the Contract, through loss or damage occasioned prior to the commencement date. When the Contractor requires the establishment of a new control point or points due to the above-mentioned loss or damage, he shall advise the Engineer who will, if he deems it necessary, arrange for the establishment of a new control point or points. Control points not affected by the works shall be protected and preserved by the Contractor. In the case of negligence on the part of the Contractor, or his employees, resulting in the destruction of control points, an amount equal to the cost of replacing the same may be deducted from subsequent payments due to the Contractor. Control points affected by the works shall be offset by the Contractor to the satisfaction of the Engineer.

(g) The Contractor shall, prior to any setting out, submit to the Engineer for his approval, the method of setting out he proposes to employ. The plan shall include the accuracy, positions of the various types of stakes, method of marking stakes, and methods to be used for protecting stakes, etc. No survey work shall proceed prior to the Engineer's approval of the Contractor's plan. At least 24 hours before he intends to survey any portion of the Works, the Contractor shall give written notice to the Engineer. Such notice shall include time, location and type of Works to be set out. The Contractor shall set out the Works and obtain approval of his setting out before proceeding with construction.

(h) In general, the Contractor shall check for the existence of original marks, lines and levels of reference not less than one month prior to commencing works in any section, to allow sufficient time for reinstatement of markings, and checking of lines and levels. Any discrepancies encountered shall be immediately reported to the Engineer, for instruction and coordination.

(i) The Contractor shall be deemed to have allowed in his bid price for checking and reinstatement of original markings. Special care shall be exercised during construction not to damage, displace or disturb property and trigonometrical survey beacons. If such beacons are disturbed or destroyed by the Contractor, they shall be replaced without delay by a registered land surveyor at the Contractor's expense. In cases where displacement of or damage to such beacons is unavoidable the Contractor shall also be responsible for relocation or suitably referencing for later reinstatement of such beacon at his own cost. The Engineer may if he deems it necessary, revise the line and grade and will require the Contractor to adjust the stake-out accordingly.

2.1.1.16 Information Furnished by the Employer

2.1.1.16.1 Information

(a) Certain information contained in these contract documents or provided separately is being offered in good faith, but in the circumstances pertaining to the type of information furnished, no guarantee can be given that all the information is necessarily correct or representative of the in-situ condition. This applies more specifically to all soil tests, soil mapping, drilling results, geophysical survey, geological reports, borrow-pit information, material surveys and reports, and similar information, the accuracy of which is necessarily subject to the limitations of testing, sampling, the natural variation of material or formations being investigated and the measure of certainty with which conclusions can be

drawn from any investigations made. It also applies to any materials utilisation plan provided, as the diagram may be subject to major alterations during the progress of the work, depending on site conditions.

(b) The Employer will not accept any liability for the correctness or otherwise of the information furnished or for any resulting damage, whether direct or consequential, should it appear, during the course of the Contract, that the information supplied is either incorrect or not representative.

2.1.1.17 Protection of the Works and Requirements to be Met Before Construction of Work

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2.1.1.17.1 Nature of Ground and Condition of Work

(a) The Contractor must satisfy himself as to the general circumstances at the site of the Works and the construction thereon, the surface of the ground and nature of the materials to be excavated, the possibility of subsidence from soft ground and bad and broken materials, and falls of rock in or arising out of the Works, and the possibility of floods and landslides, and the rates and prices in the Bill of Quantities will be held to cover all such contingencies.

(b) In order to minimise the possible adverse effects of flooding, the drainage of the natural ground in the vicinity of the earthworks and the drainage works generally shall be carried out in advance of the rest of the Works.

2.1.1.17.2 Drainage

(a) The contractor shall provide temporary drainage works such as drains, open channels, banks, etc and provide and operate temporary pumps and such other equipment as may be necessary for adequately protecting, draining and de-watering the Works and temporary works. This will be in addition to any permanent drainage works specified and installed, and in addition to any temporary drainage works specifically paid for separately.

2.1.1.17.3 Excavations

(a) Excavations for pipe drains, culverts, service ducts and similar structures shall be adequately protected against the possible ingress of water during rainstorms.

2.1.1.17.4 Completed Layer Work

(a) All completed layer work shall be protected and maintained until the following layer is constructed. Maintenance shall include immediate repairs to any damage or defects which may occur and shall be repeated as often as may be necessary to keep the layer continuously intact and in good condition.

2.1.1.17.5 Preparation of Layer Work

(a) Before any completed layer is primed or a succeeding layer is constructed thereon, any damage to the existing layer shall be repaired, so that, after repair or reconstruction, if necessary, it will conform in all respects to the requirements specified for that layer. All repair work other than minor surface damage repairs shall be submitted to the Engineer for inspection before it is covered up.

(b) The previously constructed layer shall be thoroughly cleaned by the removal of all foreign material before construction of a succeeding layer or application of a prime coat, surfacing or surface treatment. In the case of all bituminous work in particular, the existing layer

shall be thoroughly broomed and all dung, clay, mud and other deleterious material completely removed.

(c) Where necessary, the surface shall be sprayed with water before, during and after brooming to remove all foreign material.

(d) Work performed as part of the above obligations shall not be measured and paid for separately, and the cost thereof shall be included in the rates bid for the various items of work requiring protection and the items for the Contractor's establishment on the site, as specified in Section 2.1.2.

2.1.1.18 Faulty Work and Remedial Work

2.1.1.18.1 General

(a) Any work which fails to comply with the Specifications shall be rejected and the Contractor shall, at his own expense, make good any defects, as directed by and to the satisfaction of the Engineer.

(b) When any part of the Works or any equipment or material is found, upon examination by the Engineer, not to conform to the requirements or at any stage before final acceptance is damaged so that it no longer conforms to the requirements of the Specifications, the Engineer may order its complete removal and replacement, at the Contractor's expense, with satisfactory work, equipment or material, or he may permit the Contractor to apply remedial measures in order to make good any such defects or damage.

(c) The actual remedial measures taken shall at all times be entirely at the Contractor's own initiative, risk and costs, but subject to the Engineer's approval regarding the details thereof. In particular, remedial measures shall ensure full compliance with the requirements of the Specifications of the final product, shall not endanger or damage any other part of the Works, and shall be carefully controlled and submitted to the Engineer for examination when completed or at any intermediate stage as may be required.

(d) For the guidance of the Contractor, an indication is given below of what would normally be required in the more common cases of defects or damage, but the Engineer will in no way be bound to accept or approve the measures given below, as the actual remedial measures will be dictated by the circumstances of each particular case.

2.1.1.19 Water

2.1.1.19.1 Supply

(a) It is the Contractor's responsibility to provide clean and sufficient supply of fresh water for both construction purposes and also for all the offices, workshops, laboratories, etc.

(b) The construction water shall be clean, free from suspended solids and undesirable concentrations of deleterious salts and from any matter in quantities considered by the Engineer to be unsuitable for the proposed work. The water shall be applied at the location, in the amounts, and during the hours, including nights, as directed by the Engineer. The distributors used for watering shall be equipped with spray bar and shall be of ample capacity and of such design as to ensure uniform application of water in the amounts directed by the Engineer. Water supplied to the Resident Engineer's offices, laboratories

and camps shall be drinkable to the satisfaction of the Medical Officer of the Area and the Engineer. The water for drinking and cooking purposes shall be filtered, boiled or treated as necessary for human consumption. Water for the Engineer and Employer shall be approved bottled water. All water sources used shall be approved by the Engineer.

2.1.1.20 Drawings Provided by the Contractor

2.1.1.20.1 Preparation

(a) Where the Contractor is required to prepare any drawings for the purpose of this Contract, they shall be prepared as specified below and in accordance with any further requirements specified by the Engineer. The Contractor shall be provided with one transparent polyester standard drawing sheet and one steel schedule sheet, which shall be used as masters for all drawings prepared by him and submitted to the Engineer for consideration.

(b) The Contractor shall submit to the Engineer for his adjudication one transparent polyester print, 0.05mm thick, of each drawing prepared by him. The standard of detailing and quality of print shall be the same as those of the Drawings supplied to the Contractor under the Contract. The Drawings shall be compiled in the English language and shall comply in all respects with the requirements of the Employer.

2.1.1.20.2 Accepted drawings

(a) Accepted Drawings shall form an integral part of the Contract documents, and any drawing not accepted and signed will not be permitted on the site of the Works for construction purposes and / or used for the manufacture of any item. Notwithstanding the approval and / or acceptance and signing of the Drawings, the Contractor shall take full responsibility for all details, discrepancies, omissions, errors, etc, in respect of the said Drawings as well as for the consequences thereof.

(b) The Contractor shall submit only fully complete Drawings in accordance with this specification and shall not be entitled to claim for delays resulting from the submission of incomplete drawings. The Engineer will require a period of four to eight weeks, depending on circumstances, for reviewing the complete drawings.

(c) No direct payment for design, preparation and submission of Drawings will be made and all costs shall be included in the rates bid for the relevant pay items as provided in the Bill of Quantities.

2.1.1.21 Blasting

(a) No blasting shall be allowed.

2.1.1.22 Demolitions

2.1.1.22.1 General

(a) Prior to permitting employees to start demolition operations, an engineering survey shall be performed, by a Competent Person, of the structure to determine structural integrity and the possibility of unplanned collapse of any portion of the structure. Any adjacent

structure where workers may be exposed shall also be similarly checked. The employer shall have, in writing, evidence that such a survey has been performed.

2.1.1.22.2 Demolition plan

In addition, the Contractor shall submit for acceptance, a demolition plan to the Engineer that as a minimum addresses the following:

(a) Worker Safety.

(b) Protection of the public in areas surrounding the demolition site.

(c) Protection of the existing structures not to be demolished.

(d) Emergency procedures and fire protection.

(e) Work sequence.

(f) Protection of the environment.

(g) Means and methods to minimize waste and maximize salvage.

(h) Disposal procedures.

2.1.1.22.3 Demolition guidelines

(a) Before any demolition begins all utilities such as electric, gas, water, steam, sewer, and other service lines shall be de-energized, shut off, capped, or otherwise controlled.

(b) A survey shall be performed to determine whether asbestos, hazardous materials, gases, explosives, flammable materials, or similarly dangerous substances are present at the work site. When the presence of any such substance is apparent or suspected, testing and removal or purging shall be performed and the hazard eliminated before demolition is started. A copy of the survey shall be kept on the project.

(c) Demolition of all buildings and structures shall be conducted under the supervision of a Competent Person. The Competent Person shall conduct field inspections as the work progresses, to ensure that the demolition plan is being implemented and adhered to by the Contractor and to detect hazards that may have developed during the course of the demolition process. A daily inspection shall be documented and any deficiencies corrected immediately.

(d) Prior to concrete cutting operations where energized utilities may be present, the employer shall ascertain by inquiry or direct observation, or by instruments, whether any part of an energized electrical power circuit, exposed or concealed, is so located that the performance of the work may bring a person, tool, or machine into physical or electrical contact with the electrical power circuit and marked.

(e) The Contractor shall implement and follow their submitted dust control plan throughout the demolition process as required.

(f) All floor and wall opening created during the course of demolition shall be guarded and posted according requirements set forth in this program.

(g) All protruding nails or other sharp objects shall be pulled, bent over, or rendered harmless.

(h) No demolition debris shall be dumped from heights greater than 10 feet without the use of enclosed debris chutes.

(i) All stairways, passageway, and ladders being used for access and egress shall be positively identified. All others shall be barricaded and closed entirely.

(j) Housekeeping shall be maintained at all times. Walkways and passages shall be kept clear and defined.

(k) The Contractor shall have a Fire Protection/Hot Work (i.e., welding) policy in place.

(l) Additional fire protection requirements may be required when direct area suppression systems have been deactivated.

2.1.1.23 Access to Contractor's Records, Monthly Site Meetings and Progress Photographs

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2.1.1.23.1 Access

(a) The Engineer shall at all times have full access to all files, drawings, documents, records and whatsoever in connection with the execution of the Works. The Contractor or his authorised representative shall attend meetings on the site with representatives of the Employer and Engineer, at dates and times to be determined by the Engineer. Such meetings will be held for evaluating the progress of the Contract which any of the parties represented may wish to raise.

2.1.1.24 Legal Provisions

2.1.1.24.1 Legal provisions

(a) The Contractor shall keep himself fully conversant with the latest enactment, provisions and regulations of all legislative and statutory bodies and in all respects and at all time shall comply with such enactment, provisions and regulations in regard to executing the Contract.

2.1.1.25 Final Clearance

(a) Upon completion of the Works, the Contractor shall clean up the site and remove all temporary buildings, plant and debris. He shall level off and fine grade all excavated material which is surplus to requirements. The whole of the site shall be left in a clean and workmanlike condition to the satisfaction of the Engineer.

2.1.1.26 Electricity Supply

2.1.1.26.1 Power supply

(a) The Contractor shall provide and maintain at his own expense his own electricity supply. This supply must be adequate to supply the area set aside for his own and the Engineer's office as well as stores and workshops as necessary.

2.1.1.26.2 Apparatus

(a) The Contractor shall provide and maintain all necessary temporary power and lighting and all associated apparatus for the duration of the Contract at his own expense. He must make allowances for the use of the said supplies and equipment by all sub-contractors. Once equipment becomes redundant and having received the approval from the Engineer, the Contractor shall disconnect and remove said equipment and make good any works disturbed at his own expense.

2.1.1.27 Roads and Site to be Kept Tidy

2.1.1.27.1 Roads

(a) The Contractor shall take all necessary care and precautions to ensure that roads and thoroughfares used by him either for the construction of the Works or for the transport of equipment, labour and materials are kept in good repair and condition and not damaged or made untidy as a result of such construction or transport.

(b) In the event of their becoming thus dirtied in the opinion of the Engineer, the Contractor shall immediately take all necessary steps to rectify as required by the Engineer.

(c) Materials, including materials required for Temporary Works, shall be stored in an orderly manner. Rubbish and debris shall be disposed of at least once a week.

(d) Measures shall be taken to prevent mosquito breeding on the Site. The measures to be taken shall include the following:

i. Empty cans, oil drums, packings and other receptacles which may retain water shall be deposited at a central collection point and those not required for future use shall be removed from the Site regularly.

ii. Standing water shall be treated at least once every week with an oil which will prevent mosquito breeding.

2.1.1.28 Safety

2.1.1.28.1 Safety management

(a) The Contractor is responsible for accident prevention and job site safety. This responsibility cannot be delegated to Subcontractors, suppliers, the Employer, or other persons. To this end, the Contractor shall:

i. Promote a safe and healthy work environment.
ii. Provide an accident prevention program.
iii. Promote training programs to improve the skill and competency of all employees in the field of occupational safety and health.
iv. Instruct all employees of safe work methods and practices when assigning work.
v. Ensure that employees have and use the proper protective equipment and tools for the Site. The job.
vi. Ensure that all heavy equipment operators (i.e., cranes, loaders and forklifts) are properly qualified and trained on the specific piece of equipment in use.

vii. Plan and execute all work to comply with the stated objectives and safety requirements contained in the contract provisions, local laws and regulations, and industry standards.
viii. Maintain an orientation program for new employees that includes at a minimum, a review of:
- Potential hazards in the work areas
- Required personal protective equipment and apparel

ix. Hold a minimum of one weekly scheduled safety meetings with its employees.
x. Such meetings shall include a discussion of all observed unsafe work practices or conditions, a review of the accident experience and all corrective actions. The Contractor shall encourage safety suggestions from employees.
xi. Ensure prompt medical treatment is administered to any injured employee.
xii. Undertake a complete investigation of all accidents and implement corrective action to prevent a recurrence.

2.1.1.28.2 Accidents

(a) The Engineer shall be notified by the Contractor immediately any accident occurs whether on Site or off Site in which the Contractor is directly involved which results in any injury to any person whether directly concerned with the Site or whether a third party. Such initial notification may be verbal and shall be followed by a written comprehensive report within 24 hours of the accident.

2.1.1.28.3 Emergency procedures

(a) The Contractor shall have in place written Site-Specific Emergency Procedures and site evacuation plans. These plans shall include how the Contractor and their personnel will deal with severe weather conditions, natural disasters such as earthquakes or a higher security alert status, and construction related emergencies. The plan shall include primary and secondary location/assembly points where Contractor personnel will meet following such conditions, and how personnel will be accounted for.

(b) The Contractor shall advise employees of these assembly points at their initial safety orientation. This information shall be posted at the project site and updated as conditions change.

2.1.1.28.4 Subcontractors

(a) The Contractor shall insure that all Subcontractors and sub-tier contractors working under their direction comply with all applicable laws, regulations, ordinances, conditions of the contract, or orders of any public authority having jurisdiction relating to the safety of persons or property.

2.1.1.28.5 Protective equipment

(a) Personal Protective Equipment (PPE) shall be provided to employees, used where required, and maintained in proper condition.

2.1.1.28.6 Storage and handling of hazardous materials

(a) The Contractor shall train employees in the proper storage and handling of hazardous materials (i.e., flammable, combustible, toxic) and hazardous wastes.

(b) Transportation of any material by the Contractor shall be in suitable vehicles which when loaded does not cause spillage and all loads shall be suitably secured. Any vehicle which does not comply with this requirement or any of the local traffic regulations and laws shall be removed from the Site. Arrangement shall be made with

the appropriate Authority before entering in or working on existing and associated works.

2.1.1.29 Working platforms/Scaffolding

2.1.1.29.1 Scaffolding

(a) Working platforms are to be provided to enable the work to be safely and effectively carried out.

(b) Ensure that standing scaffolding is erected early enough and/or dismantled late enough to suit the programmes of all sub-contractors. The Contractor shall comply with the need to prevent unauthorised access to the scaffolding, other parts of the building or adjoining buildings.

(c) Scaffolding shall comply with **BS END 74:1-3, BS END 12810-2:2003 & BS END 12811-1:2003.**

2.1.1.30 Tests of Materials and Manufactured Articles before Use

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2.1.1.30.1 Tests

(a) Any or all of the materials and manufactured articles supplied by the Contractor for use on any of the Works throughout this Contract shall be subject in advance to tests as may be specified in the relevant Standard Specification as may from time to time be deemed necessary by the Engineer.

(b) Samples of all such materials and manufactured articles, together with all the necessary labour, materials, plant and apparatus for sampling and for carrying out of tests on the site on all such materials and manufactured articles shall be supplied by the Contractor at his own expense.

(c) The cost of special tests ordered by the Engineer to be carried out by an independent person at a place other than the site or place of manufacture or fabrication shall be borne by the Contractor.

2.1.1.31 Operation and Maintenance Materials

2.1.1.31.1 O & M manuals

(a) The Contractor is required to provide in triplicate and in English, details of all the different manufactured plant and components incorporated in the Works including but not limited to all pertinent manufacturer's brochures.

(b) Substantial completion of the scheme will not be considered until such detailed information as is required has been submitted to and accepted by the Engineer.

2.1.1.32 Abbreviations

1. The abbreviations herein, together with others in general use, are applicable to the Contract Drawings and the Contract Documents, including General Conditions, General Requirements and Technical Specifications.

2. Common Usage: Whenever the following abbreviations are used, they shall have the meanings indicated:

°C	degrees Celsius
g	gram
g/mL	gram per millilitre
g/m^2	gram per square metre
ha	hectare
hr	hour
Hz	hertz
J	joule
Kg	kilogram
kHz	kilohertz
kJ	kilojoule
km	kilometre
km/hr	kilometre per hour
kN	kilonewton
kPa	kilopascal
kV	kilovolt
kW	kilowatt
L	litre
L/min	litre per minute
L/s	litre per second
m	metre
m^2	square metre
m^3	cubic metre
m/s	metre per second
Mg	megagram
Mg/m^3	megagram per cubic metre
Min	minute
mL	millilitre
mm	millimetre
mm^2	square millimetre
mm^3	cubic millimetre
mm/s	millimetre per second
MPa	megapascal
N	newton
N/mm	newton per millimetre
N/m2	newton per square metre
No.	number
Pa.s :	pascal second
r/min :	revolution per minute
r/s :	revolution per second
s :	second
t :	tonne
µm :	micrometre
% :	percentage
DN	nominal bore
PN	pressure rating in bar
max	maximum
min	minimum
ch	chainage (distance in metres)
eo	extra over

ne	not exceeding
P. Sum	Provisional Sum
P.C.	Prime Cost
fob	free on board
cif	cost, insurance and freight
wt	weight
HYS	high yield steel
PCC	precast concrete
uPVC	unplasticized polyvinyl chloride
GMS	galvanised mild steel
DI	ductile iron
GRP	glass reinforced plastic
HDPE	high density polyethylene
SV	sluice valve
AV	air valve
WO	washout valve
CP	codes of practice
PFA	pulverised fuel ash
PPFAC	portland pulverised fuel ash cement
OPC	ordinary portland cement
SRPC	sulphate resisting portland cement
HSFG	high strength friction grip

3. Institutions: Wherever the following abbreviations are used they shall have the meanings indicated:

AASHTO	American Association of State Highway and Transportation Officials
AWWA	American Water Works Association
ACI	American Concrete Institute
ACRI	Air Conditioning and Refrigeration Institute
AI	Asphalt Institute
AISC	American Institute of Steel Construction
ANSI	American National Standards Institute
ASCE	American Society of Civil Engineers
ASHRAE	American Society of Heating, Refrigerating, and Air Conditioning Engineers
ASTM	American Society for Testing and Materials
AAMA	American Architectural Manufacturers Association
BS	British Standard
BS EN	European Standard adopted as British Standard
BSCP	British Standard Code of Practice
ISO	International Organisation for Standardisation

2.1.1.33 References and Standards

BS EN 74-1(2005): Couplers, spigot pins and baseplates for use in falsework and scaffolds. Couplers for tubes. Requirements and test procedures

BS EN 74-2 (2008): Couplers, spigot pins and baseplates for use in falsework and scaffolds. Special couplers. Requirements and test procedures

BS EN 74-3 (2007): Couplers, spigot pins and baseplates for use in falsework and scaffolds. Plain base plates and spigot pins. Requirements and test procedures

BS EN 12810-2 (2003): Façade scaffolds made of prefabricated components. Particular methods of structural design.

BS EN 12811-1 (2003): Temporary works equipment. Scaffolds. Performance requirements and general design.

BS EN 61439-1 (2009): Low-voltage switchgear and controlgear assemblies. General rules

BS EN 61439-2 (2011): Low-voltage switchgear and controlgear assemblies. Power switchgear and controlgear assemblies

BS EN 62271-200 (2012): High-voltage switchgear and controlgear. AC metal-enclosed switchgear and controlgear for rated voltages above 1 kV and up to and including 52 kV

BS 7354 (1990): Code of practice for design of high voltage open terminal stations.

2.1.2 ENVIRONMENTAL CONTROLS

2.1.2.1 Contractor's responsibilities

2.1.2.1.1 Compliance

(a) Be familiar and fully comply with the requirements of the Kenya Organic Law No. 04/2005 and its Environmental Impact Assessment Guidelines (2006).

(a) Obtain a copy & the Environmental Impact Assessment [EIA] and Environmental Audits from the Employer and fully comply with the recommendations described therein.

(b) Comply with regulations as required by the National Environment Management Authority (NEMA) and other applicable Authorities Having Jurisdiction including the Ministry of Environment

(b) Regulations pertaining to Waste, Effluent Monitoring, Air, PCB'S, Spills, 3 R Regulations and any other regulations affects the environment.

(c) Local Bylaws pertaining to sewer use and any other environmental requirements.

(d) Submit to Engineer a copy of Environmental Policy and a programme to implement the Policy prior to the commencement of the Work.

2.1.2.2 Discovery of unexpected contamination

2.1.2.2.1 Unexpected contamination

(a) During construction, contamination, which was not identified in previous site investigations, may become evident. This contamination may include;

i. Visibly contaminated soils (e.g., oil staining, organic);
ii. Soils containing methane gas (e.g., organic materials);
iii. Contamination in soil identified after testing;
iv. Building materials suspected of containing asbestos, PCB's or lead-based paint; and contaminated building materials.
v. Buried storage tank, fuel lines, and similar items.

(b) If unexpected contaminated materials are encountered, immediately inform Engineer and request direction on how to proceed.

2.1.2.3 Spills

2.1.2.3.1 Definition

(a) A spill is defined as a discharge "Into the natural environment, from or out of a structure, vehicle or other container, that is abnormal in quality or quantity in light of all the circumstances of the discharge".

2.1.2.3.2 Responsibility

(a) The Contractor is solely responsible and liable for, without being limited to, all clean up, reporting, repairs, removal, damages and associated costs, and any other actions arising from the spill.

(b) If a spill occurs, the Contractor shall, at its own expense:

i. Comply with the Construction Code
ii. Report the spill to the Ministry of the Environment.
iii. Contain the spill in a safe manner.
iv. Communicate the details immediately to the Engineer. Report the type of spill, quantity, and exact location, advise if any contaminant has entered a sewer line, floor drain or impacted any ground, which is not paved,
v. Proceed to clean up the spill in accordance with the contractor's environmental policy.
vi. Provide the necessary testing for contaminant levels and secure the necessary documentation for clean-up and disposal.

2.1.2.4 Contingency plan for control and clean-up of spill

2.1.2.4.1 Contingency plan

(a) Prior to commencing construction, prepare contingency plan for control and clean-up of spills.

2.1.2.5 Noise control

2.1.2.5.1 Noise control

(a) Control noise and vibration generated by Work.

(b) Have construction equipment used on Site comply with sound emission limits outlined in Local Authority noise by-laws. Provide temporary sound attenuation devices as required.

(c) Perform work using equipment and methods that do not create noise or vibrations that are considered by employer to be excessive or detrimental 10 ongoing airport operations. Noise levels that interfere with normal levels of conversation at security checkpoint immigration desks, customs desks or airline counters are deemed excessive. Use whatever

guards' equipment or shields that may be necessary to keep noise at an acceptable level. The maximum permissible noise level in airport operational spaces at any time of operational use is 75dB.

(d) Construction activities that create noise or vibration that is required to be stopped shall not be chargeable to owner. Employer will not pay delays, standby charges or any other contractor cost as a consequence of instances where the work is required to be stopped.

2.1.2.5.2 Noise abatement

(a) In addition to requirements of the anti-noise by-laws, take special precautions and apply noise abatement measures to reduce public exposure to noise to a minimum.
(b) These precautions and measures consist of, but are not limited to, the following:
   i. Shields or other physical barriers to restrict the transmission of noise.
   ii. Soundproof housings or enclosures for noise producing machinery such as compressors, pumps, motors or generators.
   iii. Efficient intake and exhaust silencers on air equipment.
   iv. Efficient intake and exhaust mufflers on internal combustion engines.
   v. Sound deadening lining material on hoppers and storage bins.
   vi. Conducting truck loading, unloading and hauling operations so that noise is kept to a minimum.
   vii. The use of electric rather than internal combustion engine power on chain saws, hoisting equipment in fixed locations, or other equipment, where electric power is available.
   viii. Placing stationary noise producing equipment at maximum distance from public areas.

2.1.2.6 Dust control

2.1.2.6.1 Dust

(a) During progress of the Work, provide adequate measures to control dust.

(b) Cover or wet down dry materials to prevent blowing dust and debris.

(c) Prevent blowing dust on and from the Site from paved and unpaved temporary roads and excavated areas by wetting.

(d) Comply with Ministry of the Environment and the Engineer's requirements regarding minimizing dust and airborne pollution.

(e) Wash down the streets within the Work Site on a weekly basis and as additionally directed by the Engineer.

(f) Securely cover excavated material being removed from the Site and all fill materials being delivered to the Site to prevent blowing of dust or tines into the streets and haul routes.

(g) Transport dusty materials in covered haulage vehicles.

(h) Transport wet materials in suitable watertight haulage vehicles.

2.1.2.7 Odour control

2.1.2.7.1 Odour

(a) Do not use products with strong odour, if product odour is unacceptable to Engineer change product to acceptable product at no additional cost to Employer

2.1.2.8 Insect and Pest Control

2.1.2.8.1 Insect and pest control

(a) The Contractor shall provide control measures, restraining procedures, and treatments to prevent infestation and spread of insects, rodents and other pests deemed to be present at Site and/or noticed during course of the Work.

(b) Carry out fumigation, pest control procedure, and posting of warning signs, notices including contents of such notices in accordance with requirements of International Pesticide Code of Conduct FAO (1985) and any other authorities having jurisdictions. Pesticides used shall be in accordance with International Pesticide Code of Conduct FAO and any other authorities having jurisdictions.

2.1.2.9 Equipment fuelling, maintenance and storage

2.1.2.9.1 Equipment fuelling, maintenance and storage

(a) Obtain the Engineers acceptance of refuelling areas.

(b) Submit procedures for interception and rapid clean up and disposal of fuel spillages to Engineer for review prior to starting Work.

(c) Ensure that materials required for clean-up of fuel spillages are readily accessible on Site at all times, Carry out refuelling of equipment at acceptable refuelling areas.

(d) Ensure that water used for cleaning of equipment does not drain into streams, lakes or watercourses. Do not empty fuel, lubricants and/or pesticides into any watercourse, or on ground. Clean construction equipment prior to entering public roadways to prevent littering. Do not permit debris from cleaning equipment into storm sewers or watercourses.

(e) Store equipment and materials in orderly manner and in location acceptable to the Engineer.

2.1.2.10 Protection of natural environment

2.1.2.10.1 Protection of natural environment

(a) Submit to Engineer an environmental plan.

(b) Site waste management implementation plans (if any), and sketch showing areas proposed to be used for construction storage, areas for implementation of Site separation of construction waste, and including dimensions of such areas and location and size of trees within and adjacent to these areas.

2.1.2.11 Site Review

2.1.2.11.1 Site visits

(a) Ministry of the Environment, Local Authorities or their representatives, having jurisdiction may visit Site periodically during construction. Where Work does not comply with environmental protection requirements, said authorities have power to place a stop work order. Engineer's acceptance of Work may be withheld until Ministry of the Environment or other Local Authorities concerned has issued their approval.

2.1.3 CONTRACTOR'S ESTABLISHMENT AND GENERAL OBLIGATIONS

2.1.3.1 Scope

(a) This Section covers the establishment of the Contractor's organisation, camp and constructional plant off the site and their removal on completion of the contract. It also covers payment for certain general obligations, risk and liabilities and general items of cost not covered elsewhere.

2.1.3.2 Use of the site

2.1.3.2.1 Site use

(a) The Site shall not be used by the Contractor for any purpose other than for executing the Works or carrying out other work which is associated with the Works and approved by the Engineer**.**

(b) Concrete batching and mixing plant erected on the Site shall not be used to provide concrete for work outside the Site.

(c) Bituminous materials batching and mixing plant erected on the Site shall not be used to provide bituminous materials for work outside the Site.

(d) Rock crushing plant shall not be erected on the Site unless stated in the Contract.

(e) The location and size of stockpiles of materials, including excavated material, within the Site shall be as agreed by the Engineer. Stockpiles shall be maintained in a stable condition.

(f) Entry to and exit from the Site shall be obtained only at the locations stated in the Contract or agreed by the Engineer.

2.1.3.3 General requirements

2.1.3.3.1 Camps, constructional plant and testing facilities

(a) The Contractor shall establish his construction camps, offices, stores, workshops and testing facilities off the site.

(b) The exact location of these facilities shall be approved beforehand by the Engineer. Ablution and other facilities for site staff shall also be provided off the site as required and the standard of accommodation and the location of all facilities shall comply with the requirements of the authorities concerned and those of the Engineer.

(c) Prior to starting with construction, the Contractor shall also move all constructional plant to the Site. On completion of the work and after receiving approval in writing from the Engineer, all constructional plant, buildings, fencing and other temporary structures shall be removed and the camp site shall be restored to its original condition and left neat and tidy.

2.1.3.3.2 Building regulations

(a) All buildings erected by the Contractor upon the site and camp site or sites and the layout of the buildings and the sites shall comply with the Laws of Kenya and all Bye-Laws in so far as they are applicable.

2.1.3.3.3 Signboards

(a) The Contractor shall provide and erect a signboard at the main entrance to the Site were directed by the Engineer. The board, with suitable inscription, shall include the name of the Project, the name of the Employer, the name of the Consultant and the name of the Contractor, etc. The board approx. 3.30m x 3.20m size, shall be approved by the Engineer, before erection.

2.1.3.3.4 Maintenance during construction

(a) During construction the Contractor's camps and other facilities shall be maintained in a neat and tidy condition.

2.1.3.3.5 Legal and contractual requirements and responsibility to the public

(a) The Contractor shall take all the necessary steps to comply with the Conditions of Contract, particularly in respect of the insurances and sureties required and his general obligations to the public and the Employer. He shall comply with all the regulations of statutory bodies.

2.1.3.3.6 Liaison with Government and Police Officials

(a) The Contractor shall keep in close contact with the Police and other Government officials of the area regarding their requirements in the control of traffic and other matters and shall provide all assistance or facilities which may be required by such officials in the execution of their duties.

2.1.3.4 Contractor's Offices, Stores, Workshops, Etc.

2.1.3.4.1 General

(a) Offices for the Contractor's supervisory staff and administration shall be erected by the Contractor at his own expense at a location to be agreed upon with the Engineer.

2.1.3.4.2 Contractor's offices, stores and workshops

(a) The Contractor shall provide and maintain at an approved location a suitable office together with such site offices as may be necessary for the efficient control of the Works. He shall also provide and maintain on approved sites sufficient suitable stores, tanks and workshops for the proper storage of materials, fuel, plant and equipment and the efficient maintenance of all such plant and equipment.

(b) The stores shall be of such size and construction as to provide adequate storage and protection for stocks of materials, fuel, spares and the like in quantities ensuring uninterrupted progress of the work and the workshops shall be suitably equipped for carrying out major repairs, overhaul or modification by the Contractor of all plant and equipment in or on the Works and other work connected with the permanent work.

2.1.3.4.3 Contractor's quarters and camps

(a) No Labour camps will be allowed on site.

2.1.3.4.4 First aid

(a) The Contractor shall provide, equip and maintain adequate first-aid stations throughout the Works, and erect conspicuous notice boards directing where these are situated and provide all requisite transport.

(b) The Contractor shall comply with the government medical or labour requirements at all times and provide, equip and maintain base dressing stations, where directed and at all times have experienced first-aid personnel and dressers available throughout the Works for attending minor injuries.

2.1.4 ENGINEER'S ACCOMMODATION AND ATTENDANCE UPON ENGINEER AND HIS SITE PERSONNEL

2.1.4.1 Scope

(a) The Section covers the provision of facilities for the supervisory staff of the Engineer and for the Employer.

2.1.4.2 Facilities for the Engineer

2.1.4.2.1 General

(a) The Contractor shall provide and maintain an office, survey equipment etc for the Engineer, his staff and for the Employer. Materials and workmanship shall be to generally recognised standards for temporary, prefabricated or permanent buildings of this type.

(b) Detailed drawings showing the design, the construction details, the type of materials proposed and their characteristics, shall be submitted by the Contractor for the Engineer's approval, which shall be obtained before starting the construction of the office or ordering the relevant materials.

(c) All buildings for offices shall be constructed from approved materials. Materials containing asbestos shall not be used. The Contractor shall provide the buildings with potable water, electricity, sanitary installations, sewage disposal arrangements, furniture and equipment, and shall maintain them, all to the satisfaction of the Engineer, 24 hours of the day during the Contract Period.

(d) All facilities shall conform to the best standards for the required types. The facilities described herein shall be understood to represent the minimum requirements. The Contractor shall provide all additional incidentals necessary, so that the facilities will be completely adequate and satisfactory in every respect for the intended use. All equipment and furniture shall be new and unused when initially put in place.

(e) The Contractor shall maintain, replace and / or restore as directed, any facilities or parts thereof that become damaged, worn out, lost or stolen, except through causes due to negligence. The Contractor shall also provide an adequate stock of all expendable items, such as light bulbs, light tubes, kitchenware, soap, towels, toilet paper, paper towels,

drinking cups, materials and accessories and at all times ensure proper and continuing functioning of all components and parts of the Engineer's office.

(f) The offices and installations, etc including all required equipment to be provided under this Contract shall be handed over to the Engineer in finished and fully functioning condition not later than 1 month after the Engineer's order to commence Work (according to the relevant clause of the Conditions of Contract) and such buildings shall be to the entire satisfaction of the Engineer. Suitable temporary office for the Engineer and his staff shall be provided from the date of the order to commence the Works until such time as the permanent office is available for use.

(g) The offices for the Engineer shall be adjacent to the Contractor's establishment.

(h) The Site office shall be connected to water and an electricity supply. The Contractor shall be responsible for cleaning and maintaining the office and toilets and shall provide soap, towels and all necessary fittings and cleaning materials.

2.1.4.3 Attendance upon Engineer

2.1.4.3.1 Assistance to the Engineer

(a) The Contractor shall provide all assistance such as labourers, all tools and protective clothing, wooden pegs, iron pins and pickets, water, cement and aggregate for concreting, transport for labour and materials, as may be required by the Engineer and his staff for checking, setting out, surveying and measuring or testing the work.

2.1.5 EARTHWORKS

2.1.5.1 Site Visit

2.1.5.1.1 Site visit

(a) The Contractor is recommended to visit the Site before tendering and to ascertain the nature of the ground to be excavated. No claims arising from failure to do so will be considered. Trial holes may be dug at the Tenderer's expense if prior permission is obtained from the Engineer.

(b) Trial holes must be reinstated to the approval of the Engineer after inspection.

2.1.5.2 Definitions

2.1.5.2.1 Generally

(a) "Top soil" is soil capable of supporting vegetative growth.

(b) "Suitable material" shall be approved and to consist of naturally occurring or processed material which at the time of deposition is capable of being compacted in accordance with the specified requirements to form stable areas of fill. The soluble sulphate content of the material placed within 500 mm of concrete, cement bound material or cementitious material shall not exceed 1.9 grams of sulphate, expressed as SO_3, per litre. The total sulphate content, expressed as SO_3, of the material placed within 500 mm of metal work shall not exceed 0.5% by mass.

(c) The method of testing of the total sulphate content shall be in accordance with **BS 1377**.

(d) "Unsuitable material" is material other than suitable material and shall include the following:

i. Material susceptible to volume change, including marine mud, soil with a liquid limit exceeding 65% or a plasticity index exceeding 35%, swelling clays and collapsible soils.

ii. Peat, vegetation, timber, organic, soluble or perishable material.

iii. Dangerous or toxic material or material susceptible to combustion, and

iv. Metal, rubber, plastic or synthetic material.

(e) "Rock" is hard material which in the opinion of the Engineer can only be removed by the use of blasting, wedges or pneumatic drills and shall include individual boulders or other masses exceeding 0.20 m^3 in size.

(f) "Rock fill" shall consist of pieces of hard, durable rock of which, in the opinion of the Engineer, not more than 30% by mass is discoloured or shows other evidence of decomposition. Concrete, masonry, brick and similar materials shall not be used instead of rock unless permitted by the Engineer. No individual particle shall exceed 0.1 m^3 in size or the thickness of the filling whichever is the least, suitably graded for deposition and compaction.

(g) "Hardcore" shall comprise the following material to pass rings varying from 28 to 150 mm, or else, single sized hardcore may be used:

i. Rockfill.

ii. Broken stone, hard brick, concrete or other comparable hard, inert, approved material. The material shall be free from dust, rubbish or deleterious foreign matter.

(h) "General filling material" shall be "suitable material". It may contain up to 25% rock distributed evenly throughout the whole mass of the material. General filling material shall contain no material exceeding 200 mm in size.

(i) "Special filling material" shall be "general filling material" capable of passing through a 75 mm BS sieve. The material shall be sampled and tested according to **BS 1377**.

(j) "Embankment", "filling area" or "area of fill" means an area on the Site other than a foreshore or sea-bed where the ground level shall be raised by filling in layers as part of the Works.

(k) "Trench excavation" means excavating from ground level not exceeding 5000 mm in width at surface.

(l) "Bulk excavation" means excavation in the open other than trench excavation.

Note: The definitions of trench excavation and bulk excavation stated in sub-clauses (k) and (l) are for the purposes of the Specification only and do not apply to the measurement of excavation in Bills of Quantities which are measured in accordance with the current edition of the Standard Method of Measurement of Building Works for use in East Africa.

2.1.5.3 Materials

2.1.5.3.1 Fill material

(a) Fill material shall consist of naturally occurring or processed material which at the time of deposition is capable of being compacted in accordance with the specified requirements to form stable areas of fill.

(b) Fill material, other than public fill, shall not contain any of the following:

i. material susceptible to volume change, including marine mud, soil with a liquid limit exceeding 65% or a plasticity index exceeding 35%, swelling clays and collapsible soils,
ii. peat, vegetation, timber, organic, soluble or perishable material,
iii. dangerous or toxic material or material susceptible to combustion, and
iv. metal, rubber, plastic or synthetic material.

(c) Special fill material shall consist of material which has a liquid limit not exceeding 45%, a plasticity index not exceeding 20% and a coefficient of uniformity exceeding 50.

(d) Granular fill material shall consist of clean, hard, durable material.

(e) Rock fill material shall consist of pieces of hard, durable rock of which in the opinion of the Engineer not more than 30% by mass is discolored or shows other evidence of decomposition. Crushed rock or crushed concrete may be permitted subject to approval by the Engineer.

(f) Hardcore filling shall be good hard stone, ballast or quarry waste to the approval of the Engineer, free from dust, broken from 150mm gauge downwards or to be 75% of the finished thickness of the layers being incorporated, whichever is the lesser. Hardcore shall be free from all weeds, roots, vegetable soil, clay, black cotton soil or other unstable material.

It shall be well graded with sufficient small material incorporated to fill all interstices and laid in layers not exceeding 200mm thick, each layer well compacted by at least 8 passes of a 10-ton smooth wheeled roller or a 2 ton vibrating roller until all movement ceases. Sufficient water is to be added to obtain maximum compaction to the Engineer's approval. To each layer a 25mm thick layer of sand complying with the specification for fine aggregate for concrete shall be spread over the surface and forced into the hardcore by the use of a vibrating roller weighing not less than 2 tons. This operation should be carried out when the materials are dry and repeated whilst the sand is well watered. Should all the sand be absorbed, the Engineer may require a further layer to be applied and the process repeated.

The top surfaces of the hardcore shall be levelled or graded to falls as required and shall then be blinded with a layer of similar material broken to 25mm gauge and finished with a 10 ton smooth-wheeled roller. The surface so obtained shall be to the Engineer's approval

(g) The soluble sulphate content of fill material placed within 500 mm of concrete, cement bound material or cementitious material shall not exceed 1.9 grams of sulphate, expressed as SO_3, per litre.

(h) The total sulphate content, expressed as SO_3, of fill material placed within 500 mm of metalwork shall not exceed 0.5% by mass.

(i) The use of public fill as fill material for earthwork may be permitted and the size limitation, transportation, stockpiling, deposit, spreading, compaction and any particular requirements of such material shall be as stated in the Contract.

(j) Well-graded material shall consist of material which has a coefficient of uniformity exceeding 10.

(k) Uniform-graded material shall consist of material which has a coefficient of uniformity of 10 or less.

2.1.5.4 Excavation

2.1.5.4.1 Generally

(a) Carry out and adequately support excavation in such a manner to maintain excavations in a stable condition and to prevent settlement of structures or utilities due to excavation or dewatering.

(b) Constructional Plant or other vehicles shall not be operated or parked adjacent to excavations, and earthworks, materials or other materials shall not be placed adjacent to excavations unless this has been allowed for in the design of the Temporary Works for the support of the excavation.

(c) Keep excavation free of water in accordance with Clause 2.1.5.13.

(d) Neatly trim the face of excavation.

(e) Carry out excavation to the lines, levels, dimensions and slopes specified.

(f) Carefully level the bottom of excavation and step or bench horizontally as specified. Remove any pockets of soft material or loose rock in the bottoms of pits and trenches and fill the resulting cavities and any large fissures with Grade 10 concrete. Do not trim the side faces of excavations for at least 24 hours after placing any blinding concrete required by the Contract.

(g) Backfill and compact strictly in accordance with the Specifications and at no extra cost "over-excavated" areas where the Contractor's proposed method of excavation, if approved, involves excavation in excess of that specified in certain areas.

(h) Maintain excavated surfaces to be used for construction traffic at a level of 300 mm minimum above formation level unless in rock. Make good any damage to the surface arising from such use with material having the same characteristics as the material which has been damaged.

(i) Ensure that no construction traffic uses an area once trimming to final formation level has commenced, with the exception of plant necessary for such trimming, and ensure that no damage is caused to the surface by this plant.

(j) Make good, at no extra cost, surfaces which, after excavation, have been allowed to deteriorate to a condition that makes compaction of backfilling impracticable, either by carrying out additional excavation and filling in accordance with this Specification or, by waiting until the condition of the exposed material is, in the opinion of the Engineer, fit to receive the approved backfill.

(k) Excavate in such a manner that suitable material is kept separate and store in temporary spoil heaps, where required for use in the Works without contamination by unsuitable material or deterioration. Where, in the opinion of the Engineer, suitable material has become contaminated by unsuitable material or allowed to deteriorate, this material shall be removed from Site and replaced with suitable imported material at the Contractor's expense.

(l) Take necessary precautions to prevent damage to existing drains and services encountered in and around the excavation. Should any damage occur, notify the Engineer and the relevant authorities concerned immediately and make good at no extra cost. When so instructed, temporarily divert ditches, land drains or other waterways encountered in the excavation and subsequently reinstate.

(m) Take necessary precautions to prevent damage to tops of piles during excavation.

(n) Bottoms of excavation shall be approved before any new work is laid. Inform the Engineer when excavation is ready for inspection. Do not trim and blind the bottom of excavation without approval.

2.1.5.4.2 Obstructions

(a) Notify the Engineer of the location and nature of any buried obstruction encountered during excavation. Take up disused drains encountered in the excavation and clear away. Remove any contaminated earth. Disinfect as necessary and seal off ends with concrete. Break up and remove disused manholes and backfill where required with approved material properly compacted.

(b) Break out and remove old walls, foundations, piles and other underground structures encountered in the excavation and backfill where required with approved material properly compacted.

2.1.5.4.3 Removal of excavated material

(a) Remove unsuitable material from Site. Do not remove suitable material from Site without the permission of the Engineer, unless surplus to requirements of the Contract. Unsuitable material and surplus materials shall become the property of the Contractor unless otherwise provided for in the Contract.

(b) Inform the Engineer of the proposed dumping areas and take responsibility for making arrangements for disposal of these materials. Notwithstanding the foregoing the Engineer retains the right to direct the manner in which dumping is to be carried out.

2.1.5.4.4 Excavations adjacent to structures and utilities

(a) Excavations shall be carried out by hand adjacent to utilities that are known, proven or suspected to exist.

(b) Unless otherwise permitted by the Engineer excavations next to structures shall be carried out by hand.

2.1.5.5 Excavation material

2.1.5.5.1 Interpretation

(a) The Engineer will determine the class and extent of each type of excavation material. Where the Contractor considers that materials to be excavated may be of any class other than CLASS 2 (NORMAL or SOFT) he must inform the Engineer in sufficient time for the Engineer to determine the class and the precise extent of such material. Should the Contractor fail to inform the Engineer in sufficient time, all excavated material will be deemed to be Class 2.

2.1.5.5.2 Class 1: Rock or Hard Material

(a) All material which cannot be removed except by blasting or by the use of metal wedges and sledgehammers or by ripping with a heavy tractor and rear-mounted hydraulic single type heavy-duty ripper.

(b) Boulders greater than 0.5 m^3 when their nature and size is such that they cannot be removed without recourse to one or more of the methods described in 1 above. Where such boulders

constitute 50% or more of the volume of a particular part of the excavation, such part will be considered Class 1 material throughout.

2.1.5.5.3 Class 2: Normal or Soft Material

(a) All material which can be removed without recourse to the methods described for Class 1 above and / or Classes 3 or 4 below.

2.1.5.5.4 Class 3: Compacted Gravel or Decomposed Rock

(a) All material such as consolidated murram or gravel, decomposed or stratified rock, stones and boulders less than 0.5 m^3, harder than Normal or Soft Material but which can be excavated by ripping or which, in confined spaces, requires excavation by hand using compressor tools.

2.1.5.5.5 Class 4: Waterlogged Material

(a) All material which is waterlogged at the time of excavation and which necessitates de-watering and pumping. Rates entered in the tender Bills of Quantities against excavation so described will be deemed to include for all de-watering, pumping, construction of sumps and any drains or other incidental construction or operations necessary to the work. Excavations requiring occasional pumping on account of accumulated surface water will not be included in this class.

2.1.5.6 Explosives

2.1.5.6.1 Blasting

(a) Explosives must not be used without the prior approval of the Engineer. Blasting operations are carried out at the Contractor's sole risk, and all blasting must be carried out in accordance with government regulations.

2.1.5.7 Borrow Pits

2.1.5.7.1 Borrow pits

(a) No borrow pits will be allowed to be opened on the site.

2.1.5.8 Protection against Termites

2.1.5.8.1 Termite protection

(a) The ground under surface beds and below suspended wood floors shall be poisoned with an approved registered TERMITICIDE of the chlordane or aldrin type mixed with water. Great care is to be taken to apply the solution evenly over the whole surface. The concentration of the solution shall be in accordance with the manufacturer's instructions and to the approval of the Representative / Agent.

(b) Where the ground to be treated is of earth filling, the upper layer of fill shall be levelled by raking, but where of natural ground, it shall be dug up, well loosened to a depth of not less than 50 mm so as to enable the solution to penetrate into the soil and similarly levelled. After the solution has been applied and allowed to soak in, the soil shall be well rammed and consolidated to at least 90% Modified AASHTO.

(c) Before applying the solution to the ground under the floor, 75 mm deep V-shaped channels shall be raked out alongside all walls enclosing the floors and against sleeper walls and piers etc under floors and the channels flooded with poison solution. After the solution has soaked in, the channels shall be back filled and rammed.

(d) The bottom of all foundation trenches and holes shall be similarly poisoned, but without digging up and loosening the soil.

(e) The poisoned layer of soil under suspended wood floors shall be protected with a 75 mm thick layer of approved clean gravel or broken stone, levelled to an even surface on top.

(f) Where the concrete surface beds are laid above damp course level, the ground at damp course level shall be poisoned as above and a layer of clean earth filling laid on the poisoned ground up to underside of concrete beds, all well consolidated to at least 90% Modified AASHTO.

(g) Great care shall be taken whilst laying the concrete floor beds, protective layers and filling to avoid rupturing the poisoned layer of soil under the floors. Should the poisoned layer be ruptured at any point it shall be made good and the affected areas treated again.

(h) The termiticide shall be delivered to the site in sealed containers, clearly labelled or stamped with the name of the product;

(i) Contractors are advised that special precautions must be taken to protect the workmen working with the termiticide;

(j) The poisoning of the ground under floors shall be done as soon as practicable, so that it may dry out before the floors are laid;

(k) The poisoning of the ground must be carried out under the supervision of the Representative / Agent;

(l) Post signs in areas of application to warn workers that soil termiticide treatment has been applied. Remove signs after areas are covered by other construction.

(m) The Contractor shall provide a written warranty, executed by Applicator and Contractor, certifying that applied soil termiticide treatment will prevent infestation of subterranean termites. If subterranean termite activity is discovered during warranty period, Contractor will re-treat soil and repair or replace damage caused by termite infestation.

(n) Warranty period shall be 10 years from date of substantial completion.

2.1.5.8.2 Application

(a) Apply soil treatment solution as follows:

Under slab on grade structures, treat soil before concrete slabs are placed, using the following application rates:

i. Apply 15 litres of chemical solution per 3m to soil in critical areas under slab, including entire inside perimeter of foundation walls, along both sides of interior partition walls,

around plumbing pipes and electric conduit penetrating slab, and around interior column footers.

ii. Apply 3.75 litres of chemical solution per 3 m^2 as an overall treatment under slab and attached slab areas where fill is soil or unwashed gravel. Apply 5.75 litres of chemical solution to areas where fill is washed gravel or other coarse absorbent material.

iii. Apply 15 litres of chemical solution per 3m of trench for each foot of depth from grade to footing, along outside edge of building. Dig a trench 150 mm to 200 mm wide along outside of foundation to a depth of not less than 300 mm. Punch holes to top of footing at not more than 300 mm OC and apply chemical solution. Mix chemical solution with the soil as it is being replaced in the trench.

(b) Under crawlspace and basement structures, treat soil along exterior and interior walls of foundations with shallow footings as specified above for exterior of slab on grade structures.

Treat soil under or around crawlspace structures as follows:

i. Apply 15 litres of chemical solution per 3m of trench along inside of foundation walls, along both sides of interior partitions, and around piers and plumbing. Do not apply an overall treatment in crawlspaces.

ii. Apply 15 litres of chemical solution per 3m of trench, for each 300 mm of depth from grade to footing, along outside of foundation walls, including part beneath entrance platform porches, etc.

iii. Apply 15 litres of chemical solution per 3m along the inside and outside of foundation walls of porches.

iv. Apply one gallon per 3 m^2 of soil surface as an overall treatment only where attached concrete platform and porches are on fill or ground.

(c) At hollow masonry foundations or grade beams, treat voids at rate of 2 gallons per 3m, poured directly into the hollow spaces.

(d) At expansion joints, control joints, and areas where slabs will be penetrated, apply at rate of 15 litres per 3m of penetration.

(e) All Government laws and regulations, as well as local authorities' regarding the termiticide, shall be strictly adhered to.

2.1.5.9 Damp-Proof Membrane

2.1.5.9.1 Damp proof membrane

(a) A protective membrane of No 500 gauge or 1000 gauge to BS EN 13967:2012, shall be laid over the building under the floor slab where specified.

(b) Where the joints occur, the membrane shall be triple folded with a 150mm fold and taped at 300mm centres with approved 50mm wide adhesive tape. The sheeting shall not be stretched, but shall be laid loose with sufficient wrinkles to permit shrinkage up to 15%.

(c) The Contractor shall include for all necessary costs to ensure that membrane surfaces shall not be pierced during the laying and concreting of floors.

2.1.5.10 Forming of Embankments

2.1.5.10.1 Forming embankments

(a) The Contractor shall carry out the forming of embankments in accordance with the Drawings and shall adhere to the slopes, levels, depths and heights shown thereon.

(b) Unless otherwise directed or permitted by the Engineer, all suitable excavated materials shall be used to form embankments. Any such excavated material which is surplus to this requirement shall be disposed of in tips. Any material which according to the Specification requirements is unsuitable for forming embankments shall be similarly disposed of.

(c) All filling material other than rock in embankments or below formation level in cuttings shall be deposited in layers not exceeding 225mm loose depth unless as a result of compaction trials the Engineer approves spreading to a greater depth up to a maximum of 375mm loose depth. Each layer shall extend over the full width of the embankment and shall be compacted.

(d) Rock used in rock-fill embankments shall be of such size that it can be deposited in horizontal layers each not exceeding 450 mm loose depth and extending over full width of the embankment except for any specified external cover to slopes or new formation level.

The materials shall be spread and levelled by a crawler tractor weighing not less than 15 tonnes. Each layer shall consist of reasonably well-graded rock and all large voids shall be filled with broken fragments before the next layer is placed. The top surface and side slopes of embankments so formed shall be thoroughly blinded with approved fine graded material to seal the surface. Such material may be surface soil on side slopes.

(e) Isolated boulders each within the range 0.05 m^3 to 0.3 m^3 in size may be incorporated more than 600 mm below formation level in embankments not or rock-fill at the discretion of the Engineer, provided that the specified compaction requirements are met. No stone exceeding 0.05 m^3 should be placed less than 600 mm below formation level of carriageways and verges.

(f) During the construction of embankments the Contractor shall control and direct constructional traffic uniformly over the full width.

(g) Fill material shall not be stockpiled on embankments, unless this is permitted by the Engineer.

(h) Should the quantity of excavation from the Works, including that from any widened cuttings, be insufficient to make up the embankments, the deficiency shall be made good by approved imported suitable material and the Contractor shall be responsible for locating and obtaining such material.

(i) Where materials of different characteristics are readily available those of relatively high bearing capacity shall be placed in the topmost 600mm below formation level.

2.1.5.11 Compaction of Earthworks

2.1.5.11.1 Compaction of fill material

(a) Fill material in areas of fill shall be compacted in layers to a stable condition as soon as practicable after deposition and in a manner appropriate to the location and to the material to be compacted.

(b) The permission of the Engineer shall be obtained before the next layer is deposited on each laye of compacted fill material.

(c) Except as stated in Clauses 2.1.5.11.3 (b), 2.1.5.11.4(a) and 2.1.5.12.2(b), fill material shall be compacted to obtain a relative compaction of at least 95% throughout unless otherwise stated in the Contract.

2.1.5.11.2 Moisture content of fill material

(a) Fill material other than rock fill material and material as stated in Clause 2.1.5.11.4(a) shall be at optimum moisture content during compaction. The tolerance on the optimum moisture content percentage shall be ±3%, provided that the fill material is still capable of being compacted in accordance with the specified requirements to form stable areas of fill. All necessary measures shall be taken to achieve and maintain the specified moisture content.

2.1.5.11.3 Compaction of fill material adjacent to structures and utilities

(a) Fill material shall be compacted in such a manner that structures or utilities are not disturbed or damaged.

(b) Fill material around water, sewage and drainage pipes which are constructed as part of the permanent work shall be compacted by hand rammers or manually operated power equipment. Fill material within 300 mm above the top of sewage and drainage pipes shall be compacted to obtain a relative compaction of at least 85% throughout.

2.1.5.11.4 Compaction of rock fill material

(a) Every layer of rock fill material shall be compacted by at least eight passes of a vibrating roller or by other equivalent compaction method approved by the Engineer. The final surface of rock fill material shall be compacted by at least two additional passes of a vibrating roller or by other equivalent compaction method approved by the Engineer.

(b) Vibratory rollers used for the compaction of rock fill material shall have a static load per 100 mm width of roll of at least 2 kN for layers with a compacted thickness not exceeding 500 mm and atleast 4 kN for layers with a compacted thickness exceeding 500 mm.

2.1.5.11.5 Compaction of general fill material with a large portion of coarse material

(a) For general fill material of which less than 90% passing a 20 mm BS test sieve, it will be difficult to permit determination of the moisture content and maximum dry density.

(b) Spread and level each horizontal layer of general fill material with a thickness not less than 1.5 times of the maximum size of the general fill material and not exceeding the maximum depth of compacted layer in accordance with Table 2.1.5.1. If this criterion is not met due to the presence of over-sized coarse material in the general fill, the over-sized coarse material shall be removed or broken down to sizes acceptable to the Engineer. Each layer shall be systematically compacted by a vibratory roller with the stipulated minimum number of passes corresponding to the minimum static load per 100 mm width of the roller.

(c) The number of passes of the roller shall only be counted when the roller is travelled on the material to be compacted at a speed of not more than 2 km per hour with full vibration. The plant other than vibratory roller to carry out material spreading or to provide some preliminary compaction only to assist the use of heavier plant shall be disregarded in counting the number of passes.

(d) Variation from the method or the use of plant different from that specified in Clause 2.1.5.11.4(b) will be permitted only if the Contractor demonstrates at site trials that equivalent compaction is achieved by the alternative method or plant. The procedure to be adopted for these site trials shall be agreed with and approved by the Engineer.

(e) Without prejudice to the provision of the Conditions of Contract and in order that the Engineer may take proper provision for the supervision of compaction in the permanent work, the Contractor shall, not less than 24 hours before he proposes to carry out compaction processes, apply in writing to the Engineer for permission to do so.

(f) When materials of widely divergent grading are used in embankments and fill areas, they shall be spread and compacted in separate clearly defined areas.

(g) If more than one class of material is being used in such a way that in the opinion of the Engineer it is not practicable to define the areas in which each class occurs, compaction plant shall be operated as if only the material which requires the greatest compactive effort is being compacted.

Table 2.1.5.**1: Compaction requirement for general fill material with a large portion of coarse material**

Force per 100 mm width	Well graded material		Uniform graded material	
	Maximum depth of compacted layer (mm)	Minimum no. of passes	Maximum depth of compacted layer (mm)	Minimum no. of passes
0.25-0.45			150	16
0.46-0.70			150	12
0.21-1.25	125	12	150	10
1.26-1.75	150	8	200	10
1.76-2.30	150	4	250	10
2.31-2.80	175	4	275	8
2.81-3.50	200	4	250	8
3.51-420	225	4	300	8
4.21-4.90	250	4	300	8

2.1.5.12 Completion of earthwork surfaces

2.1.5.12.1 Completion of earthworks final surfaces

(a) Earthworks final surfaces shall be completed to a stable condition as soon as practicable after excavation or after deposition and compaction of fill material has been completed. The subsequent permanent work or surface protection shall be carried out as soon as practicable after the earthworks final surface has been completed.

(b) Earthworks final surfaces shall be completed to smooth alignments without abrupt irregularities unless otherwise stated in the Contract.

2.1.5.12.2 Completion of formations

(a) Formations above structures or utilities shall be completed after construction of the structure or utility.

(b) Except in excavations in rock and in areas of fill formed of rock fill material or fill material as stated in Clause 2.1.5.11.4(a) formations shall be compacted to obtain a relative compaction of at least 98% to a depth of 200 mm below the formation.

(c) Unless otherwise permitted by the Engineer, proof rolling shall be carried out on formations. The formation shall be rolled in the presence of the Engineer by at least two passes of a non-vibrating rubber tyred roller. The roller shall have a static load per 100 mm width of roll of at least 4 kN and shall travel at a speed not exceeding 2 km/h. Any defect in the formation which is revealed during proof rolling by deformation of the formation which in the opinion of the Engineer is excessive shall be made good as instructed by the Engineer.

(d) After all other formation work and testing have been completed and damage caused by testing reinstated, formations for pavements shall be rolled with one pass of a smooth steel-wheeled non-vibrating roller. The roller shall have a load per 100 mm width of roll of at least 2 kN.

(e) Unless otherwise permitted by the Engineer, formations which will not be immediately covered by the subsequent permanent work shall be protected by methods agreed by the Engineer.

2.1.5.12.3 Protection of earthworks final surfaces and formations

(a) Earthworks final surfaces and formations shall be maintained in a stable condition and shall be protected from damage due to water or other causes and from exposure to conditions which may adversely affect the surface.

(b) Formations shall not be used by Constructional Plant or vehicles other than those which in the opinion of the Engineer are essential to construct the subsequent work.

2.1.5.13 Earthworks to be kept free of water

2.1.5.13.1 Earthworks to be kept free of water

(a) The Contractor shall arrange for the rapid dispersal of water shed on to or entering the earthworks from any source at any time during construction, or of water which is shed onto the completed sub-grade. He shall provide within the Site where necessary temporary water-courses, ditches, drains, pumping or other means of maintaining the earthworks free from standing water. Water discharged from the Site shall not be run into a road but be carried direct to an approved sewer, ditch or river through troughs, chutes or pipes.

(b) Such provision shall include carrying out the work of forming the cutting and embankments in such a manner that their surfaces have at all times a sufficient minimum crossfall and, where practicable, a sufficient longitudinal gradient to enable them to shed water and prevent ponding.

(c) In pumping out excavations and in any lowering of the water tables the Contractor shall pay due regard to the stability of all structures.

(d) The cost of compliance with the requirements of this Clause shall be covered in the rates for earthworks.

2.1.5.14 Use of Vibratory Compaction Plant

2.1.5.14.1 Vibratory compaction plant

(a) Where vibratory rollers or other vibratory compaction plant are used the mechanism for vibration shall be kept working continuously during compaction operations, except during periods when the Engineer permits or directs discontinuance of vibration.

(b) Unless otherwise permitted by the Engineer, the frequency of vibration shall be maintained within the range of amplitude and frequency recommended by the manufacturers of the plant for the material to be compacted.

(c) The frequency shall be recorded by a tachometer indicating speed of rotation of any shaft producing vibration.

2.1.5.15 Provision of Spoil Heaps

2.1.5.15.1 Spoil heaps

(a) The Contractor shall provide spoil heaps at his own expense for the disposal of surplus materials and all rubbish collected when clearing the Site and during the Construction of the Works. The sites for these shall be approved by the Engineer.

2.1.5.16 Testing: fill material – general requirements

2.1.5.16.1 Batch: fill material

(a) A batch of fill material is any quantity of fill material of the same type and which in the opinion of the Engineer has similar properties throughout. For the purpose of testing for moisture content and relative compaction a batch shall, in addition to the above, be fill material which is deposited in a single layer in any area of fill presented by the Contractor for testing on one occasion.

2.1.5.16.2 Samples: fill material

(a) Each sample of fill material shall consist of at least four increments taken from different parts of the batch. The increments shall be combined and thoroughly mixed and shall then be divided by quartering or by using a riffle box to obtain specimens of an appropriate size to carry out the individual tests.

(b) The size of samples of fill material other than rock fill material shall be in accordance with BS 1377, Part 1, Section 7. Each sample of rock fill material of Grade size not exceeding 200 shall have a mass of at least 250 kg and each sample of rock fill material of Grade size exceeding 200 shall have a mass of at least 1000 kg.

2.1.5.17 References and Standards

BS 1377-1 (1990): Methods of test for soils for civil engineering purposes. General requirements and sample preparation.

BS EN 13967(2012): Flexible sheets of waterproofing, Plastic and rubber damp proof sheets including plastic and rubber basement tanking sheet. Definitions and characterstics.

2.1.6 STEEL REINFORCEMENT

2.1.6.1 Steel Rod Reinforcement

2.1.6.1.1 Materials

(a) Steel rod reinforcement shall consist of:

i. Mild steel bars complying with **BS 4449**

ii. Hot rolled high yield bars complying with **BS 4449**

iii. Cold reduced steel wire **BS 4483**

(b) Where cold worked high yield bars are to be used these shall be square twisted bars formed by a torsion-controlled process.

2.1.6.1.2 Workmanship

(a) The Contractor shall obtain a manufacturer's certificate of test in accordance with the appropriate standard for each steel batch relating to reinforcement delivered to site and shall immediately forward copies of the same to the Engineer for his retention.

(b) Where hot rolled high yield deformed bars are to be used, the results of bond tests to **ASTM C234-91a**, using concrete of the same quality as that to be used in the works shall be forwarded to the Engineer.

(c) Notwithstanding the manufacturer's certificate, the Engineer may require that any reinforcement delivered to the site be sampled and tested. Any reinforcement so sampled and tested which fails to comply with this specification will be rejected.

All reinforcement shall be delivered to the Site either as straight bars or ready- cut and bent to shape.

All reinforcement shall be stored in clean conditions in an orderly manner to the satisfaction of the Engineer such that the batch to which each piece belongs can be readily identified.

2.1.6.2 Steel Fabric Reinforcement

2.1.6.2.1 Materials

(a) Steel fabric reinforcement shall be electrically cross-welded steel mesh reinforcement complying with **BS 4483.**

(b) Epoxy coatings to reinforcement and patching material for epoxy coatings shall comply with **BS ISO 14654**: Parts 1 & 2 except as stated in Clauses 2.1.6.2.1(b). The coatings shall be applied by the electrostatic spray method in accordance with **BS ISO 14654**: Part 1 at a factory approved by the Engineer.

(c) The film thickness of the coating after curing shall be at least 0.15 mm and shall not exceed 0.28 mm over the complete periphery including deformations and ribs. The bond classification of coated bars determined in bond performance tests shall not be less than that of uncoated bars.

(d) Galvanizing to reinforcement shall comply with **BS 729**. Galvanized reinforcement shall be chromate passivated as part of the galvanizing process by quenching the bars immediately after galvanizing in a solution containing at least 0.2% sodium dichromate in water. The galvanizing shall be applied after cutting and bending of the reinforcement.

(e) Metallic zinc-rich priming paint for repairs to galvanized reinforcement shall comply with BS **4652**.

2.1.6.3 Tying Wire

2.1.6.3.1 Materials

(a) Tying wire for reinforcement adjacent to and above Class F4 and F5 finishes shall be 1.2 mm diameter stainless steel wire complying with **BS 1052**.

(b) Tying wire for epoxy coated reinforcement shall be 1.6 mm diameter soft annealed steel wire coated with nylon, epoxy, plastic or other dielectric material.

(c) Tying wire for galvanized reinforcement shall be 1.6 mm diameter galvanized soft annealed steel wire.

(d) Tying wire for other reinforcement shall be 1.6 mm diameter soft annealed steel wire.

2.1.6.4 Tying devices and clips

2.1.6.4.1 Materials

(a) Tying devices and clips for reinforcement shall be a proprietary steel type approved by the Engineer.

(b) Tying devices and clips for reinforcement adjacent to and above Class F4 and F5 finishes shall be stainless steel.

(c) Tying devices and clips for epoxy coated reinforcement shall be coated with nylon, epoxy, plastic or other dielectric material.

(d) Tying devices and clips for galvanized reinforcement shall be galvanized.

2.1.6.5 Cover Spacers

2.1.6.5.1 Materials

(a) Cover spacers for reinforcement shall be concrete blocks or a proprietary plastic or concrete type. Proprietary plastic and concrete cover spacers shall be a type approved by the Engineer.
(b) Cover spacers for Class F3, F4 and F5 finishes shall be a proprietary plastic or concrete type.

(c) Cover spacers for epoxy coated reinforcement and galvanized reinforcement shall be a proprietary plastic type.

(d) Cover spacers shall be as small as practicable consistent with their purpose and shall be designed to maintain the specified cover to reinforcement.

(e) Cover spacers shall be capable of supporting the weight of reinforcement and construction loads without breaking, deforming or overturning.

(f) The strength and durability of concrete blocks and proprietary concrete cover spacers shall not be less than that of the surrounding concrete.

(g) Cover spacers for Class F3, F4 and F5 finishes shall be of a colour similar to that of the surrounding concrete and shall not cause indentations in the formwork.

(h) Chairs, supports and spacers other than cover spacers for reinforcement shall be steel. The steel shall be coated with nylon, epoxy, plastic or other dielectric material for epoxy coated reinforcement and shall be galvanized for galvanized reinforcement.

2.1.6.6 Reinforcement connectors

2.1.6.6.1 Materials

(a) Reinforcement connectors shall be a proprietary type approved by the Engineer.

(b) Reinforcement connectors for tension joints shall be a cold swaged or threaded type. The connectors shall be capable of developing the full tensile strength of the parent bar and shall comprise high tensile steel studs and seamless steel tubes fitted with protective plastic caps.

(c) Reinforcement connectors for compression joints shall be a wedge locking or bolted sleeve type.

2.1.6.7 Handling and storage of reinforcement

2.1.6.7.1 Handling of reinforcement

(a) Reinforcement shall not be subjected to rough handling, shock loading or dropping from a height.

(b) Reinforcement shall be stored off the ground on level supports and in a manner which will not result in damage or deformation to the reinforcement or in contamination of the reinforcement.

2.1.6.7.2 Storage of reinforcement

(a) Fabric reinforcement shall be stored horizontally.

(b) Different types and sizes of reinforcement shall be stored separately.

(c) Reinforcement shall not be stored on or adjacent to concrete surfaces which form part of the permanent work.

(d) Epoxy coated reinforcement and galvanized reinforcement shall be stored on wooden or padded cribbing.

2.1.6.8 Cutting and bending reinforcement

2.1.6.8.1 Cutting and bending reinforcement

(a) Reinforcement shall be cut and bent in accordance with **BS 8666** to the specified shapes and dimensions and shall be bent at temperatures of at least 5°C and not exceeding 100°C.

(b) Epoxy coated reinforcement shall be bent cold. Bar cutting and bar bending equipment for epoxy coated reinforcement shall have padded supports and contact areas shall be fitted with nylon or plastic mandrels.

(c) Grade 460/425 reinforcement shall not be rebent or straightened after bending. Grade 250 reinforcement which projects from the hardened concrete may be bent aside and rebent provided that the internal radius of the bend is at least twice the diameter of the bar and that bending is not carried out by levering against the concrete or by other methods which in the opinion of the Engineer are likely to damage the concrete.

(d) The ends of bars to be used with reinforcement connectors for compression joints shall be sawn square with all burrs removed.

2.1.6.9 Surface condition of reinforcement

2.1.6.9.1 Surface condition of reinforcement

(a) Reinforcement shall be clean at the time of fixing and shall be free from loose mill scale, loose rust or any substance which in the opinion of the Engineer is likely to reduce the bond or affect the reinforcement or concrete chemically; the reinforcement shall be maintained in this condition until concrete is placed around it.

(b) If the surface condition of the reinforcement deteriorates such that it does not comply with the requirements stated in Clause 2.1.6.9.1 (a), the reinforcement shall be cleaned or dealt with by other methods agreed by the Engineer.

2.1.6.9.2 Repairs to epoxy coatings and galvanised coatings

(a) If the coating to epoxy coated reinforcement is delaminated or split at any point or if the coating to epoxy coated reinforcement or galvanized reinforcement is damaged:

- at any point by an amount exceeding 25 mm^2 in area or 50 mm in length, or
- at more than three points in a 1 m length by amounts each even not exceeding 25 mm^2 in area or 50 mm in length,

that part of the reinforcement shall not be used in the permanent work. If the coating to epoxy coated reinforcement or galvanized reinforcement is damaged at more than six points in the cut and bent length of a bar by amounts each even not exceeding 25 mm^2 in area or 50 mm in length, that length of bar shall not be used in the permanent work.

(b) All damaged areas not exceeding 25 mm2 in area or 50 mm in length and cut ends of epoxy coated reinforcement shall be repaired using patching material applied in accordance with the manufacturer's recommendations.

(c) Damaged areas not exceeding 25 mm^2 in area or 50 mm in length and cut ends of galvanized reinforcement shall be repaired by applying two coats of metallic zinc-rich priming paint. Sufficient paint shall be applied to provide a zinc coating of at least the same thickness as the galvanized coating.

(d) Repairs to epoxy coatings and galvanized coatings shall be carried out within 8 hours of cutting or damage. Traces of rust shall be removed from the surface of the reinforcement before the repair is carried out.

2.1.6.10 Fixing reinforcement

2.1.6.10.1 Fixing reinforcement

(a) Bar reinforcement, fabric reinforcement and reinforcement connectors for tension joints from each batch shall not be fixed until testing of the batch has been completed.

(b) Reinforcement shall be fixed rigidly in position and secured against displacement.

(c) A sufficient number of intersecting and lapping bars shall be tied using tying wire, tying devices or clips to prevent movement of the reinforcement. The ends of tying wire, tying devices and clips shall not encroach into the cover to reinforcement.

(d) Laps and joints in reinforcement shall be made only at the specified positions and by the specified method.

(e) Sufficient numbers of cover spacers, chairs, supports and spacers other than cover spacers shall be provided to maintain the reinforcement in the correct location and to maintain the specified cover at all positions. Cover spacers, chairs, supports and spacers other than cover spacers shall be placed at a maximum spacing of 1.5 m. Chairs, supports and spacers other than cover spacers shall be positioned adjacent to or above cover spacers and shall have at least the same cover as that specified for the reinforcement.

(f) Prefabricated reinforcement cages shall be adequately supported and braced before lifting.

(g) Reinforcement which is free-standing shall be secured in position and braced to prevent movement due to wind and other loads.

2.1.6.10.2 Reinforcement connectors

(a) Reinforcement connectors shall be fixed in accordance with the manufacturer's recommendations and using equipment recommended by the manufacturer.

2.1.6.10.3 Welding

(a) Reinforcement shall not be welded unless approved by the Engineer.

2.1.6.10.4 Exposed reinforcement

(a) Reinforcement which is to be left exposed shall be protected by coating with cement slurry or by other methods agreed by the Engineer.

2.1.6.10.5 Access over reinforcement

(a) Reinforcement shall not be contaminated or displaced as a result of access over the reinforcement; access shall be obtained by using planks and ladders or by other methods agreed by the Engineer

2.1.6.10.6 Tolerances

Tolerances on cutting and bending reinforcement shall comply with **BS 8666**, Table 2.

The cover to reinforcement shall be within 5 mm of the specified cover.

2.1.6.10.7 Inspection of reinforcement

(a) The Contractor shall allow the Engineer to inspect the completed reinforcement before carrying out any work, including erecting formwork adjacent to reinforcement, which will make access to the reinforcement difficult. The Contractor shall inform the Engineer 24 hours, or such shorter period agreed by the Engineer, before carrying out such work.

2.1.6.11 References and Standards

BS EN ISO 1461 (2009): Hot dipped galvanised coatings on fabricated iron and steel articles. Specifications and test methods.

BS 1052 (1980): Specification for mild steel wire for general engineering purposes.

BS 8666 (2005): Scheduling, dimensioning, bending and cutting of steel reinforcement of concrete. Specification.

BS 4652 (1995:2000): Specification for zinc-rich priming paint (organic media).

BS ISO 14654 (1999): Epoxy-coated steel for the reinforcement of concrete.

BS 4483 (2005): Steel fabric for the reinforcement of concrete. Specification.

BS 4449 (2005+A2:2009): Steel for the reinforcement of concrete. Weldable reinforcing steel. Bar, coil and decoiled product. Specification

ASTM C234-91a (2011): Standard test method for comparing concrete on the basis of bond development with reinforcing steel.

2.1.7 FORMWORK AND FINISHES TO CONCRETE

2.1.7.1 Materials

2.1.7.1.1 Formwork

(a) Formwork shall be timber, metal, plastic or other material which will produce the specified finish. Materials used as formers for profiled formwork, chamfers, splays, rebates and other features shall be such that they produce the same finish as the main formwork.

(b) Plywood for formwork shall have a close, uniform grain and the edges shall be sealed with barrier paint, polyurethane varnish or other impermeable material.

(c) The faces of formwork for Class F4 and F5 finishes shall have a uniform texture and a matt, not a shiny or polished, surface. The edges of the formwork shall be straight and square.

2.1.7.1.2 Formwork Class of finish

(a) The characteristics of each class of finish shall be as stated in Tables 2.1.7.1, Tables 2.1.7.2, and Tables 2.1.7.3.

(b) Formwork of the type stated in Tables 2.1.7.1 will normally produce a concrete surface which complies with the characteristics of finish stated in Tables 2.1.7.1 but other types of formwork may be used to produce the specified finish.

(c) The Class of formed and unformed finish required for different concrete surfaces shall be as stated in Tables 2.1.7.1unless otherwise stated in the Contract. The higher Class of finish shall start at least 150 mm below the finished ground level for concrete surfaces which are partly buried.

2.1.7.1.3 Release agents

(a) Release agents shall be a proprietary type approved by the Engineer. Release agents containing mineral oils shall not be used. Barrier paint, polyurethane varnish, wax or other materials shall not be used instead of a release agent.

(b) Release agents shall be a type which will not stain or colour the concrete and which will not affect the bond between the concrete and subsequent coverings. Release agents other than those which incorporate a surface retarder to produce a Class T1 finish shall be a type which will not affect the hardening of the concrete.

(c) Release agents used on formwork for water retaining structures for potable and fresh water shall be non-toxic and shall not impart a taste to the water.

(d) Release agents used on steel formwork shall contain a rust-inhibiting agent.

(e) Release agents used on formwork for Class F4 and F5 finishes shall be a chemical release agent.

(f) On areas of formwork which in the opinion of the Engineer are likely to be affected by pedestrian traffic, rain or dust, release agents for Class F4 and F5 finishes shall be a type which evaporates to leave a dry film on the formwork, unless protection from such effects is provided.

Tables 2.1.7.**1: Formed finishes**

Class of finish	**Type of formwork normally used**	**Characteristics of finish**			
		Formwork pattern	Abrupt irregularities permitted	Gradual irregularities permitted	Specific requirements
F1	Sawn timber	Not required	< 10 mm	< 15 mm in 2 m	No specific requirements
F2	Plywood	Pattern of formwork joints and tie holes as stated in Clause 2.1.7.4.3 (a) and 2.1.7.4.3 (b)	< 5 mm	< 10 mm in 2 m	Even surface No grout runs
F3			< 3 mm	< 5 mm in 2 m	Even surface No grout runs
F4	Sealed plywood				Uniform, dense and smooth surface No grout runs No grain pattern No crazing No major blemishes
F5			< 2 mm	< 3 mm in 2 m	Uniform, dense and smooth surface No grout runs No grain pattern No crazing No blemishes No staining or discolouration

Table 2.1.7.**2: Unformed finishes**

Class of finish	**Method of producing finish**	**Characteristics of finish**		
		Abrupt irregularities permitted	Gradual irregularities permitted	Specific requirements
U1	Levelling the surface of the compacted concrete with a screed board	Screed marks < 5 mm	< 10 mm in 2 m	No specific requirements
U2	Forming a Class U1 finish and tamping the surface	Tamp marks < 10 mm	Not applicable	Ridged surface
U3	Forming a Class U1 finish and wood floating or power floating the surface	Float marks < 3 mm	< 10 mm in 2 m	Uniform, dense and smooth surface
U4	Forming a Class U3 finish and brushing the surface with a stiff brush	Brush marks < 3 mm	< 10 mm in 2 m	Rough texture
U5	Forming a Class U3 finish and steel trowelling the surface under firm pressure or power floating the surface	Nil	< 5 mm in 2 m	Uniform, dense and smooth surface, free from trowel marks No staining or discolouration

Table 2.1.7**.3: Treated finishes**

Class of finish	**Type of finish**	**Method of producing finish**	**Characteristics of finish**
T1	Exposed Aggregate	Washing and brushing the concrete surface	Cement matrix removed and coarse aggregate exposed to a depth not exceeding one-third of the nominal maximum coarse aggregate size
T2	Point tooled	Point tooling the concrete surface	Cement matrix and aggregate surface removed sufficiently to expose the aggregate with a minimum penetration into the matrix between aggregates
T3	Bush hammered	Bush hammering the concrete surface	Uniform, dense and smooth surface
T4	Broken rib	Hammering or chiselling the edges and faces of the concrete surface	Fragments of concrete ribs removed
T5	Light blasting	Blasting the concrete surface by abrasives and compressed air or by water jetting	Cement matrix removed and coarse aggregate exposed to a minimum depth
T6	Heavy blasting		Cement matrix removed and coarse aggregate exposed to a depth not exceeding one-third of the nominal maximum coarse aggregate size

Table 2.1.7.**4: Class of finish**

Description of surface	**Type**	**Class of finish**	
		Formed	**Unformed**
Surfaces to be covered	screeded	-	U2
	rendered, plastered	F2	-
	Tiled	F2	U3
	painted	F4	U5
Surfaces for treated finishes		F3	U3
Surfaces for pedestrian traffic		-	U4
Construction joints (for Class T1 finish)		F2	U3
Movement joints		F3	U3
Benching, screeds		F3	U5
Blinding, foundations, pile caps		F1	U1
Piers, blocks, pipe surrounds	below FGL	F1	U1
	above FGL	F2	U3
Manholes, chambers	external below FGL	F1	U1
	external above FGL	F2	U3
	internal	F2	U3
Culverts, channels	external below FGL	F1	U1
	external above FGL	F2	U3
	internal	F4	U5
Water retaining structures	external below FGL	F2	U3
	external above FGL	F4	U5
	internal	F4	U5
Buildings	external below FGL	F1	U1
	external above FGL	F2	U3
	internal	F4	U5
Bridges, retaining walls, walls	below FGL	F1	U1
	above FGL, not exposed to direct public view	F4	U5
	above FGL, exposed to direct public view	F5	U5
	internal,not exposed to direct public view	F2	U1

2.1.7.1.4 Formwork ties

(a) Formwork ties and components shall be a type such that any removable part can be removed without damaging the concrete; any part left in the concrete shall be at least 40 mm or the specified nominal cover to the reinforcement, whichever is greater, from the concrete surface.

(b) Unless otherwise permitted by the Engineer, formwork ties and components used with profiled formwork shall be a type such that holes left by the ties and components are small enough to be located completely within the recesses in the concrete surface.

2.1.7.1.5 Cement mortar for concrete surfaces

(a) Cement mortar for filling blowholes shall consist of cement and fine aggregate together with the minimum amount of water necessary to achieve a consistency suitable for completely filling the blowholes.

(b) Cement mortar for filling holes left by formwork ties and components shall consist of 1 part of cement to 3 parts of fine aggregate together with the minimum amount of water

necessary to achieve a consistency suitable for compacting the mortar into the holes; the mix shall contain a non-shrink admixture.

(c) Cement mortar for filling blowholes and holes left by formwork ties and components in concrete surfaces with Class F4 and F5 finishes shall be the same colour as the hardened concrete; light-coloured sand or white cement may be used for this purpose.

2.1.7.1.6 Surface retarders and abrasives

(a) Surface retarders shall be a proprietary type approved by the Engineer and shall be a type which will not stain or colour the concrete.

(b) Abrasives for blasting shall be grit or other materials approved by the Engineer and shall not contain any iron, clay or other materials which will stain or colour the concrete.

2.1.7.2 Trial panels

2.1.7.2.1 Trial panels

(a) A trial panel shall be constructed for each Class F4, F5, U5 and T finish to demonstrate that the proposed materials, mix design, methods of production and methods of construction, including curing and removal of formwork, will produce the specified finish.

(b) Trial panels for Class F4 and F5 finishes shall be constructed before the relevant formwork for the permanent work is erected, and trial panels for Class U5 and T finishes shall be constructed before the relevant permanent work is concreted. The trial panels shall be constructed at least 4 weeks before the relevant permanent work is carried out.

(c) The Contractor shall inform the Engineer at least 24 hours, or such shorter period agreed by the Engineer, before constructing trial panels.

(d) Trial panels shall be constructed using the materials, mix design, methods of production and methods of construction, including curing and removal of formwork, submitted to the Engineer

(e) Trial panels shall be horizontal, vertical or inclined as appropriate and shall be constructed at locations agreed by the Engineer. Unless otherwise stated in the Contract each trial panel shall be not less than 2 m by 2 m by 300 mm thick, and shall contain reinforcement representative of the most congested reinforcement which will be used in the permanent work.

(f) Trial panels shall incorporate formwork ties and components, horizontal joints, vertical joints, chamfers, splays, rebates and other features representative of those which will be used in the permanent work.

(g) Trial panels shall be protected from damage and shall be left in position until the Engineer instructs their removal.

(h) If in the opinion of the Engineer the specified finish has not been produced in the trial panel, particulars of proposed changes to the materials, mix design, methods of production or methods of construction shall be submitted to the Engineer; further trial panels shall be constructed until the specified finish is produced in the trial panel. Further trial mixes shall be made unless in the opinion of the Engineer non-compliance of the trial panel was not due to the concrete mix.

(i) Formwork for Class F4 and F5 finishes shall not be erected and elements with Class U5 and T finishes shall not be concreted until in the opinion of the Engineer the specified finish has been produced in the trial panel.

(j) Unless permitted by the Engineer, the materials, mix design, methods of production or methods of construction, including curing and removal of formwork, used to produce the specified finish in trial panels shall not be changed.

2.1.7.3 Storage of materials

2.1.7.3.1 Storage of formwork

(a) Formwork shall be stored off the ground on level supports and in a manner which will not result in damage or deformation to the formwork or in contamination of the formwork.

(b) Formwork for Class F4 and F5 finishes shall be covered and protected from exposure to conditions which may affect the formwork.

2.1.7.3.2 Storage of release agents and surface retarders

(a) Release agents and surface retarders shall be stored in sealed containers marked to identify the contents and protected from exposure to conditions which may affect the material. The materials shall be stored in accordance with the manufacturers' recommendations and shall not be used after the recommended shelf life has been exceeded.

2.1.7.4 Design and construction of falsework and formwork

2.1.7.4.1 Design and construction of falsework and formwork

(a) Falsework and formwork shall be designed and constructed to maintain the position and shape of the formwork such that the hardened concrete surface complies with the characteristics of finish stated in Tables 2.1.7.1 and with any more stringent tolerances stated in the Contract; allowance shall be made for cambers.

(b) Falsework and formwork shall be capable of being dismantled and removed without shock, disturbance, damage or loading to the concrete and in such a manner that the specified requirements for removing or leaving in position side formwork, soffit formwork and props will be achieved without disturbing other formwork or props.

(c) Formwork shall be used to form the top surface of concrete inclined at a slope exceeding 15^{o} to the horizontal unless it can be demonstrated that the specified finish will be produced without the use of formwork.

2.1.7.4.2 Construction of formwork

(a) Formwork to top surfaces shall be anchored to prevent flotation.

(b) Formwork shall not have any splits, cracks or other defects. The faces and edges of formwork shall be clean and formwork faces shall be free of projecting nails.

(c) Formwork which has been previously used shall be repaired and the edges resealed before it is erected. Formwork which in the opinion of the Engineer has deteriorated to an extent such that it will not produce the specified finish shall not be used for that Class or a higher Class of finish.

(d) Formwork shall be firmly supported and individual panels shall be rigid. Joints between formwork panels, stop ends and adjoining concrete shall be tight and shall not permit grout loss. Gaps shall be sealed with gaskets, filler, sealant or tape before the application of release agents.

(e) Formwork shall be cut in such a manner that reinforcement and built-in components passing through the formwork are maintained in position; the joints shall be tight and shall not permit grout loss.

(f) Formers for profiled formwork, chamfers, splays, rebates and other features shall be rigidly and evenly fixed to the formwork along the complete length and shall not permit grout loss.

(g) Formwork ties and components shall be fixed in such a manner that they do not touch reinforcement or built-in components. Formwork ties and components shall fit tightly against formwork faces and shall not permit grout loss.

(h) If required for cleaning or inspection, temporary openings shall be provided in the formwork. Formwork panels for Class F2, F3, F4 and F5 finishes shall be the same size and shall form a regular pattern approved by the Engineer. The lines of joints between panels shall be straight and continuous, horizontal and vertical, or inclined to suit the pattern of profiled formwork, and shall be coincident with construction joints and other joints and with recesses in the concrete surface. The number of make-up pieces shall be kept to a minimum.

2.1.7.4.3 Construction of formwork for Class F2, F3, F4 and F5 finishes

(a) Holes left by formwork ties and components in concrete surfaces with Class F2, F3, F4 and F5 finishes shall be in line horizontally and vertically and shall form a regular pattern approved by the Engineer. Unless otherwise permitted by the Engineer, holes in profiled formwork shall be located in such a manner that the holes are completely within recesses in the concrete surface.

(b) Unless otherwise stated in the Contract or permitted by the Engineer, chamfers shall be provided for all external angles of 90° or less in concrete surfaces with Class F2, F3, F4 and F5 finishes.

(c) Formwork for curved concrete surfaces with Class F2, F3, F4 and F5 finishes shall not be made up of a series of flats unless permitted by the Engineer.

2.1.7.4.4 Construction of formwork for Class F4 and F5 finishes

(a) Each type of formwork for Class F4 and F5 finishes shall be obtained from one source and different types of formwork shall not be mixed unless permitted by the Engineer. Damaged formwork shall not be used unless permitted by the Engineer. Parts of steel formwork which will be in contact with concrete shall be free from rust.

(b) For concrete surfaces with Class F4 and F5 finishes, joints between formwork panels shall be sealed with foamed rubber strips. The foamed rubber strips shall be sufficiently compressible to form a grout-tight joint. The width of the resulting gap between the panels shall not be greater than 1mm and the sealing strips shall not protrude proud of the surface of the formwork panels. Alternatively, subject to the approval of the Engineer, joints between formwork panels may be sealed with an approved filler provided the butting

edges of the panels are smooth and the resulting gap between the panels is not wider than 1 mm. Joints between formwork panels shall not be sealed by tape fixed to the formwork faces.

(c) Formwork for Class F4 and F5 finishes shall be protected from spillages, rust marks and stains.

2.1.7.4.5 Built-in components

(a) Built-in components, void formers and box-outs shall be fixed in position before concreting. Unless permitted by the Engineer, void formers and box-outs shall not be used instead of built-in components. Polystyrene shall not be used for void formers and box-outs unless permitted by the Engineer.

2.1.7.5 Application of release agent

2.1.7.5.1 Application of release agents

(a) A release agent shall be used on all formwork other than permanent formwork and formwork on which a surface retarder is used to produce a Class T1 finish. The release agent shall be applied by the method and at the rate of application recommended by the manufacturer or as demonstrated to be satisfactory by use in the trial panel.

(b) Formwork faces shall be cleaned before release agents are applied. Concrete, reinforcement and built-in components shall not be contaminated by release agents.

(c) Each type of release agent used on formwork for Class F4 and F5 finishes shall be obtained from one manufacturer and different types of release agent shall not be used on formwork for the same element.

(d) Release agents shall be applied to formwork for Class F4 and F5 finishes after the formwork has been erected and before the reinforcement is fixed or, if this is not practicable, immediately before the formwork is erected. The release agent covering shall be complete and uniform.

2.1.7.6 Inspection of formwork and reinforcement

2.1.7.6.1 Inspection of formwork and reinforcement

(a) The Contractor shall allow the Engineer to inspect the completed formwork and reinforcement, including trial panels, before carrying out any work, including fixing reinforcement adjacent to formwork and erecting formwork adjacent to reinforcement, which will make access to the formwork faces or reinforcement difficult. The Contractor shall inform the Engineer 24 hours, or such shorter period agreed by the Engineer, before carrying out such work.

(b) The Contractor shall allow the Engineer to inspect formwork for Class F4 and F5 finishes before it is erected and shall inform the Engineer 24 hours, or such shorter period agreed by the Engineer, before erecting the formwork.

2.1.7.7 Removal of falsework and formwork

2.1.7.7.1 Times for removal of falsework and formwork

(a) Except as stated in Clause 2.1.7.7.1(c), falsework and formwork shall not be loosened or removed before the minimum times stated in Table 2.1.6.5 have elapsed. The times stated are for a minimum ambient temperature of 15°C, for elements without superimposed loads and for concrete containing OPC, PPFAC or both OPC and PFA not exceeding the OPC replacement level as specified in Clause 16.14. If other conditions apply, particulars of proposed changes to the minimum times shall be submitted to the Engineer for approval.

(b) For the purpose of determining the minimum times for loosening or removing falsework and formwork, copings at the top of columns in water retaining structures shall be classified as slabs and roof slabs in water retaining structures shall be classified as beams.

(c) Falsework and formwork supporting concrete in flexure may be loosened or removed when the strength of the concrete in that element is 10 MPa or twice the stress to which it will be subjected, whichever is greater, provided that deflection which in the opinion of the Engineer is unacceptable will not result and that superimposed loads will not be applied. The strength of the concrete shall be determined from tests on test cubes which have been made with concrete from the same pour and which have been cured by the same method and under similar conditions as the concrete in the element.

Table 2.1.7**.5: Minimum times for loosening or removing falsework and formwork**

Type of falsework or Class F1, F2, F3 and F4 finishes formwork	**Class F1, F2, F3 and F4 finishes**		**Class F5 finish**
	Concrete without PFA	**Concrete with PFA**	**Concrete with or without PFA**
Vertical (non-profiled) (profiled)	12 hours 7 da	15 hours 7 days	48 hours 7 days
Inclined to top surfaces	12 hours	15 hours	48 hours
Soffits of slabs (props left in)	4 days	4 days	10 days
Soffits of beams (props left in)	7 days	7 days	14 days
Props to slabs	10 days	10 days	10 days
Props to beams	14 days	14 days	14 days

2.1.7.7.2 Removal of falsework and formwork

(a) Formwork shall be removed without hammering or levering to the concrete and in such a manner that there is no shock, disturbance, damage or loading to the concrete. Side formwork shall be removed without disturbing soffit formwork and soffit formwork shall be removed without disturbing props except as provided for in Clause 2.1.7.7.2 (b).

(b) Individual props may be removed to allow the removal of soffit formwork provided that the formwork has been designed accordingly and that each prop is replaced as soon as the

formwork has been removed.

(c) Falsework and formwork for Class F5 finishes shall be loosened and removed in a continuous operation and in accordance with a consistent programme agreed by the Engineer. All formwork shall be loosened before individual panels are removed and all formwork shall be removed within the programmed period. Individual panels or make-up pieces shall not be left in position.

(d) After removal, formwork which is intended for re-use shall be cleaned and stored as stated in Clause 2.1.7.3.1.

2.1.7.8 Unformed finishes

2.1.7.8.1 Unformed finishes

(a) Unformed finishes shall be produced by the methods stated in Table 2.1.7.2.

(b) Brushing to produce a Class U4 finish shall be carried out in straight lines in a direction agreed by the Engineer; brushing shall be carried out when the concrete has hardened sufficiently for the float marks to be removed and for the ridges to be formed without displacing the aggregate.

(c) Floating and trowelling shall not be carried out until the concrete has hardened sufficiently to allow the specified finish to be produced with the minimum amount of floating and trowelling such that excess laitance is not produced.

2.1.7.9 Treated finishes

2.1.7.9.1 Treated finishes

(a) Treated finishes shall be produced by constructing a concrete surface with a Class F3 or U3 finish as appropriate and applying the treatment to the surface by the methods stated in Table 2.1.7.3.

(b) The treatment shall be applied in a continuous operation in accordance with a consistent programme agreed by the Engineer.

(c) Washing and brushing to produce a Class T1 finish shall not be carried out until the concrete has hardened sufficiently for the cement matrix to be removed without disturbing the coarse aggregate. After washing and brushing have been completed and the concrete surface has hardened, the surface shall be cleaned.

(d) The cement matrix shall not be removed or the aggregate exposed by mechanical methods unless permitted by the Engineer.

(e) Class T1 finishes may be produced by using a surface retarder applied to the formwork or to the concrete surface. The surface retarder shall be applied by the method and at the rate of application recommended by the manufacturer, or as demonstrated to be satisfactory by use on the trial panel.

(f) Plywood to which a surface retarder is to be applied shall be sealed with barrier paint, polyurethane varnish or other impermeable material agreed by the Engineer. The

formwork shall be removed in small sections and the coarse aggregate exposed by washing and brushing the concrete surface.

(g) Unless permitted by the Engineer, formwork to which a surface retarder has been applied shall not be re-used unless a surface retarder is to be used again on the formwork. Formwork to which a surface retarder has been applied and which is to be re-used shall be cleaned before the retarder is applied.

(h) Point tooling to produce Class T2 finishes and bush hammering to produce Class T3 finishes shall be carried out evenly in small areas and not in distinct lines. Tooling and hammering shall not start until at least 7 days after concreting.

(i) Hammering or chiselling to produce a Class T4 finish shall be applied from only one direction, and only either hammering or chiselling shall be applied, on any one face. Hammering and chiselling shall not start until at least 14 days after concreting.

(j) Blasting to produce Class T5 and T6 finishes shall not be carried out until the concrete has hardened sufficiently for the cement matrix to be removed without disturbing the coarse aggregate. Adjacent surfaces shall be protected from blasting and dust shall be controlled by screens and by water-spraying.

2.1.7.10 Compliance of finishes

2.1.7.10.1 Inspection of finishes

(a) Before any subsequent work is carried out on a concrete surface, the surface shall be inspected by the Engineer to determine if the specified finish has been produced. Formed finishes shall be inspected as soon as the formwork has been removed.

(b) Blowholes or holes left by formwork ties and components shall not be filled and spatterdash or other coverings shall not be applied before the inspection; any such filling or covering carried out before the inspection may be rejected.

2.1.7.10.2 Compliance of finishes

(a) Concrete surfaces shall have the characteristics stated in Table 2.1.7.1 and Table 2.1.7.2 for the different Classes of formed and unformed finish before any subsequent work is carried out on the concrete surface and shall have the characteristics stated in Table 2.1.7.3 for the different Classes of treated finish.

(b) The Engineer shall determine if the specified finish has been produced and may use the trial panels as a means of comparison.

(c) Abrupt irregularities shall be measured by direct measurement. Gradual irregularities shall be measured using a 2 m long straight edge on surfaces intended to be flat and by a method agreed by the Engineer on other surfaces.

2.1.7.11 Work on concrete surfaces

2.1.7.11.1 Remedial and repair work on concrete surfaces

(a) Remedial or repair work shall not be carried out on concrete surfaces unless permitted by

the Engineer; any such work carried out without permission may be rejected.

2.1.7.11.2 Filling blowholes and formwork tie holes

(a) Blowholes exceeding 3 mm in size in water retaining structures and water tight structures, and blowholes exceeding 10 mm in size in other structures shall be filled with cement mortar. The size of blowholes shall be the maximum dimension measured across the hole on the concrete surface.

(b) If the number and size of blowholes in concrete surfaces with Class F3, F4 and F5 finishes is in the opinion of the Engineer greater than in the trial panel the blowholes shall be filled, unless in the opinion of the Engineer filling is not required.

(c) Holes left by formwork ties and components shall be cleaned and filled by ramming cement mortar into the holes in layers. Holes in concrete surfaces with a Class F5 finish shall be filled to a level slightly below the concrete surface; the holes shall not be overfilled and rubbed down.

(d) Filling of blowholes and holes left by formwork ties and components shall be carried out as soon as practicable after the Engineer has inspected the finish and with the minimum interruption to curing.

2.1.7.11.3 Spatterdash

(a) Spatterdash shall consist of cement and coarse sand or granite fines in the proportions 1:2 by volume mixed with the minimum amount of water necessary to achieve the consistency of a thick slurry. Spatterdash shall be thrown with a hand trowel onto the surface to a thickness not exceeding 6 mm and shall cover at least 60% of the area which is to be plastered or rendered. Spatterdash shall be wetted one hour after application and shall be allowed to cure and harden before under coats are applied.

(b) Spatterdash shall be applied as soon as practicable after the Engineer has inspected the finish and after the concrete surface has been cleaned and wetted.

2.1.7.12 Protection of finishes

2.1.7.12.1 Protection of finishes

(a) Materials, Constructional Plant or other vehicles shall not use or be placed on or against concrete surfaces unless permitted by the Engineer.

(b) Concrete surfaces with Class F4, F5, U5 and T finishes shall be protected from running water, spillages, rust-marks and stains by covering the surface with polyethylene sheeting or timber or by other methods agreed by the Engineer. Protection from rust-marks caused by reinforcement bars shall be by polyethylene sleeves tied to the bars or by coating the bars with cement slurry; the bars shall not be coated with oil or grease.

(c) Concrete surfaces with Class F4, F5, U5 and T finishes shall be protected from damage by securing timber battens to the surface, by erecting barriers or fences or by other methods agreed by the Engineer.

(d) Concrete surfaces with a Class F5 finish shall be protected from exposure to extreme variations in weather conditions for at least 14 days after the formwork has been removed.

2.1.8 CONCRETE WORK

2.1.8.1 General

2.1.8.1.1 Designation of concrete mixes

(a) Designed mix concrete shall be designated by the grade strength in MPa followed by the nominal maximum aggregate size in mm and the suffix D.

(b) Standard mix concrete shall be designated by the grade strength in MPa followed by the nominal maximum aggregate size in mm and the suffix S.

(c) Designed mix concrete or standard mix concrete of the same grade strength but with different constituents, work abilities or other properties shall be designated as such by the addition of a suitable description. If the grade of concrete is designated by one number only, the number shall be the grade strength in MPa.

2.1.8.2 Materials

2.1.8.2.1 Cement

(a) Cement shall comply with the following:

Ordinary and rapid hardening Portland cement: **BS EN 197-1:2011**

Sulphate resisting Portland cement : **BS 4027**

Portland pulverised-fuel ash cement : **BS EN 197-1:2011**

(b) The PFA content of PPFAC shall be 25% ± 3% by mass of the PPFAC.

(c) PFA shall comply with **BS 3892**: Part 1 except that the criterion for maximum water requirement shall not apply.

2.1.8.2.2 Aggregates

(a) Aggregates shall be obtained from a source approved by the Engineer.

(b) Fine aggregate shall be clean, hard, durable crushed rock, or natural sand, complying with **BS 12620**.

(c) Coarse aggregate shall be clean, hard, durable crushed rock complying with **BS EN 12620**. The ten percent fines values shall be at least 100 N. The water absorption shall not exceed 0.8%. The flakiness index shall not exceed 35%.

2.1.8.2.3 Water

(a) Water for concrete and for curing concrete shall be clean fresh water taken from the public supply.

2.1.8.2.4 Admixtures

(a) Admixtures shall comply with the following:

Pigments for Portland cement and Portland cement products	:	**BS EN 12878**
Accelerating admixtures, retarding admixtures and water-reducing admixtures	:	**BS EN 480**
Super plasticising admixtures	:	**BS EN 480**

(b) The chloride ion content of admixtures for concrete containing embedded metal or for concrete made with SRPC shall not exceed 2% by mass of the admixture or 0.03% by mass of the cementitious content, whichever is less.

2.1.8.2.5 Curing compound

(a) Curing compound shall be a proprietary type approved by the Engineer and shall have an efficiency index of at least 80%.

(b) Curing compound shall contain a fugitive dye. Curing compounds containing organic solvents shall not be used. The curing compound shall become stable and achieve the specified resistance to evaporation of water from the concrete surface within 60 minutes after application. Curing compound shall not react chemically with the concrete to be cured and shall not crack, peel or disintegrate within one week after application. Curing compound shall degrade completely within three weeks after application.

(c) Curing compound for use on concrete surfaces against which potable or fresh water will be stored or conveyed shall be non-toxic and shall not impart a taste to the water.

2.1.8.3 Concrete

2.1.8.3.1 Concrete mix

(a) Concrete shall be a designed mix unless the Engineer permits the use of a standard mix. Designed mixes shall be designed by the Contractor.

(b) Unless otherwise permitted by the Engineer, the minimum design slump value for designed mix concrete for reinforced elements, after the addition of superplasticiser if used, shall be 75 mm. Should the Contractor wish to use designed mix concrete with a design slump value less than 75 mm in reinforced elements, the Engineer may require the Contractor to demonstrate that such concrete can be satisfactorily placed and compacted in trial sections simulating the appropriate sections of the Works.

i. Cement, PFA, aggregates, water and admixtures for concrete shall comply with Clauses 2.1.8.2.1 to 2.1.8.2.4. All-in aggregate shall not be used.

ii. SRPC shall only be used if stated in the Contract. PFA shall not be used with SRPC.

iii. PFA shall not be used in addition to PPFAC.

2.1.8.3.2 Standard mix

(a) Standard mix concrete shall comply with the following requirements:

i. Cement shall be OPC or PPFAC.

ii. The total mass of dry aggregate to be used with 100 kg of OPC or with 110 kg of PPFAC shall be as stated in Table 2.1.8.1

iii. The percentage by mass of fine aggregate to total aggregate shall be as stated in Table 2.1.8.2.

iv. Admixtures other than water-reducing admixtures shall not be used unless permitted by the Engineer.

Table 2.1.8**.1: Mass of total aggregate for standard mix concrete**

Grade strength (MPa)	Nominal maximum aggregate size (mm)	40	20	10
	Slump value (mm)	85-170	75-150	65-130
10	Mass of total aggregate (kg)	800	690	-
20		550	500	400
25		490	440	360
30		440	380	300

Table 2.1.8**.2.: Percentage by mass of fine aggregate to total aggregate for standard mix concrete**

Grade strength (MPa)		Nominal maximum aggregate size (mm)	40	20	10
10	C, M or F	Percentage by mass of fine aggregate to total aggregate	30 - 45	35 - 50	-
20, 25 or 30	C		30 - 40	35 - 45	45 - 55
	M		25 - 35	30 - 40	40 - 50

		(%)			
	F		25 - 30	25 - 35	35 - 45

2.1.8.3.3 No fines concrete

(a) No-fines concrete shall comply with the following requirements:

i. Cement shall be OPC or PPFAC.

ii. The nominal maximum aggregate size shall be 20 mm; not more than 15% by mass shall be retained on a 20 mm BS test sieve and not more than 10% by mass shall pass a 10 mm BS test sieve.

iii. The aggregate: cement ratio by mass shall be at least 10 and shall not exceed 15.

iv. The cementitious content shall be such that each particle of aggregate is coated with cement paste but the compacted concrete has an open texture which permits the flow of water through the hardened concrete.

2.1.8.4 Submissions

2.1.8.4.1 Particulars of materials for concrete

(a) The following particulars of the proposed cement, PFA and aggregates shall be submitted to the Engineer:

i. a certificate not older than 6 months for each type of cement showing the manufacturer's name, the date and place of manufacture and showing that the cement complies with the requirements stated in the Contract and including results of tests for:- chemical composition
   - fineness
   - compressive strength at 3, 7 and 28 days
   - initial and final setting times
   - soundness
   - proportion by mass of PFA contained in PPFAC.

ii. a certificate not older than 6 months for PFA showing the source of the PFA and showing that the PFA complies with the requirements stated in the Contract and including results of tests for:
   - chemical composition
   - fineness
   - moisture content, and

iii. a certificate not older than 6 months for each nominal maximum aggregate size showing the source of the aggregate and showing that the aggregate complies with the requirements stated in the Contract and including results of tests for:
   - grading
   - silt content
   - chloride content
   - flakiness index of coarse aggregate.
   - ten percent fines value
   - water absorption

(b) The following particulars of the proposed admixtures shall be submitted to the Engineer:

i. manufacturers'

ii. description of physical state, colour and composition,
iii. recommended storage conditions and shelf life,
iv. method of adding to the concrete mix,
v. any known incompatibility with other admixtures or cement,
vi. dosage,
vii. effects of under-dosage and over-dosage, and
viii. a certificate not older than 6 months for each type of admixture showing the manufacturer's name, the date and place of manufacture and showing that the admixture complies with the requirements stated in the Contract and including results of tests for:
- uniformity
- chloride content.

(c) The following particulars of the proposed curing compound shall be:

i. submitted to the Engineer:
ii. manufacturer's
iii. description of physical state, colour and composition,
iv. recommended storage conditions and shelf life,
v. method of application,
vi. rate of application, and
vii. a certificate showing the manufacturer's name, the date and place of manufacture and showing that the curing compound complies with the requirements stated in the Contract and including results of tests for efficiency index.

2.1.8.4.2 Particulars of concrete mix

(a) The following particulars of each proposed designed concrete mix shall be submitted to the Engineer:

i. quantity of each constituent per batch and per cubic metre of compacted concrete, with required tolerances on quantities of aggregates to allow for minor variations in grading, silt content etc. The maximum permitted variation in the quantity of fine aggregate shall be ± 20 kg of fine aggregate per 100 kg of cement.

ii. grading of coarse and fine aggregates,

iii. workability after the addition of superplasticisers, in terms of designed slump value or designed flow value,

iv. method of placing concrete,

v. method of controlling the temperature of the concrete, if required,

vi. test or trial mix data for designed mix concrete of the same grade and with similar constituents and properties, if available, and

vii. test data for designed mix concrete of the same or other grade produced in the plant or plants proposed to be used, if available.

(b) The particulars shall be submitted to the Engineer for information at least 7 days before trial mixes are made or, if trial mixes are not required, at least 7 days before the mix is placed in the permanent work.

2.1.8.4.3 Particulars of ready- mixed concrete supplier

(a) The name of the suppliers and the location of each plant, including a back- up plant, from which the Contractor proposes to obtain ready-mixed concrete shall be submitted to the

Engineer at least 14 days before trial mixes are made or, if trial mixes are not required, at least 14 days before the ready-mixed concrete is placed in the permanent work.

2.1.8.4.4 Particulars of batching and mixing plant

(a) Particulars of the proposed batching and mixing plant to be used on the Site, including a layout plan and the output of the plant, shall be submitted to the Engineer at least 7 days before the plant is delivered to the Site.

2.1.8.4.5 Particulars of precast concrete units

(a) The following particulars of the proposed precast concrete units shall be submitted to the Engineer:

ii. details of precasting yards,

iii. a certificate showing the manufacturer's name, the date and place of manufacture, the identification numbers of the precast concrete units and including results of tests for:

- compressive strength of concrete cubes at 28 days
- routine tests, including loading tests, carried out at the precasting yards,

iv. details of lifting points and methods of handling, and

v. procedure for testing precast units.

(b) The particulars, other than certificates, shall be submitted to the Engineer at least 14 days before the first delivery of the precast concrete units to the Site. The certificates shall be submitted for each batch of precast concrete units delivered to the Site.

2.1.8.4.6 Particulars of construction joints

(a) Particulars of the proposed positions and details of construction joints in concrete which are not stated in the Contract shall be submitted to the Engineer for approval at least 14 days before the relevant elements are concreted.

2.1.8.5 Trials

2.1.8.5.1 Trial mix concrete

(a) Trial mixes are not required for designed mix concrete of Grade 20 and below, or for standard mix concrete.

(b) If test data for designed mix concrete of the proposed grade and with similar constituents and properties and produced in the plant or plants proposed to be used are submitted in accordance with Clause 2.1.8.4.2, and are acceptable to the Engineer, no trials for that designed mix will be required.

(c) If test data for designed mix concrete of the proposed grade and with similar constituents and properties produced in plant other than that proposed to be used are submitted in accordance with Clause 2.1.8.4.2, and are acceptable to the Engineer, the Engineer may require Plant Trials to be carried out in accordance with Clause 2.1.8.5.2.

(d) If test data for designed mix concrete produced in the plant or plants proposed to be used,

but of a grade or with constituents and properties other than those proposed, are submitted in accordance with Clause 2.1.8.4.2, and are acceptable to the Engineer, the Engineer may require Laboratory Mix Trials to be carried out in accordance with Clause 2.1.8.5.3

(e) If no test data for designed mix concrete are submitted or if test data submitted in accordance with Clause 2.1.8.4.2, do not in the opinion of the Engineer demonstrate the suitability of the proposed plant and mix design, the Engineer may require both Plant Trials and Laboratory Mix Trials in accordance with Clause 2.1.8.5.2and Clause 2.1.8.5.3 respectively.

(f) Plant Trials and Laboratory Mix Trials shall be completed at least 35 days before the concrete mix is placed in the permanent work.

(g) The Contractor shall inform the Engineer at least 24 hours before conducting Plant Trials or Laboratory Mix Trials.

2.1.8.5.2 Plant Trials

(a) Plant Trials shall be made using the plant or plants proposed and the mix designs and constituents submitted to the Engineer.

(b) One batch of concrete of a proposed designed mix shall be made on each of three days in each plant proposed to be used. The batch shall be at least 60% of the mixer's nominal capacity. If the concrete is batched in a central plant and mixed in a truck mixer, three different truck mixers shall be used.

(c) Three samples of concrete shall be provided from each batch at approximately $^1/_6$, $^1/_2$ and $^5/_6$ of the discharge from the mixer. Each sample shall be of sufficient size to perform a slump test or a flow table test, and make two 150mm test cubes.

(d) Each sample taken in accordance with the above Clause shall be tested to determine its slump value or its flow value.

(e) Two 150 mm test cubes shall be made from each sample taken in accordance with the above Clause and stored, cured and tested to determine the compressive strength at 28 days.

2.1.8.5.3 Laboratory Mix Trials

(a) Laboratory Mix Trials shall be made in the Contractor's laboratory using the mix designs and constituents submitted to the Engineer.

(b) Three separate batches shall be made, each of sufficient size to provide samples for two slump tests or two flow table tests, and to make six 150mm test cubes.

(c) Two slump tests or two flow table tests shall be performed on separate specimens from each batch of Laboratory Trial Mix concrete.

(d) Six 150 mm test cubes shall be made from each batch of Laboratory Trial Mix concrete, stored, cured and tested for compressive strength at 28 days.

2.1.8.5.4 Compliance criteria plant trials

(a) The results of tests on concrete taken from Plant Trials in accordance with Clause 2.1.8.5.2

and shall comply with the following requirements:

i. The average of the nine slump values shall be within 20mm or 25%, whichever is the greater, of the designed slump value. The average of the nine flow values shall be within +/- 35mm of the designed flow value.

ii. The range of the three slump values for each batch of concrete shall not exceed 20% of the average of the three slump values for that batch. For flow table tests, the range of the three flow values for each batch of concrete shall be within 70mm.

iii. The average compressive strength at 28 days of the 18 test cubes shall exceed the Grade strength by at least 10 MPa and the compressive strength of each individual test cube shall exceed the Grade strength by at least 4 MPa.

iv. The range of the compressive strength of the six test cubes from each batch of concrete shall not exceed 20% of the average compressive strength of the six test cubes from that batch.

2.1.8.5.5 Compliance criteria: Laboratory Mix Trials

(a) When test data relating to the proposed plant or plants submitted in accordance with Clause 2.1.8.4.2 show that the plant standard deviation exceeds 5 MPa, or in the absence of acceptable data, the results of tests on Laboratory Mix Trial concrete shall comply with the following requirements:

i. The average of the six slump values shall be within 20mm or 25%, whichever is the greater, of the designed slump value. The average of the six flow values shall be within +/- 35mm of the designed flow value.

ii. The average compressive strength at 28 days of the 18 test cubes shall exceed the Grade strength by at least 12 MPa and the compressive strength of each individual test cube shall exceed the Grade strength by at least 6 MPa.

(b) When test data relating to the proposed plant or plants submitted in accordance with Clause 2.1.8.4.2 show that the plant standard deviation does not exceed 5 MPa and the data are acceptable to the Engineer, the results of tests on Laboratory Mix Trial concrete shall comply with the following requirements:

i. The average of the six slump values shall be within 20 mm or 25%, whichever is the greater, of the designed slump value. The average of the six flow values shall be within +/- 35mm of the designed flow value.

ii. The average compressive strength at 28 days of the 18 test cubes shall exceed the Grade strength by at least 8 MPa and the compressive strength of each individual test cube shall exceed the Grade strength by at least 2 MPa.

2.1.8.5.6 Non-compliance: trial mix concrete

(a) If the result of any test for workability or compressive strength of laboratory mix trial and plant trial concrete does not comply with the specified requirements for the property, particulars of proposed changes to the materials, mix design or methods of production shall be submitted to the Engineer; further laboratory mix trials or plant trials shall be made until the result of every test complies with the specified requirements for workability and compressive strength of laboratory mix trial and plant trial concrete.

(b) If trial lengths or trial panels are constructed using the non-complying trial mix, further trial lengths or trial panels shall be constructed unless in the opinion of the Engineer the

changes to the materials, mix design or methods of production will not affect the results of the previous trial lengths or trial panels.

2.1.8.5.7 Approved concrete mix

(a) A concrete mix which complies with the specified requirements for laboratory mix trials, plant trials and for trial lengths or trial panels shall become an approved concrete mix. The designed slump value or designed flow value used to produce an approved concrete mix shall become the approved slump value or approved flow value.

(b) If laboratory mix trials or plant trials are not required, a concrete mix submitted as stated in Clause 2.1.8.4.2 and which complies with the specified requirements for trial lengths or trial panels shall become an approved concrete mix. The designed slump value or designed flow value of the concrete mix shall become the approved slump value or approved flow value.

2.1.8.5.8 Commencement of concreting

(a) Concrete shall not be placed in the permanent work until the concrete mix has been approved by the Engineer.

2.1.8.6 Handling and storage materials

(a) Cement in bags shall be stored in a dry, weatherproof store sheltered on the top and 3 sides with a raised floor. Each delivery shall be identified and kept separate and shall be used in the order of delivery.

(b) Bulk cement and PFA shall be kept dry. Cement and PFA of different types and from different sources shall be stored in separate silos clearly marked to identify the different contents of each.

(c) Aggregates shall not be handled or stored in a manner which will result in mixing of the different types and sizes or in segregation or contamination of the aggregates.

(d) Different types and sizes of aggregates shall be stored in separate hoppers or in separate stockpiles. The stockpiles shall have well drained concrete floors and shall have dividing walls of sufficient height to keep the different aggregates separate.

(e) Admixtures and curing compounds shall be stored in sealed containers marked to identify the contents and protected from exposure to conditions which may affect the material. The materials shall be stored in accordance with the manufacturers' recommendations and shall not be used after the recommended shelf life has been exceeded.

(f) The identification number, date of casting and lifting points shall be marked on precast concrete units in a manner agreed by the Engineer.

(g) Precast concrete units shall be lifted and supported only at the designed lifting points and shall not be subjected to rough handling, shock loading or dropping.

(h) Precast concrete units shall be stored off the ground on level supports and in a manner which will not result in damage or deformation to the units or in contamination of the units. Precast concrete units shall be protected from damage and damaged units shall not be used in the permanent work unless permitted by the Engineer.

2.1.8.7 Batching and mixing concrete

2.1.8.7.1 Batching concrete

(a) Measuring and weighing equipment for batching concrete shall be maintained in a clean, serviceable condition. The equipment shall be zeroed daily and calibrated when the equipment is set up on the Site and at a frequency of at least once per month. The accuracy of the measuring equipment shall be within 3% of the quantity of cementitious materials, total aggregates or water being measured and within 5% of the quantity of admixtures being measured.

(b) The quantities of cement, PFA and fine and coarse aggregate shall be measured by mass except that cement supplied in bags may be measured by using a whole number of bags in each batch. The mass of aggregates shall be adjusted to allow for the free moisture content of the aggregates.

(c) Separate weighing equipment shall be used for cementitious material and aggregates.

(d) The quantity of water shall be adjusted for the free moisture content of the aggregates and shall be measured by mass or volume.

(e) Liquid admixtures shall be measured by mass or volume and powdered admixtures shall be measured by mass.

2.1.8.7.2 Mixing concrete

(a) The quantities of concrete mixed and the speed of operation of a mixer shall comply with the manufacturer's recommendations.

(b) A mixer shall not be loaded in excess of its rated capacity and shall be emptied before being re-charged. A mixer which has been out of use for more than 30 minutes shall be cleaned before fresh concrete is mixed in it. Mixers shall be cleaned whenever there is a change in the type of cement being used.

(c) Mixing times or the number and rate of revolutions of mixer drums shall not be less than those recommended by the manufacturer unless it is demonstrated in the production of concrete that a shorter time or fewer or slower revolutions are adequate. Constituents shall be thoroughly mixed and admixtures shall be uniformly distributed throughout the concrete

(d) Water shall be added to truck mixed concrete at the batching plant and shall not be added in transit. Water shall not be added at the Site unless approved by the Engineer.

(e) Super plasticising admixtures used with concrete mixed off the Site shall be added at the Site unless otherwise permitted by the Engineer.

(f) Water shall not be added to partially hardened concrete.

2.1.8.8 Transportation of concrete

(a) Concrete shall not be transported in a manner which will result in contamination, segregation, loss of constituents or excessive evaporation.

(b) Concrete batched off the Site shall be transported to the Site in purpose-made agitators operating continuously or in truck mixers.

2.1.8.9 Records of concrete

(a) Delivery notes shall be provided for each delivery of concrete to the Site. The delivery notes shall be kept on the Site and shall be available for inspection by the Engineer at all times. Delivery notes shall contain the following details:

i. serial number of delivery note,

ii. name and location of batching and mixing plant,

iii. name of purchaser,

iv. name and location of the Site,

v. designation of concrete mix and approved slump value or approved flow value,

vi. constituents,

vii. quantity of concrete, and

viii. time of introduction of water to the concrete.

(b) Records of concreting operations shall be kept by the Contractor on the Site and shall be available for inspection by the Engineer at all times. Records shall contain the following details:

(a) designation of concrete mix and approved slump value or approved flow value,

(b) total quantity of each concrete mix produced that day,

(c) serial number of delivery note,

(d) arrival time of delivery vehicle,

(e) time of completion of discharge,

(f) quantity of water added at the Site,

(g) position where concrete is placed,

(h) results of flow table tests or slump tests,

(i) details of test cubes made, and

(j) temperature of concrete if a restriction on the temperature is stated in the Contract.

2.1.8.10 Records of concrete

2.1.8.10.1 Placing concrete

(a) The permission of the Engineer shall be obtained before concrete is placed in any part of the permanent work. If placing of concrete is not started within 24 hours of permission having been given, permission shall again be obtained from the Engineer. The Contractor shall inform the Engineer before concreting starts and shall allow the Engineer sufficient time to inspect the work which is to be concreted.

(b) Concrete shall be placed and compacted in its final position within 2½ hours of the introduction of cement to the concrete mix.

(c) Concrete which in the opinion of the Engineer is no longer sufficiently workable shall not be placed in the permanent work.

(d) Concrete shall not be placed in water other than by tremie or in bags.

(e) Concrete shall be placed as close as practicable to its final position and shall not be moved into place by vibration. Trunking or chutes shall be used to place concrete which will fall more than 2.7 m unless otherwise permitted by the Engineer.

(f) Concrete shall be placed in such a manner that the formwork, reinforcement or built-in components are not displaced.

(g) Unless otherwise permitted by the Engineer, concrete other than concrete placed by tremie shall be placed in horizontal layers to a compacted depth of not more than 450 mm if internal vibrators are used and to a compacted depth of not more than 150 mm in other cases.

(h) Concrete shall be placed continuously within the element to be concreted. Fresh concrete shall not be placed against concrete which has been in position for more than 30 minutes unless in the opinion of the Engineer the concrete already placed is sufficiently workable and the permission of the Engineer has been obtained. If permission is not obtained, a construction joint shall be formed as stated in Clause 2.1.8.11; concrete shall not be placed against the concrete already placed for at least 24 hours unless permitted by the Engineer.

2.1.8.10.2 Placing concrete by pumping

(a) Concrete pumps shall be operated and maintained in accordance with the manufacturer's recommendations. The pumps and pipelines shall be maintained in a clean condition. Internal surfaces of pipelines shall not be aluminium. Joints in pipelines shall be tightly fixed and shall not permit grout loss.

(b) Concrete pumps shall be positioned such that pipelines are as short and straight as practicable and require as little repositioning as practicable. Bends in pipelines shall be arranged in such a manner that the concrete, formwork, reinforcement or built-in components are not disturbed.

(c) Pipelines shall be lubricated by passing cement grout or concrete through the pipeline before the concrete is pumped. The initial discharge of pumped concrete shall not be placed in the permanent work.

2.1.8.10.3 Placing concrete by tremie

(a) Tremies used to place concrete shall be securely supported in position and the joints shall be watertight. A temporary seal of a type agreed by the Engineer shall be used to keep the water and the concrete separate at the start of concreting.

(b) After the concrete is flowing, the tremie shall be raised in a manner agreed by the Engineer; the lower end of the tremie shall be kept immersed in the concrete to a depth of at least 1 m. Water, mud and other deleterious material shall be prevented from entering the tremie after concreting has started.

(c) If the tremie becomes blocked or is removed from the concrete, concreting shall be stopped immediately unless otherwise permitted by the Engineer. Concreting shall not recommence for at least 24 hours unless permitted by the Engineer; contaminated concrete shall be removed before concreting recommences.

(d) Concrete placed by tremie shall be placed above the specified level by an amount which is sufficient to allow for the removal of contaminated concrete; contaminated concrete shall be removed.

2.1.8.10.4 Compacting concrete

(a) Concrete shall be compacted to form a dense homogeneous mass.

(b) Unless otherwise permitted by the Engineer, concrete shall be compacted by means of internal vibrators of suitable diameter. A sufficient number of vibrators shall be maintained in serviceable condition on the Site to ensure that spare equipment is available in the event of breakdown.

(c) Vibrators shall be used in such a manner that vibration is applied continuously and systematically during placing of the concrete until the expulsion of air has practically ceased; vibrators shall not be used in a manner which will result in segregation. Internal vibrators shall be inserted to the full depth of the concrete placed and shall be withdrawn slowly.

(d) Vibration shall not be applied by way of the reinforcement, and contact between internal vibrators and formwork, reinforcement or built-in components shall be avoided as far as possible. Concrete shall be vibrated in such a manner that the formwork, reinforcement or built-in components will not be displaced.

(e) Concrete which has been in position for more than 30 minutes shall not be vibrated except as stated in Clause 2.1.8.10.1 (h).

(f) No-fines concrete shall be compacted using a minimum amount of punning.

2.1.8.11 Construction joints

(a) Construction joints in concrete shall be formed only at the specified positions and by the specified method unless otherwise approved by the Engineer. The position and details of construction joints which are not stated in the Contract shall be arranged in such a manner that the possibility of the occurrence of shrinkage cracks is minimised.

(b) Construction joints shall be normal to the axis or plane of the element being constructed unless otherwise permitted by the Engineer.

(c) Water stops shall be provided at construction joints in water retaining structures and water tight structures.

(d) Laitance and loose material shall be removed from the surface of construction joints and the aggregate shall be exposed by a method agreed by the Engineer. The work shall be carried out as soon as practicable after the concrete has hardened sufficiently for the cement matrix to be removed without disturbing the coarse aggregate. The surface of the construction joint shall be cleaned after the matrix has been removed.

(e) The surface of the construction joint shall be clean and dry when fresh concrete is placed against it.

2.1.8.12 Curing concrete

(a) Concrete shall be protected against harmful effects of weather, running water and drying out by one of the following methods:

i. Method 1: A liquid curing compound shall be applied to the concrete surface by a low-pressure spray until a continuous visible covering is achieved.

ii. Method 2: The concrete surface shall be covered with hessian, sacking, canvas or other absorbent material agreed by the Engineer or with a layer of fine aggregate at least 25 mm thick; the hessian, sacking, canvas, absorbent material or fine aggregate shall be kept constantly wet.

iii. Method 3: The concrete surface shall be covered with polyethylene sheeting; concrete surfaces which have become dry shall be thoroughly wetted before the sheeting is placed.

iv. Method 4: Unformed concrete surfaces shall be covered with polyethylene sheeting until the concrete has hardened sufficiently for water curing to be carried out. Water curing shall be carried out by spraying the concrete surface continuously with cool water or by ponding immediately after the sheeting is removed. If in the opinion of the Engineer water curing is impracticable, Method 2 shall be used instead of water curing.

(b) Method 1 shall not be used on concrete surfaces against which concrete will be placed or which will have a Class T1 finish or which will be painted or tiled.

(c) Method 1, 2, 3 or 4 shall be carried out on unformed concrete surfaces immediately after the concrete has been compacted and finished. Method 1, 2 or 3 shall be carried out on formed concrete surfaces immediately after the formwork has been removed.

(d) Polyethylene sheeting shall be impermeable and shall have a nominal thickness of 0.125 mm.

(e) Hessian, sacking, canvas, absorbent material and polyethylene sheeting shall be lapped and securely held in position in such a manner that the concrete surface will not be damaged.

(f) Cold water shall not be applied to concrete surfaces or formwork intermittently in large quantities.

(g) The different methods of protection shall be maintained for the minimum periods stated in Table 2.1.8.3 after the concrete has been placed. The minimum periods may be reduced by the number of days during which formwork is left in position.

Table 2.1.8**.3. : Minimum periods of protection for concrete**

Type of structure	Method of protection	Minimum period of protection (days)	
		Concrete not containing PFA or PPFAC	Concrete containing PFA or PPFAC
Water retaining structures and water tight structures	1	7	7
	2,3 or 4	7	9
Others	1	7	7
	2,3 or 4	7	5

2.1.8.13 Installation of precast units

(a) Contact surfaces between in-situ concrete and precast concrete units shall be prepared as stated in the Contract. Dimensional tolerances shall be checked before the precast concrete units are lifted into position.

(b) Temporary supports and connections shall be provided as soon as practicable during installation of precast concrete units.

(c) Final structural connections shall be completed as soon as practicable after the precast concrete units have been installed.

(d) Levelling devices which have no load bearing function in the finished structure shall be slackened, released or removed after the precast concrete units have been installed.

2.1.8.14 Loading of concrete

(a) Loads which will induce a compressive stress in the concrete exceeding one-third of the compressive strength of the concrete at the time of loading or exceeding one-third of the grade strength, whichever is less, shall not be applied to concrete; allowance shall be made for the weight of the concrete in determining the loading. The strength of the concrete and the stresses produced by the loads shall be assessed by a method agreed by the Engineer.

(b) Loads from materials not forming part of the permanent work or from Constructional Plant or other vehicles shall not be applied to no-fines concrete.

2.1.8.15 Joints in concrete

2.1.8.15.1 Materials

(a) Materials for joints in water retaining structures and water tight structures for sewage and

effluent treatment shall be resistant to aerobic and anaerobic microbiological attack and resistant to attack by petrol, diesel oil, dilute acids and alkalis.

(b) Materials for joints in water retaining structures for potable and fresh water shall comply with the requirements of **BS 6920**.

(c) Joint filler shall be a proprietary type approved by the Engineer and shall be a firm, compressible, single-thickness, non-rotting filler; joint filler for joints in water retaining structures and water tight structures shall be non- absorbent.

(d) Bitumen emulsion for joints in water retaining structures and water tight structures shall comply with **BS 3416**. Bitumen emulsion for surfaces against which potable or fresh water will be stored or conveyed shall comply with **BS 3416**, type II.

(e) Joint sealant shall be a grade suited to the local climatic conditions and shall perform effectively over a temperature range of 0°C to 60°C. Joint sealant for exposed joints shall be grey.

(f) Joint sealant other than cold-applied bitumen rubber sealant shall be:

i. a gun grade for horizontal joints 15 mm wide or less and for vertical and inclined joints,

ii. a pouring grade for horizontal joints wider than 15 mm.

(g) Polysulphide-based sealant shall be a cold-applied two-part sealant complying with **BS EN ISO 11600**. Polysulphide-based sealant for expansion joints in water retaining structures and water tight structures shall have a transverse butt-joint movement range of at least 20%.

(h) Polyurethane-based sealant shall be a cold-applied two-part sealant complying with the performance requirements of **BS EN ISO 11600**.

(i) Hot-applied bitumen rubber sealant shall comply with **BS EN 14188-1**, type N1.

(j) Cold-applied bitumen rubber sealant shall be a proprietary type 200 approved by the Engineer.

(k) Joint sealant for joints in water retaining structures and water tight structures shall be as stated in Table 2.1.8.4.

(l) Primers and caulking material for use with joint sealant shall be a proprietary type recommended by the joint sealant manufacturer and approved by the Engineer.

(m) Different types of joint sealant and primers which will be in contact shall be compatible.

Table 2.1.8**.4: Joint sealant for water retaining structures and water tight structures**

Structure for retaining/excluding	**Type of joint**	**Type of joint sealant**
Sewage	All joints	Polyurethane-based
Other than sewage	Expansion joints	Polysulphide-based or polyurethane-based

	Horizontal joints other than expansion joints	Hot-applied bitumen rubber, polysulphide-based or polyurethane-based
	Vertical and inclined joints other than expansion joints	Polysulphide-based, polyurethane-based or cold-applied bitumen rubber

(n) Waterstops, including intersections, reducers and junctions, shall be a proprietary type approved by the Engineer. Waterstops shall be natural or synthetic rubber or extruded polyvinyl chloride

2.1.8.15.2 Storage of materials rubber

(a) Bitumen emulsion, joint sealant and primer for joint sealant shall be joints stored in sealed containers marked to identify the contents and protected from exposure to conditions which may affect the material. The materials shall be stored in accordance with the manufacturers' recommendations and shall not be used after the recommended shelf life has been exceeded.

(b) Joint filler, bond breaker tape and water stops shall be stored in accordance with the manufacturers' recommendations in a dry weatherproof store with a raised floor; absorbent joint filler shall be stored in sealed plastic bags and shall not be exposed to moisture or air.

(c) Bearing strip for sliding joints supplied in rolls of 5 m length or less shall be unrolled immediately after delivery and shall be stored flat at full length on an even surface; bearing strip supplied in rolls of more than 5 m length may be left in the original packing. Bearing strip shall be stored in accordance with the manufacturer's recommendations and shall be protected from mechanical damage and creasing; the two layers of strip shall be kept free from deleterious material.

2.1.8.15.3 Forming joints

(a) Materials for joints shall be used in accordance with the manufacturers' recommendations or as otherwise stated in the Contract.

(b) Joint filler shall be cut to size before fixing and shall be securely fixed in position to the existing concrete surface before concreting. There shall be no gaps between the joint filler and formation.

(c) Waterstops shall be securely fixed in position to formwork in such a manner that compaction of the concrete will not be affected. In-situ joints in waterstops shall be made using methods and equipment recommended by the manufacturer. Exposed waterstops shall be protected from exposure to conditions which may affect the waterstop and shall be kept free from rust, hydrocarbons and other deleterious material.

(d) Joints shall be formed in straight lines perpendicular to the surface of the concrete unless otherwise stated in Contract.

(e) Grooves for joint sealant shall be straight and shall be perpendicular to the surface of the concrete. The bottom of the groove shall be flat and shall be parallel to the surface of the concrete.

(f) Grooves shall be formed by using timber or other approved formers and shall not be formed by cutting back or raking out the joint filler. The grooves shall be located over the joint filler such that the upper surface of the joint filler is entirely contained in the groove.

(g) Before permanent sealing, grooves for joint sealant shall be protected from contamination by a temporary sealing strip or cover or by other methods agreed by the Engineer.

(h) The permanent sealing of joints shall be carried out at least 7 days after concreting unless otherwise permitted by the Engineer.

(i) Immediately before permanent sealing, timber formers, temporary seals, dirt and loose material shall be removed from the groove and the sides of the groove shall be cleaned and roughened by water jetting, sand blasting or by other methods agreed by the Engineer.

(j) Caulking material shall be firmly packed in the bottom of the groove if the joint sealant is not required to extend to the bottom of the groove.

(k) Bond breaker tape shall be fixed continuously and evenly along the bottom of the groove for the full width and length of the groove.

(l) Concrete surfaces within 75 mm of the edges of the joint shall be masked with tape before the primer is applied and until the sealing of the joint is complete.

(m) Primer for the joint sealant shall be applied to the sides of the groove in accordance with the manufacturer's recommendations.

(n) Joint sealant shall be applied between the minimum and maximum drying times of the primer recommended by the manufacturer. The components of the sealant shall be thoroughly mixed in accordance with the manufacturer's recommendations using a power operated paddle mixer for sufficient time to produce a homogeneous mass without entrapped air. The sealant shall be dispensed into the groove as soon as practicable after mixing and within the time recommended by the manufacturer.

(o) The groove shall be clean and dry at the time of applying the primer and joint sealant.

(p) Excess joint sealant shall be removed by using a purpose made finishing tool such that the finished surface of the sealant is between 4 mm and 6 mm below the face of the concrete.

(q) The best fit straight line of straight joints shall be within 25 mm of the specified line. The line of straight joints shall be within 10 mm of the best fit straight line.

(r) The best fit curved line of curved joints shall be as agreed by the Engineer and shall be within 25 mm of the specified line. The line of curved joints shall be within 10 mm of the best fit curved line.

(s) Joints shall be continuous across intersections of joints to within 5 mm of the best fit straight lines or best fit curved lines of each joint.

(t) The depth of grooves for joint sealant shall be within 3 mm of the specified depth.

2.1.8.16 Attendance upon Sub-Contractors

(a) Particular care shall be exercised by the Contractor to ensure that all pipes, ducts, drains, conduit, junction boxes, anti-static installations etc, are laid before the concrete floor and roof slabs is poured, and the Contractor will be held responsible for the cost of any additional cutting etc, and making good which becomes necessary through his failure to make proper arrangements for all sub-contractor work to be done in close co-operation with his own.

2.1.8.17 References and Standards

BS EN 197-1 (2011): Cement. Composition, specifications and conformity criteria for common cements

BS 4027 (1996): Specification for sulphate-resisting Portland cement.

BS EN 12620 (2013): Aggregates for concrete

BS EN 12878 (2005): Pigments for the colouring of building materials based on cement and/or lime. Specifications and methods of test

BS EN 480-14 (2006): Admixtures for concrete, mortar and grout. Test methods. Determination of the effect on corrosion susceptibility of reinforcing steel by potentiostatic electro-chemical test.

BS 6920-4 (2001): Suitability of non-metallic products for use in contact with water intended for human consumption with regard to their effect on the quality of the water. Method for the GCMS identification of water leachable organic substances
.
BS 3416 (1991): Specifications of bitumen-based coatings for cold application suitable for use in contact with potable water.

BS EN ISO 11600 (2003+A1:2011): Building construction. Jointing products. Classification and requirements for sealants

BS EN 14188-1 (2004): Joint fillers and sealants. Specifications for hot applied sealants

BS EN 450-1 (2012): Fly ash for concrete. Definition, specifications and conformity criteria

2.1.9 BRICKWORK AND BLOCKWORK

2.1.9.1 Generally

(a) Brickwork and blockwork shall be in accordance with **PD 6697:2010, BS EN 1996-3:2006, BS EN 1996-2:2006 and BS EN 1996-1-2:2005**

2.1.9.2 Materials

2.1.9.2.1 Clay bricks

(a) Clay bricks shall be a brand approved by the Engineer and shall be well burnt, hard, sound, square and clean.

(b) Brick size shall comply with **BS EN 771-1**. The nominal dimensions of clay bricks shall be 225 mm x 112.5 mm x 75 mm, 200 mm x 100 mm x 75 mm, and special sizes and shapes in accordance with the requirements stated in the Contract.

(c) Clay bricks for fair faced work shall be selected for evenness, texture, sharpness of arrises and uniformity of colour.

(d) The compressive strength of the clay bricks shall be at least 7.0 MPa.

2.1.9.2.2 Concrete bricks and blocks

(a) Concrete bricks and blocks shall be to **BS EN 771-2 & 3**, obtained from a manufacturer approved by the Engineer. The compressive strength of the concrete bricks shall be at least 7.0 MPa and for blocks and fixing bricks at least 2.8 MPa.

(b) The nominal dimensions of concrete bricks shall be 225 mm x 105 mm x 70 mm. The size of concrete blocks shall be as approved by the Engineer.

(c) Concrete bricks and blocks for fair faced work shall be selected for evenness, texture and sharpness of arises.

2.1.9.2.3 Concrete hollow blocks

(a) Concrete hollow blocks shall be obtained from an approved manufacturer.

(b) The average crushing strength of a random selected sample of 10 blocks shall not be less than 5.0 MPa of the gross area.

2.1.9.2.4 Brickwork reinforcement

(a) Brickwork reinforcement shall be expanded metal or mild steel rods and shall be galvanized or painted with two coats of bituminous paint.

2.1.9.2.5 Damp proof course

(a) Damp proof course shall be two layers of 2-ply bituminous paper or other types complying with **BS 6398** Class E; hessian-based types of bitumen damp proof course shall not be used.

2.1.9.2.6 Wall ties

(a) Wall ties between the ends of walls and concrete shall be:

i. 6 mm diameter steel rods 350 mm long galvanized or painted with two coats of bituminous paint, or

ii. 20 mm x 3 mm galvanized mild steel flats 350 mm long and fanged at both ends.

(b) Wall ties for walls built against the face of concrete structures shall be 20 mm x 3 mm galvanized mild steel flats 150 mm long and fanged at both ends.

(c) The length of mild steel flat ties which are fixed by shot firing into concrete walls may be reduced if permitted by the Engineer.

2.1.9.2.7 Mortar for brickwork and blockwork

(a) Cement shall be as Clause 2.1.8.2.1

(b) Water shall be as Clause 2.1.8.2.3

(c) Sand shall be as stated in Clause 2.1.17.1.

(d) Lime putty as **PD CEN/TR 15123, BS 8481 & BS EN 13914-2** shall be prepared by mixing hydrated lime with the minimum amount of water necessary to achieve a thick creamy consistency; the putty shall be left undisturbed for at least 16 hours before use.

(e) Lime shall be hydrated lime to **BS EN 459-1:2010 and BS EN 459-3:2011**, delivered in sealed bags bearing the manufacturer's name or brand.

(f) Measure mortar constituents by volume, using clean gauge boxes made to suit volumes required.

(g) Mix constituents shall be to the following proportions:

i. Cement mortar cement and sand 1:30
ii. Cement/lime mortar cement, lime putty and sand 1:1:6 for external walls and 1:2:9 for internal walls
iii. Fire brick mortar shall be:
   - An approved proprietary brand of fire cement, used neat, or
   - High alumina cement shall be to **BS EN 14647** and fine crushed fire brick 1:2

(h) Proportions given are for dry sand. Allow for bulking.

(i) Where plasticizers are used, they shall be used strictly in accordance with manufacturer's recommendations and the proportions of the mortar mix adjusted accordingly.

2.1.9.3 Submissions

2.1.9.3.1 Particulars of brickwork and blockwork

(a) The following particulars of the proposed materials for brickwork and blockwork shall be submitted to the Engineer:

- a certificate showing the manufacturer's name, the date and place of manufacture and showing that the materials comply with the requirements stated in the Contract and including results of tests for crushing strength of clay bricks, concrete bricks and blocks and concrete hollow blocks,

- details of brickwork reinforcement, damp proof course and wall ties, and details of materials for mortar.

(b) The particulars, including certificates, shall be submitted to the Engineer at least 14 days before the first delivery of the material to the Site. Certificates shall be submitted for each batch of the material delivered to the Site.

2.1.9.3.2 Samples of materials

(a) Samples of the following proposed materials shall be submitted to the Engineer at the same time as particulars of the material are submitted:

i. each type of brick and block, and

ii. Brickwork reinforcement, damp proof course and wall ties.

2.1.9.4 Trial panels

2.1.9.4.1 Trial panels

(a) A trial panel shall be constructed for each type of faced and fair faced brickwork or blockwork to demonstrate that the proposed materials will produce brickwork or blockwork which complies with the specified requirements.

(b) Trial panels shall be constructed at least 14 days before the relevant work starts.

(c) The Contractor shall inform the Engineer 24 hrs, or such shorter period agreed by the Engineer, before constructing trial panels.

(d) Trial panels shall be constructed using the materials submitted to the Engineer.

(e) Each trial panel shall be 1 m x 1 m and shall be constructed at a location agreed by the Engineer.

(f) Trial panels shall be used as a means of comparison against which the Engineer shall determine the compliance or otherwise of the brickwork or blockwork in the permanent work. Trial panels shall be protected from damage and shall be left in position until the Engineer instructs their removal.

2.1.9.4.2 Non-compliance: brickwork and blockwork

(a) If in the opinion of the Engineer the brickwork or blockwork in the trial panel does not comply with the specified requirements for brickwork or blockwork, particulars of proposed changes to the materials and methods of construction shall be submitted to the Engineer; further trial panels shall be constructed until the trial panel complies with the specified requirements.

2.1.9.4.3 Commencement of brickwork and blockwork

(a) Brickwork and blockwork shall not commence until in the opinion of the Engineer the trial panel complies with the specified requirements.

2.1.9.4.4 Changes in materials

(a) Unless permitted by the Engineer, the materials used to produce a trial panel which complies with the specified requirements shall not be changed.

2.1.9.5 Handling and storage of materials

2.1.9.5.1 Handling and storage of materials

(a) Bricks and blocks shall be unloaded and handled in a manner which will not result in soiling, chipping or other damage to the bricks and blocks. Bricks and blocks shall be stacked on a dry, level base and in a manner which will not result in damage to the bricks or blocks or in contamination of the bricks or blocks. Bricks and blocks shall be protected from damage and damaged bricks and blocks shall not be used in the permanent work unless permitted by the Engineer.

2.1.9.6 Laying bricks and blocks

2.1.9.6.1 Type of mortar

(a) Cement mortar shall be used for brickwork and blockwork:

i. below the damp proof course, including basement walls,

ii. for brickwork and blockwork not exceeding 150 mm thick,

iii. in load-bearing walls, and

iv. for pointing where the bed is cement mortar or where stated in the Contract.

(b) Cement lime mortar shall be used for brickwork and blockwork.

(c) Mortar shall be mixed using the minimum amount of water necessary to achieve the required consistency and shall be used within one hour after mixing. Unless otherwise permitted by the Engineer, the materials shall be mixed by a mechanical method.

2.1.9.6.2 Bond and gauge of brickwork and blockwork

(a) Stretcher bond shall be used for half brick walls and English bond shall be used for brick walls exceeding half brick thick. Stretcher bond shall be used for blockwork.

(b) Brick courses shall be gauged with four courses to 300 mm including joints.

(c) Bricks and blocks shall be laid on a full bed of mortar and the joints shall be filled solid to a thickness of 10 mm.

(d) Single frog bricks in load-bearing walls shall be laid with the frog facing upward and filled with mortar.

(e) Courses shall be kept level and perpends shall be kept in line vertically. Quoins and other angles shall be plumbed as the work proceeds and shall be constructed in advance of the remainder of the wall, but not exceeding five courses, and shall be racked back between levels.

(f) Bricks and blocks shall be wetted before laying during dry weather using the minimum amount of water necessary to prevent premature drying out of the mortar.

2.1.9.6.3 Laying damp proof courses

(a) Brickwork shall be flushed up with cement mortar to form a level and even bed to receive the horizontal damp proof course.

(b) Damp proof courses shall be laid in a continuous strip with 150 mm laps at the end of the length and at returns. The mortar joint shall be completed to the normal thickness.

2.1.9.6.4 Fixing wall ties

(a) At junctions of walls and concrete, wall ties shall be fixed at 300 mm centres vertically and shall project 250 mm into the wall.

(b) Wall ties shall be fixed for walls built against the face of concrete structures and shall be spaced at intervals of 900 mm horizontally and 300 mm vertically in a staggered pattern; the ties shall project 75 mm into the wall.

2.1.9.6.5 Finishing of joints in brickwork and blockwork

(a) Joints which will not be visible in the finished brickwork and blockwork shall be struck off as the work proceeds. Joints which will be exposed shall be struck flush and weather pointed as the work proceeds. Joints in brickwork to which plaster or other wet applied finishes will be applied shall be raked out to a depth of 10 mm.

2.1.9.7 Tolerances

2.1.9.7.1 Tolerances: brickwork and blockwork

(a) Brickwork and blockwork shall comply with the following requirements:

i. The position on plan shall be within 15 mm of the specified position.

ii. The length shall be within 15 mm of the specified length.

iii. The height shall be within 10 mm of the specified height.

iv. The level of bed joints shall be within 10 mm of the specified level in any 5 m length.

v. The brickwork and blockwork shall be straight to within 15 mm in any 5 m length.

vi. The brickwork and blockwork shall be vertical to within 15 mm in any 3 m height.

2.1.9.8 Testing: bricks and block

2.1.9.8.1 Batch: bricks and blocks

(a) A batch of bricks or blocks is any quantity of bricks or blocks of the same type, manufactured or produced at the same time in the same place, covered by the same certificates and delivered to the Site at any one time.

2.1.9.8.2 Samples: bricks and blocks

(a) Unless otherwise permitted by the Engineer, one sample of each type of bricks or blocks shall be provided at the same time as particulars of the material are submitted to the Engineer and one sample of each type of bricks or blocks shall be provided from each batch of the material delivered to the Site.

(b) The number of bricks or blocks in the sample shall be 10 for each batch of 15,000 bricks or blocks or part thereof.

(c) The method of sampling shall be in accordance with **BS EN 771-1**.

2.1.9.8.3 Testing: bricks and blocks

(a) Each brick or block in the sample shall be tested to determine the crushing strength of the brick or block.

(b) The method of testing shall be in accordance with **BS EN 771-1**.

(c) The average of the 10 crushing strengths of the bricks or blocks shall be calculated and referred to as the compressive strength.

2.1.9.8.4 Compliance criteria: bricks and blocks

The compressive strength of bricks and blocks shall be as stated in Clauses 2.1.9.8.1, 2.1.9.8.2 and 2.1.9.8.3 or as stated elsewhere in the Contract.

2.1.9.9 References and Standards

BS EN 771-1 (2011): Specification for masonry units. Clay masonry units

BS EN 771-2 (2011): Specification for masonry units. Calcium silicate masonry units

BS EN 771-3 (2011): Specification for masonry units. Aggregate concrete masonry units (dense and lightweight aggregates)

BS EN 998-1 (2010): Specification for mortar for masonry. Rendering and plastering mortar

PD 6697 (2010): Recommendations for the design of masonry structures to BS EN 1996-1-1 and BS EN 1996-2

BS EN 1996-3 (2006): Eurocode 6. Design of masonry structures. Simplified calculation methods for unreinforced masonry structures

BS EN 1996-2 (2006): Eurocode 6. Design of masonry structures. Design considerations, selection of materials and execution of masonry

BS EN 1996-1-2 (2005): Eurocode 6. Design of masonry structures. General rules. Structural fire design

PD CEN/TR 15123 (2005): Design, preparation and application of internal polymer plastering systems

BS 8481 (2006): Design, preparation and application of internal gypsum, cement, cement and lime plastering systems. Specification

BS EN 13914-2 (2005): Design, preparation and application of external rendering and internal plastering. Design considerations and essential principles for internal plastering
BS EN 459-1 (2010): Building lime. Definitions, specifications and conformity criteria
BS EN 459-3 (2011): Building lime. Conformity evaluation
BS 6398 (1983): Specification for bitumen damp-proof courses for masonry
BS EN 14647 (2005): Calcium aluminate cement. Composition, specifications and conformity criteria

BS 8215 (1991): Code of practice for design and installation of damp-proof courses in masonry construction

BS 6398 (1983): Specification for bitumen damp-proof courses for masonry

2.1.10 CURTAIN WALLING

2.1.10.1 Source

(a) Furnish curtain wall system components by one manufacturer or fabricator; however, all components need not be products of the same manufacturer.

2.1.10.2 Scope

2.1.10.2.1 Scope of the Works

(a) The Works comprise the design, fabrication, transportation, assembly and installation of the curtain walls as specified. Provide full-scale testing to show compliance.

2.1.10.2.2 Works included

(a) The Works include, but shall not be limited to :-

i. Aluminium/stainless steel framing members.

ii. Galvanized mild steel sections as reinforcement.

iii. Fixings, connections and provision of anchorages. Concrete embedments shall be provided under the Works but set by others.

iv. Glass and glazing materials including glass spacers, gaskets, sealants etc.

v. Spandrels, dressings to roofs/abutments, integral louvres and screens to A/C intakes/exhausts and operable windows.

vi. Stone panels and their support systems.

vii. Ironmongery and fittings.

viii. Sills, copings, water bars, flashings, seals and other attachments.

ix. Insulation against fire between storeys and designated compartments.

x. Isolation of dissimilar metals and moving parts.

xi. All preparatory work to the adjoining structure for attachment of the Works.

xii. Sealants within work of this section and at boundaries with work of other sections.

xiii. Thermal insulation at non-vision areas.

xiv. Mock-up erection and tests.

xv. Field tests for resistance to water leakage.

xvi. Material tests.

xvii. Final cleaning.

xviii. Lightning protection.

xix. Field or Site mock-up.

2.1.10.2.3 Related work

(a) Work related to, and requiring coordination with, but not forming part of the Works includes :-

i. Reinforced concrete structure.

ii. Rendering and screed to concrete structure.

iii. External and internal finishes.

iv. External paving and asphalt work.

v. Forming grooves and chases in the structure for the proper execution of the Works.

vi. Mechanical air-handling installation.

vii. Ceiling installation.

viii. Fixing of anchorages into structure.

ix. External curtain wall cleaning system.

x. Granite cladding.

xi. Lightning protection installation.

xii. Closure panel for Venetian Blind/shutter.

xiii. Waterproofing/water-tightness.

2.1.10.3 Contractor's design responsibility

(a) The Drawings and Specifications define design intent and performance requirements.

Details show preferred profiles. The Contractor shall be responsible for the final design.

Responsibilities include, but shall not be limited to, the following :-

i. Unless otherwise specified, the appearance of exposed elements, including width and depth, shall be consistent throughout the project.

ii. Unless otherwise specified, the overall thickness of each glass type, and the component thicknesses of each multiple layer glass type, shall be consistent throughout the project.

iii. Provide anchor adjustment capability for the full range of specified tolerances.

iv. Provide movable joints to accommodate the full range of manufacturing tolerances, field tolerances, thermal movements, floor sag, beam sag, and column settlement.

v. Provide corrosion protection between dissimilar materials.

vi. Provide a water-tightness/ "pressure equalization and rain screen" curtain wall.

vii. Provide a completed external envelope which is accessible and maintainable internally or externally.

2.1.10.4 Information to be provided

2.1.10.4.1 Tender submission

(a) Submit one copy of the following information when specified in the tender documents:-

i. Basic design of the curtain wall.

ii. Quality, finish, thickness and standard of aluminium/stainless steel and galvanized mild steel reinforcement.

iii. Quality, coating, thickness, standard and manufacturer of glass together with the manufacturer's certification that the glass proposed meets the testing requirement specified in Clause 2.1.10.5.4.

iv. Details of provision for wind load, thermal and building movements.

v. Sections of major mullions and transoms with supporting typical structural calculations.

vi. Typical design of spandrels, copings, louvres, and operable windows.

vii. Typical arrangement and jointing of components.

viii. Typical arrangement of fire barriers between perimeters of floors and curtain wall.

ix. Proposals for mock-up and testing.

x. The Contractor shall be required to submit the name, experience and qualification of the person who shall provide full-time supervision during installation of the curtain wall.

xi. Provide an itemized list of deviations from the Specification and Drawings for the Works. Identify the Specification item, or the Drawing. In the event that there are no deviations, provide a written statement of full compliance with the Drawings and Specifications. Failure to provide an itemized list of deviations in the required form, or a statement of full compliance shall, at the Engineer's discretion, be cause for return of some or all submittals for approval without review.

xii. Within 6 weeks of the date of acceptance of the tender or nomination by the Engineer, submit as specified a detailed programme for the Work, to show the

following :-

2.1.10.4.2 Programme for the Works.

(a) Submission of structural calculations, shop drawings and samples of materials.

i. Ordering of components.
ii. Manufacture of components.
iii. Preparation of all mock-up samples required.
iv. Testing in laboratory.
v. Delivery of components.
vi. Installation.
vii. Field tests.
viii. Final cleaning.

(b) 'Installation' shall be further sub-divided into principal constituent operations.

2.1.10.4.3 Provision of drawings and calculations

(a) Provide as specified the following submittals for approval. First submittals and resubmittals shall be complete and in the required form. Resubmittals shall include requested corrections and shall respond to previous comments.

(b) Each sheet that is revised shall bear a revision date and number. Revisions shall be flagged with a conspicuous revision symbol and number. Failure of a submittal to be complete, in the proper form, responsive to comments, or identifying revisions shall, at the Engineer's discretion, be cause for non-approval and return of documents without review.

(c) Failure of review comments to note a noncompliance with the Specification and Drawings shall not relieve the Contractor from his obligation to comply.

(d) The failure of the Contractor to note a noncompliance on a given submittal shall not preclude a directive by the Engineer for the Contractor to comply on future submittals. Allow sufficient time for preparation and processing of submittals and resubmittals.

(e) Provide drawings certified by a registered structural engineer, showing materials in place. Drawings shall include elevations, floor plans, sections and full size details. Details shall be fully drawn (not outlined). Drawings shall include the following information :-

i. Assembly and water-tightness and/or pressure equalization and rain screen system of curtain wall.

ii. Glass and metal thicknesses.

iii. Metal alloy, temper and finish.

iv. Glass strength, tint, coating, opacifier, frit and safety backing.

v. Fastener alloy, strength, plating, diameter, length and spacing.

vi. Glazing materials identification.

vii. Sealants identification by product name.

viii. Relative layout of walls, beams, columns and slabs with dimensions noted.

ix. Dimensioned position of glass edge relative to metal surface.

x. Provisions for thermal movements and building movements.

xi. Locations of, and details for, any embedded anchors.

xii. Identification of, and details for, thermal insulation.

xiii. Weld information and weld symbols conforming to **BS 499**.

xiv. Glazing details applicable to replacement glass, with outline of procedure for glass replacement.

xv. Provisions for adjustment of anchors relative to tolerances of building structure.

xvi. Details of spandrels, copings, louvres and operable window.

xvii. Details of ceiling and bottom/floor closure panels or strips if applicable.

xviii. Details of fire barriers between perimeters of floors and curtain wall.

xix. Details of lightning protection.

(f) Provide, as specified, shop drawings and fully coordinated structural calculations, certified by a registered structural engineer. Calculations shall be legible and shall incorporate sufficient cross
references to the shop drawings to make the calculations readily understandable and reviewable. Test reports shall not be an acceptable substitute for calculations. Calculations shall include the
following information :-

i. Analysis for all applicable loads on framing members.

ii. Analysis for all applicable loads on anchors, including anchors embedded in concrete.

iii. Section property computations for framing members.

iv. Analysis of stress in structural silicone applications at vision or spandrel glass lights.

v. Certification of a registered structural engineer.

(g) Drawings and structural calculations shall be required for test mock-ups. The requirements for test mock-ups shall generally be the same as for the actual Works, with particular reference to mock-up conditions.

(h) Additional submittal requirements :-

i. Prior to, or at the same time as, the first submittal of structural calculations for approval, provide dimensioned die drawings for all aluminium extrusions. In the event that extrusion profiles are not finalized, provide die drawings for the profiles contemplated at that time. If profiles are revised, providerevised die drawings with the first calculation or shop drawing submittal which follows the revision.

ii. Die drawings shall show all profile dimension, metal thickness, alloy and temper.

iii. Prior to construction, provide die drawings of gaskets and weather-strips. Die drawings shall show all profile dimensions and shall identify materials.

iv. Prior to construction, provide glass manufacturer's wind pressure analysis and thermal stress analysis, as well as glass manufacturer's review of shop drawings stating that details shall be suitable for the proposed glass products.

v. Prior to construction, provide sealant manufacturer's test reports confirming sealant adhesion, compatibility and absence of staining for all relevant substrates.

vi. Prior to construction, provide certification that insulating glass conforms to BS 5713.

vii. Prior to submitting any documents for approval, submit laboratory test reports for structural silicone assembly.

(i) Samples of materials :-

i. Submit together with Clause 2.1.10.4.3(e) above, samples of all materials together with fully glazed samples of principal junctions and assemblies.

ii. Submission shall consist of three samples of each material and principal junction or assembly, two to be retained by the Engineer, and the other to be returned after approval. Approved samples shall be so marked by the Engineer. Samples of materials required shall be as follows :-

Aluminium/Stainless steel sections	300 mm length of each.
Galvanized mild steel	300 mm length of each section.
Sheet, plate, mesh	500 x 1000 mm piece of each type.
Glass	600 x 600 mm piece per type and/or edge finish.
Fastening devices	Each type.
Sealants	150 mm cured sample each type.
Gaskets	300 mm length of each type.
Flashings	300 x 300 mm piece of each type.
Stone	300 x 300 mm piece of each type.
Access panel/sash window	500 x 500 mm part with all accessories.

(j) Samples shall show the complete range of colour, texture and other characteristic changes through the manufacture, fabrication, assembly, installation and cleaning processes. Submit finished samples of every extrusion or section to be used and of every other material of the thickness and weight as required by the Engineer. Aluminium samples shall include samples
of high and low colour range of anodic and organic coating finish and shall be labelled accordingly. Stone samples should specify the name of the quarry, country and provide samples of full range of colour, texture and the grading of the stone.

(k) Erection and protection method statement;

Submit together with Clause 2.1.10.4.3(e) above, a detailed method statement for erection

and protection of the works.

(l) Mock-up samples;

Refer to Clause 2.1.10.6.13

(m) Structural adequacy tests of anchorages;

2.1.10.5 Materials

2.1.10.5.1 Generally

(a) Materials shall be structurally sound, able to withstand local pollutants and marine conditions, as well as the varying relative humidity as may be experienced in the vicinity of the project. In addition, the materials shall be free from defects and blemishes and shall conform to the relevant specified standards.

(b) Materials of common type shall be obtained from the same manufacturer.

(c) All materials or components shall be fully compatible with each other. Submit test certificates to prove compatibility of any materials or components as requested by the Engineer.

2.1.10.5.2 Steel

(a) Stainless steel shall be to **BS EN 10029** grading not inferior to 304 S15 with minimum thickness of 1 mm and with all exposed edges rolled round. Manufacturer's test certificates shall be provided with each consignment to the Site to show that the material has been tested and found to comply with the relevant requirements of **BS EN 10029**.

(b) Structural steel shall be to Clause 2.1.20.2.2, shall be galvanized in accordance with Clause 2.1.20.4.19 and be tested in accordance with Clause 2.1.20.3.2.

2.1.10.5.3 Aluminium

(a) Aluminium and Aluminium alloy shall be to Clause 17.07.

i. The following alloy and temper combinations are acceptable for extrusions subject to fabrication, finish and structural requirements : 6063-T5; 6063-T6; 6061-T6. Other alloys of the 6xxx series and other tempers may be submitted for approval.

ii. Nominal wall thickness of 3.0 mm or greater is acceptable for structural extrusions; wall thickness less than 3.0 mm may be acceptable and is subject to approval. Minimum nominal wall thickness for non-structural trim shall be 1.5 mm.

iii. The following alloy and temper combinations are acceptable for sheet and plate subject to fabrication, finish and structural requirements : 3003-Hl4; 5005-H14. Other alloys of the 3xxx, 5xxx and 6xxx series and other tempers may be submitted for approval. Provide 3.0 mm minimum nominal thickness

2.1.10.5.4 Glass

(a) Glass shall conform, as a minimum, to the following standards :-

i. **BS 952**.

ii. Heat-treated flat glass shall conform to **ASTM C 1048-4**, except that surface compression of heat strengthened glass shall be in the range 24000 to 45000 kPa.

iii. Tempered and laminated glass shall conform to **ANSI Z97.1-1984**.

(b) Provide tempered and/or laminated glass at the following locations :-

i. Doors.

ii. Fixed and operable glazing with a vertical edge within 300 mm of a door in the closed position and with the bottom edge less than 1500 mm above the walking surface.

iii. Fixed glazing with area exceeding one square meter, and with the lowest edge less than 450 mm above a walking surface, which is within 900 mm of such glazing; tempered and/or laminated glass is not required if there is a horizontal member with minimum 40 mm width located between 600 and 900 mm above the walking surface.

iv. Any additional locations required by local building regulations.

(c) Provide heat strengthened glass where required by design wind pressures, anticipated thermal stress, and use in a spandrel area. Provide fully tempered and/or laminated glass only where required by local building regulations or where design pressures are beyond the capacity of heat strengthened glass.

(d) Glass reflective metallic coatings shall conform to the following criteria.

i. Pinholes with diameter exceeding 1 mm shall not be acceptable and shall be permitted only within 75 mm of an edge.

ii. Clusters of pinholes shall not be acceptable.

iii. Scratches shall not have length exceeding 75 mm and shall be permitted only within 75 mm of an edge.

iv. No objectionable mottle or streaking shall be visible when glass is viewed at angles of 45 degrees through 90 degrees from a distance of 4 m or more.

(e) Reflective glass shall have the following properties :-

i. Shade coefficient shall not exceed : 0.30.

ii. Summer heat gain 'U' shall not exceed : 5.5 $W/m^2/oC$.
('U' = thermal conductance value.)

iii. Visible daylight transmittance shall not be less than: 8%.

(f) Edge quality criteria for annealed and heat strengthened glass shall be as follows :-

i. Shark teeth shall not penetrate more than half of glass thickness.

ii. Serration hackle may occur only within 150 mm of corners.

iii. Flare shall not exceed 1.0 mm as measured perpendicular to glass surface across the

edge. Flare shall not occur at setting blocks.

iv. Bevel shall not exceed 1.6 mm.

v. Flake chips may occur only within 200 mm of corners; depth shall not exceed 0.8 mm and length or diameter shall not exceed 6.0 mm.

vi. Rough chips shall not be permitted. Rough chips shall be those which exceed any of the dimensional limits for flake chips.

(g) Insulating glass shall have double edge seals. Primary seal shall be extruded polyisobutylene continuously bonded to glass surfaces and desiccant filled metal spacer, including corners. Minimum width of primary seal shall be 3.0 mm. Secondary seal shall be a 2 part neutral cure structural silicone. Secondary seal shall completely cover spacer with no gaps or voids, and shall be continuously bonded to both plates of glass.

(h) Laminated glass shall consist of two layers of heat strengthened glass with equal thickness and an interlayer with 1.5 mm nominal thickness.

(i) In addition to conforming to **BS 952** and **ASTM C 1048-4**, monolithic heat strengthened and tempered glass shall conform to the following flatness tolerances :-

i. Bow and warp have the same meaning. They are both defined as deviation of a glass surface from a true plane, with the glass free-standing or installed in a frame and positioned in a vertical plane.

ii. Localized bow refers to any straight line segment with a length of 300 mm on a glass surface.

iii. Overall bow refers to any straight line segment on a glass surface which extends between opposite edges across the smaller glass dimension and is perpendicular to at least one edge. The length of the line segment is the gage length.

iv. Localized bow shall not exceed 1.6 mm.

v. Overall bow shall not exceed : 1.0 mm per 300 mm for gage length in the range zero to 1 m; 0.75 mm per 300 mm for gage length in the range 1 m to 2.40 m; one half of the values listed in **ASTM C 1048-4**, Table 2 for gage lengths exceeding 2.40 m.

vi. Where heat treating results in essentially parallel ripples or waves, the maximum peak-to-valley deviation shall not exceed 0.127 mm. Requirements for localized bow and overall bow shall also be satisfied. Direction of ripples shall be consistent throughout the building and approved by the Engineer.

vii. The specified bow and ripple tolerances are intended as manufacturing quality control limits.

(j) Tempered glass shall be subjected to quality control measures (i.e. heat soaking) to minimize inclusions which could result in spontaneous breakage. Such inclusions are defined as a material defect by this specification. Installed tempered glass which experiences spontaneous breakage shall be replaced (material and labour) under the warranty provisions.

(k) Plastic films used to opacify glass shall conform to the following requirements :-

i. Minimum nominal thickness of polyethylene shall be 0.1 mm. Colour shall be black.

ii. Minimum nominal thickness of polyester shall be 0.08 mm. Film shall be pigmented and have a black colour.

iii. The bonding surface shall be completely coated with a solvent based adhesive.

iv. Monolithic opacified glass shall have a safety backing for fallout resistance.

(l) Vision glass shall be as specified.

(m) Spandrel glass shall be as specified.

2.1.10.5.5 Stone

(a) Stone nominal thickness shall be determined by the specified tests and design rules but shall not be less than as specified.

(b) Actual stone thickness shall not be less than nominal thickness minus 2.0 mm.

(c) Stone shall be free of damage to front face, back face and edges.

(d) Stone type shall be as specified.

(e) Stone finish shall be as specified and within acceptable colour range.

2.1.10.5.6 Anchors in stone

(a) Stone shall be supported by continuous kerf clips in sawn grooves at two opposite edges of each piece of stone. Kerf clips shall be set in a continuous bed of neutral cure silicone sealant, which has been shown by specified test requirements not to stain the stone.

(b) Kerf clips shall be formed stainless steel or anodized aluminium extrusions.

(c) Anchors in stone other than kerf clips for use in limited areas shall be considered if submitted. Such anchors shall be stainless steel and may be supplemented by an epoxy adhesive. However anchors
which rely solely on adhesive shall not be acceptable. Alternate anchors shall be subject to approval.

(d) The following types of anchors shall not be acceptable :-

i. Wires.

ii. Anchors whose only means of attachment to stone or building is a bed of grout or mortar.

iii. Anchors which are secured in a hole with lead wool packing.

iv. Anchors which transfer load from one piece of stone to another, rather than to the building structure.

(e) Anchors in stone shall provide for differential thermal movement of stone and the support system.

2.1.10.5.7 Glazing materials

(a) Gaskets and weather-strips except at structural silicone glazing shall conform as a minimum to **BS 6262** except :-

i. Sponge gaskets shall be extruded black neoprene with a hardness of 40± 5 durometer Shore A and conforming to **ASTM C 509**. Design sponge gaskets to provide 20% to 35% compression.

ii. Dense gaskets shall be black extrusions with a Shore A hardness of 75±5 for hollow profiles and 60± 5 for solid profiles, and conforming to **ASTM C 864-5**. Outdoor gaskets shall be neoprene or Santoprene. Indoor gaskets shall be neoprene, Santoprene or EPDM. Where indoor and outdoor gaskets are reversible for reglazing, EPDM shall not be used for either gasket.

iii. Injection mold all corners of gaskets where compatible with installation procedures.

iv. Interior and exterior gasket profiles shall be designed to produce a glass edge pressure of not less than 0.70 N/mm, nor more than 1.75 N/mm.

(b) Gaskets at structural silicone glazing :-

i. Glazing gaskets, sealant backers within glazing pockets and continuous glass spacer pads at structural silicone shall be black heat cured silicone rubber.

ii. Gaskets which maintain glass face clearance while serving as a backer for a silicone weather seal may have a friction fit. All other gaskets and weather strips, including backers for structural silicone, shall have a continuous spline or a continuous groove which engages a matching groove or leg on the aluminium frame.

iii. Double side tape is acceptable as a glass spacer pad when used in conjunction with structural silicone, subject to verification of compatibility.

(c) Setting Blocks :-

i. Setting blocks shall be dense extruded neoprene, silicone or EPDM with a hardness of 85±5 durometer Shore A, a minimum length of 100 mm and a minimum width corresponding to the glass thickness. Setting blocks shall be equidistant from the glass centreline. Location of setting blocks at glass quarter points is acceptable. The distance from the vertical glass edge to the nearest edge of the setting block shall not be less than 150 mm or 0.125 times glass width, whichever is greater.

ii. Shims used in conjunction with setting blocks shall be of thesame material, hardness, length and width as the setting locks.

iii. Setting blocks and chairs shall be secured against migration.

iv. Silicone setting blocks shall be required where structural silicone occurs at the sill.

v. Silicone setting blocks shall be acceptable for insulating glass units with silicone edge seals. Neoprene or EPDM setting blocks shall be acceptable only if permitted by the insulating glass fabricator, and if structural silicone does not occur at the sill.

(d) Side/Centering Blocks

i. Provide side blocks at both jambs, between the midheight and top corner of the glass. Blocks shall be 55 □ 5 durometer Shore A dense neoprene, silicone or EPDM.

ii. Install block with clearance between block and bearing surface. Positively secure blocks in position.

iii. Side blocks shall not be required where glass is supported along the vertical edges with structural silicone.

iv. Extruded silicone side blocks shall be acceptable for insulating glass units with silicone edge seals. Neoprene or EPDM side blocks shall be acceptable only if permitted by the insulating glass fabricator.

(e) Structural gasket

i. Structural gaskets shall be composed of rubber based material having proven compatibility with silicone sealants when used in a 'wet' system.

ii. 'Dry' system gaskets shall be extruded with integral locking strips or 'zipper' type insertions producing a compression grip on the frame structure and the glass. They shall be continuously placed around the glazing. The dimensional tolerance and the resulting edge bite shall be as recommended by the manufacturer.

iii. Colour of the gaskets shall be as selected/approved by the Engineer.

2.1.10.5.8 Anchors in concrete and masonry

i. Anchors embedded in concrete and masonry shall be hot dip galvanized rolled steel, or hot dip galvanized cold formed steel to **BS EN ISO 1461**. Galvanize steel parts of anchors. After field welding, remove weld slag and touch up affected area as specified in Clause 2.1.20.4.19.

ii. Strength of embedded anchors shall be developed by integral projections or by welded deformed bars or headed studs.

iii. At masonry, through bolts shall be acceptable provided that bearing plates are used at both masonry surfaces. Expansion bolts shall be acceptable only with prior approval from the Engineer.

iv. At concrete, all bolts should be cast-in-situ. Expansion bolts shall be acceptable only when prior approval has been obtained from the Engineer.

v. Self drilling, self threading screws shall not be acceptable. Screws in plugs and powder actuated fasteners shall not be acceptable.

vi. Areas where curtain walls are installed in “wet area”/“area exposed to weather”, anchors are upgraded to Stainless Steel Anchors embedded in concrete.

2.1.10.5.9 Fasteners

(a) Fastener requirements listed below shall be applicable to screws, bolts, nuts, washers, rivets and pins.

(b) Fasteners outboard of or within a glazing pocket, gutter, flashed cavity or other potentially wet location (after completion of construction) shall be stainless steel type 302 or 304. Fasteners inboard of potentially wet locations shall be stainless steel type 302 or 304, cadmium plated carbon steel or zinc plated carbon steel.

(c) Stainless steel fasteners shall be to BS EN 10263-1 & BS EN 10263-5 and BS EN ISO 3506. Stainless steel washers shall comply with BS 4320 and BS 4464 as far as sizes and

tolerances are concerned.

(d) Bolts, screws, nuts and washers shall be to item 2.1.20.2.6, shall be galvanized to item 2.1.20.4.16 and be tested in accordance with item 2.1.20.3.9.

(e) Provide lock washer or other locking device at all bolted connections.

(f) Power actuated fasteners shall not be acceptable.

(g) Aluminium fasteners shall be to BS 1473.

(h) Actions subsequent to any failure of material or test specimens shall be in accordance with the requirements of Clause 2.1.20.3.10

2.1.10.5.10 Shims

(a) At connections subject to thermal movement or other movement, separate all pairs of moving surfaces with friction reducing pads. Pads shall have minimum 3 mm thickness, shall sufficiently reduce friction to permit movement, shall be resistant to wear, shall be positively retained in position (open ended slots shall not be acceptable). Pads shall not be subjected to heat damage from welding or cutting, or to excessive pressure from over-tightening of bolts.

(b) Shims which transfer shear forces (tending to slide one shim against another) shall be steel plates, set in a staggered pattern and fillet welded to each other and to the adjacent steel surfaces. The shims and welds shall be structurally designed to support the applied loads.

(c) Plastic shims shall be acceptable at static connections for which the shims transfer only compressive forces.

(d) Wood shims shall not be acceptable.

2.1.10.5.11 Weep hole filters

(a) Weep hole filters shall be 8 to 18 pore per centimeter PVC coated open cell urethane foam, compressed 30 to 50 percent.

2.1.10.5.12 Sealants

(a) Capping sealant shall be a one part gun grade moisture curing silicone elastomeric sealant.

The colour of the sealant shall be as selected/approved by the Engineer.

(b) Caulking sealant shall be either :-

i. One part gun grade neutral moisture curing silicone elastomeric sealant.

ii. One part gun grade moisture curing modified polyurethane.

The colour of the sealant shall be as selected/approved by the Engineer.

(c) Structural sealant shall be either :-

i. One part gun grade neutral moisture curing silicone elastomeric sealant.

ii. Two part neutral curing silicone elastomeric sealant. Products requiring mixing of components shall be acceptable only for shop application with mixing and

applicating equipment acceptable to the sealant manufacturer.

(d) Comply with printed instructions and recommendations of the sealant manufacturer regarding joint size limitations, mixing, priming, and application. Unless printed instructions advise to the contrary, do not apply sealants when substrates are wet or when the temperature is below 4^{o}C.

(e) Sealant back-up materials shall be polyethylene foam, urethane foam or extruded silicone as recommended by sealant manufacturer.

(f) All sealant shall be tooled as a separate operation after application.

(g) Coordinate with other sections to assure compatibility of intersecting sealants.

2.1.10.5.13 Thermal insulation and fire-proofing insulation

(a) The maximum Overall Thermal Transfer Values (OTTV) to be used in the design of the building envelope shall be :-

	Building (including walls and roof) (overall)
Commercial Building	23 w/ m^2

(b) Insulate spandrel glass and other non-vision areas with thermal insulation having a 63.0 mm minimum thickness and a 0.127 mm thick reinforced aluminium foil vapour barrier. Minimum R-value for insulation alone shall be 1.90 square meter - K/w.

(c) Insulation shall be retained by aluminium or galvanized steel clips or straps, or integral pockets within the window frames. Maximum spacing of clips and straps shall be 600 mm. Welded or glued impaling pins shall not be acceptable. Maintain 25 mm nominal air space between insulation and glass.

(d) Support insulation where it contacts fire-safing, to prevent bow of insulation from pressure exerted by fire-safing.

(e) Completely fill void at floor and roof edges with fireproof material. Thickness as required to provide a 2 hour fire rating.

(f) Support fire-safing insulation on galvanized steel support clips spaced at a maximum of 450 mm centres.

2.1.10.5.14 Operable windows

(a) Operable windows shall be required to conform to the requirements of this specification. Except as otherwise specified herein, operating windows shall also conform (as a minimum) to **BS 4873** and **BS 6375** :-

i. Weather-strips, glazing gaskets and glazing blocks shall be extruded neoprene. Provide gaskets on both sides of the vent glass.

ii. The required test specimen size is the maximum size operable window for this project.

iii. Locks and strikes shall be white bronze or type 302 or 304 stainless steel. Provide a minimum of two locks and two strikes per vent.

iv. Fixed frames and vent frames shall be extruded aluminium. Vent frames shall consist

of a tubular profile.

v. Weather-strips shall have a continuous spline engaged in a continuous groove in the aluminium sash and/or fixed frame. Two continuous lines of weather-strip shall be required at vent perimeters.

vi. Balance arms shall be four-bar stainless steel type 302 or 304 with adjustable friction shoe. Provide two balance arms per vent.

vii. Provide two limit stops per operable window. Material shall be type 302 or 304 stainless steel. Stops shall restrict clear opening to 100 mm. Effective ventilating area shall be based on the maximum clear opening, not on the gross window area.

viii. Special keys shall be required to open the operable windows.

ix. Hinges and fastening mechanisms shall withstand positive and negative pressures due to specified wind conditions when the windows are in the open or closed positions.

2.1.10.5.15 Aluminium honeycomb panels

(a) Overall nominal thickness shall be 25.0 mm.

(b) Face and back sheets shall be aluminium with nominal thickness of 1.0 mm. Alloy shall be of the 3xxx, 5xxx or 6xxx series and shall satisfy structural and finish requirements. Provide formed edge returns and seal edges with silicone sealant. Bonding surfaces shall be chemically pretreated to assure effective and durable bond.

(c) Core shall be hexagonal cell aluminium foil with minimum nominal thickness of 0.0762 mm. Cell size shall not exceed 6.0 mm measured across flats. Foil shall have an organic corrosion resistant coating. Alloy shall be 3003, 5052, or 2024.

(d) Adhesive shall be a thermal setting modified epoxy with a minimum set temperature of 121^{o}C. The adhesive shall form a fillet at the perimeter of each cell, and shall continuously bond each cell to the face and back sheets.

(e) The face sheet, back sheet, and core of each panel shall be cut from single piece of material.

(f) For panels in p lace, deviation from flatness of exterior face shall not exceed 2 mm along any straight line which extends from a panel edge to any other edge. Where the edge is concealed, the nearest exposed point to the edge shall be used.

(g) Panel exterior face shall be free of visual discontinuities such as ripples, creases, dents, bubbles and blisters, regardless of the measured deviation from flatness at such discontinuities.

2.1.10.5.16 Louvres

(a) Louvres shall consist of extruded aluminium perimeter frames and blades. Frame corners and blade ends shall be welded or fastened with 300 series stainless steel screws. Provide concealed extruded aluminium stiffeners for blades, such that vector sum of blade deflections parallel to blade principal axes does not exceed 1/175 times span at design pressure. Assume that pressure acts perpendicular to the plane formed by the corners of the perimeter frame, and that the tributary area for one blade equals its projected area on the same plane.

(b) Coordinate free area of louvres with mechanical requirements.

(c) Inactive louvres shall be closed by aluminium sheet with minimum 3.0 mm nominal thickness, fastened and sealed to the indoor louver surfaces.

(d) Provide aluminium bird screen mesh at active louvres. Mesh wire shall have 1.6 mm minimum nominal thickness. Openings within mesh shall be 13.0 mm.

(e) Finish for louvres and screens shall be the same as for other aluminium members.

2.1.10.5.17 Copings

(a) Copings shall comply with the following :-

i. Copings shall comprise aluminium minimum 3.0 mm thick or stainless steel minimum 2.0 mm thick. The surface of aluminium shall have finish to match colour of framing.

ii. Copings shall be rigid, reinforced with a metal frame if required and shall be fixed rigidly to the structure. Copings shall be strong enough to resist forces due to extreme wind forces and casual impact.

iii. Ends of coping panels and joints to curtain wall frame shall be tightly sealed up and an effective drainage system shall be provided to drain out any water that may penetrate through the joints.

2.1.10.5.18 Concealed and exposed flashing

(a) Acceptable materials are PVC sheet, neoprene sheet, stainless steel sheet and mill finish aluminium sheet. Minimum thicknesses are 1.6 mm for PVC and neoprene, 0.25 mm for stainless steel, and 1.0 mm for aluminium. Aluminium shall be required to have a bituminous coating against dissimilar materials.

(b) Provide sealed lap joints, end dams and transitions to gutters, dressings to roofs/abutments, louvres and screens to A/C intakes and exhausts.

(c) PVC sheet and neoprene sheet shall not be acceptable as primary gutters, which shall be metal with suitable corrosion protection.

(d) Exposed flashing shall be strong enough to resist forces due to typhoon and casual impact.

2.1.10.5.19 Maintenance/ replacement standby materials

(a) Upon completion of construction, deliver to a designated storage area replacement standby materials for maintenance and repair. Materials shall conform to the same requirements as materials used for construction.

(b) The replacement standby materials shall be stored in clearly labelled protective boxing and/or crates and positioned on support frames and/or storage racks which are placed in appropriate locations to ensure the material shall not be damaged or deteriorate.

2.1.10.5.20 Finishes

(a) Exposed metal surfaces shall be finished to match the appearance, colour and texture of the samples as approved by the Engineer.

(b) Finishes to metals shall be :-

i. Clear or coloured anodic finish to aluminium shall comply with **BS 3987**.

ii. No. 8 bright polished finish to exposed faces of stainless s teel.

iii. No. 7 polished finish to stainless steel or chromium plated ironmongery.

iv. Alternative finishes shall be approved by the Engineer.

v. Organic coatings to meet the requirements of **BS 4842** and/or **BS 6496**.

(c) All as specified and indicated on the drawings.

2.1.10.5.21 Protective treatments

(a) Protective treatment to concealed steel parts of the curtain wall system such as fixings, connectors, etc., shall be hot dip galvanizing to **BS EN ISO 1461**.

(b) All welding and provision of holes shall be completed before galvanizing.

(c) No in-situ welding is allowed unless prior approval has been obtained from the Engineer.

2.1.10.5.22 Anodic coating to aluminium and testing of same

(a) The thickness of anodic coating shall be minimum 0.025 mm. Coloured anodic coatings and testing of same shall be as approved by the Engineer.

(b) Samples of finished aluminium from production lots shall be tested in accordance with BS 3987.

(c) Complete certified inspection records for quality of finish and complete finish process records shall be maintained and made available to the Engineer on request.

(d) Repair of damage to finished surfaces by mechanical means (other than those specified) or by painting is strictly forbidden unless authorized in writing by the Engineer.

(e) Surfaces to be finished shall be free from mechanical imperfections such as scratches, scrapes and dents. Finished surfaces shall be free from finished imperfections such as spots, stains and streaks.

(f) Materials may be finished more than once provided that all specified requirements are satisfied. However, any material which has been finished twice and is still not acceptable shall be rejected

2.1.10.5.23 Organic coating finish to aluminium

(a) Organic coating finish shall comply with the following general requirements :-

i. All coatings, when cured, shall be visibly free of flowlines, streaks, sags, blisters or other surface imperfections.

ii. All finishes shall match in gloss, and fall within the colour range of the approved samples.

iii. Dry film thickness of coating on exposed s urface, when measured in accordance with **BS 4842** shall not be less than 45 microns, except in channel recesses and internal corners, which shall be visually covered.

(b) Paint all surfaces of metal cladding.

(c) Prepare and submit colour samples to the Engineer. After selection by the Engineer, prepare 6 sets each of two samples which shall define the colour and gloss range and submit to the Engineer for endorsement. Samples shall be identified and attached with a full laboratory report as per **BS 4842** and **BS 6496**.

(d) Painted aluminium finish shall be factory oven cured minimum two-coat finish of fluoropolymer resin supplied by a licensed formulator. The licensed formulator shall identify the finish which he supplies to meet the minimal requirements for formulation as set forth in the licensing agreement.

(e) Application of the finish shall be carried out in accordance with the specifications issued by the licensed formulator and by an applicator specifically approved by one (or more) of the formulators. The applicator shall provide written notification of approval by a formulator prior to application of the finish. The formulation shall contain at least 70% fluoropolymer resin in the residual solids.

(f) Pretreat metal surfaces in accordance with the procedure recommended by the manufacturer to provide proper surfaces for coating.

(g) Pigmented organic coatings for extrusions, structural shapes, sheet or plate, spray applied in the factory, shall meet the requirements of **BS 4842** and **BS 6496.**

(h) Field touch-up of painted aluminium is permitted only with the written permission of the Engineer. Unless touch-up is authorized, replace damaged material with new material.

2.1.10.5.24 Aluminium finish at structural silicone

(a) Mill finish shall not be acceptable at structural silicone bonding surfaces.

(b) Aluminium surface to which structural silicone will be adhered shall have a finish which demonstrates by test the ability to satisfy specified requirements. Subject to testing, acceptable finishes shall be as follows :-

i. Factory applied two-coat oven cured fluoropolymer paint conforming to **BS 4842** and/or **BS 6496**.

ii. Architectural Class I anodizing conforming to **BS 3987**.

iii. Alodine conversion coating.

2.1.10.6 Workmanship

2.1.10.6.1 Generally

(a) Material, components and systems shall be used in compliance with the standards and procedures of the appropriate manufacturers. All work shall be of the highest quality and be
carried out by competent tradesmen holding relevant trade certification, such that the finished

work satisfies the requirements of the specification. Practice shall conform to the relevant part and in the priority of :-

i. **BS EN 1999-1-1:2007+A1:2009**: Structural Use of Aluminium.

ii. Structural steel shall be to Section 2.1.19.

iii. **BS 6262** - Code of practice for glazing of buildings.

iv. **BS 8200** - Design of non-load bearing external vertical enclosures of buildings.

v. **BS EN ISO 11600:2003+A1:2011**- Specification for one-part gun grade silicone based sealants.

(b) Recommended glazing guidelines for reflective insulating glass by AAMA.

(c) Aluminium Curtain Wall Design Guide Manual by AAMA.

(d) Metal Curtain Wall Manual by AAMA.

(e) No temporary stress or force shall be applied at any time to the assembly, units, individual components or fixing devices which these have not been designed to withstand. Provide temporary supplementary frame stiffeners for curtain wall units for handling purposes when required.

(f) Conform strictly to the material finishes, shapes, sizes, thickness, and joint locations required by the agreed shop drawings and the Specification.

(g) Match all materials to produce continuity of line, colour and texture.

(h) Protect from damaging curtain wall units and components stored on the site.

(i) Store glass on the site in a dry well-ventilated sheltered location.

(j) Handling glass shall be kept to a minimum and all glass shall be carefully protected from soiling, condensation and damage. To avoid damage of glass, all glass must not be slided directly on hard surface and ensure the frames free from sand and any hard bits before installation.

(k) Carry out all final fitting and assembly work on the Site in a workshop established and equipped for that purpose.

(l) All components exposed in the finished work shall be free from warping, oil-canning effects and the telegraphing of welds, studs and other fasteners.

(m) Provide specified finishes on all exposed surfaces. Provide specified galvanizing on concealed steel.

(n) Systems with glass supported at all edges by structural silicone shall be unitized and shall be fully assembled, including silicone and glass, in the workshop.

2.1.10.6.2 Setting out

(a) Before commencing any work, verify all measurements of the "as constructed" building. If any discrepancies are found they shall be brought immediately to the attention of the Engineer. Design curtain wall anchorage to accommodate a minimum 25 mm construction tolerance in any direction of the building structure.

(b) Accurately set out the Works and take all necessary Site dimensions.

2.1.10.6.3 Joints in curtain wall

(a) Visible joints in the curtain wall shall be as shown on the drawings. Other joints shall be hairline joints, tightly fitted and coordinated with mullion grids.

(b) All fastening, jointing and splicing of members shall be concealed. Exposed fasteners shall only occur where expressly permitted by the Engineer. Where exposed in the finished work, screws shall be the countersunk head type, finished to match the adjacent surface.

(c) Fasteners shall not penetrate gutters and drainage systems.

2.1.10.6.4 Corrosion protection

(a) Aluminium in contact with dissimilar metal excluding non-magnetic stainless steel shall be treated with an approved treatment for the prevention of electrolytic action and corrosion.

(b) Aluminium surfaces in contact with mortar, concrete, plaster, masonry and similar materials and wet-applied materials in fire -proofing and absorptive materials shall be coated with an approved anti-corrosive moisture-barrier material.

(c) The Contractor shall clearly state what material is to be applied and provide a certificate from the curtain walling manufacturer certifying that the material is suited for its intended purpose

2.1.10.6.5 Metal to metal contact

(a) Separate metal surfaces in such a manner that metal does not rub against metal. Materials used for this purpose shall be lubricating devices, sealants, slip pads or gaskets.

2.1.10.6.6 Welding

(a) Welding of steel shall be in accordance with **BS 499** and **BS EN 1011-1** and **BS EN 1011-2**.

(b) Welding of aluminium shall be to **BS EN 1011-4:2000**

(c) Welding of Aluminium shall be tested to**, BS EN ISO 4136:2011**, **BS EN ISO 5173:2010+A1:2011, BS EN 1320:1997, BS EN 1321:1997**.

(d) The type, size and spacing of welds shall be as shown on the agreed shop drawings. Welding materials and methods shall be such as not to cause distortion, discolouration, or result in any other adverse effect on the required profiles and finishes of the exposed curtain wall.

(e) Weld spatter and welding oxides on exposed surfaces shall be removed, and prime painted with zinc rich coating.

(f) Unless otherwise shown or specified, weld beads on exposed surfaces shall be ground and finished to match and blend with finish on adjacent metal. Grinding and polishing of nonferrous metal shall be done only with clean wheels and compounds free from iron and iron compounds. No soldering and/or brazing shall be allowed.

2.1.10.6.7 Application of sealant and gaskets

(a) Sealant application shall be to **BS EN ISO 11600:2003+A1:2011**. Sealant and gaskets shall be as shown on the approved shop drawings.

(b) The design of all sealed joints shall be in accordance with the recommendation of the

sealant and/or gasket manufacturer.

(c) Protect all adjoining surfaces to s ealants and gaskets against staining.

(d) Joints, joint surfaces and glazing rebates shall be clean, dry, and free of any material that may have an adverse effect on the bonding or sealing of the sealant and gasket materials or on the proper drainage of the glazing rebates.

(e) Apply sealants and gaskets under the conditions and in the manner recommended by the manufacturer. No sealant that has started to set in its container or has exceeded its shelf life shall be used. Do not apply sealants externally during raining period.

(f) The sealant manufacturer shall provide written notification if the relevant substrates in contact with sealants shall or shall not require priming. The recommendations shall be based on tests conducted by the sealant manufacturer using samples of the relevant substrates for the project. Unless printed instructions state to the contrary, sealant shall not be applied when substrates are wet or when the temperature is below 4.5^{o}C.

(g) Fill all joints continuously and completely with sealant, forming a neat, uniform, concave or flat bead finish flush with adjoining surfaces unless otherwise shown on the drawings. All sealant surfaces shall be tooled smooth.

(h) Exposed sealants shall be installed so that top surfaces of the horizontal sealant beads shall be sloped to drain water away.

(i) Glazing gaskets shall be of the profile, dimension and durometer required to support the glass and resist water penetrations. Exterior glazing gaskets shall have factory made pre-molded corners.

2.1.10.6.8 Render stops

(a) Incorrect placement, leveling or lining-through of angles to in-situ finishings and the like fixed by others shall be immediately reported in writing to the Engineer.

2.1.10.6.9 Sequence of installation

(a) Coordinate and carry out the installation of the curtain wall in sequence with related work operations to be executed by others as necessary to achieve a weather-tight and satisfactory visual relationship between the various components and the structure, finishes and weather seals.

2.1.10.6.10 Erection

(a) Install materials in accordance with approved drawings. Provide labour, materials, equipment and supervision necessary for a complete installation. Align and anchor materials to building structure. Seal joints within work of this section and at joints with adjacent construction.

(b) Coordinate erection with requirements of materials hoist and manlift. Defer installation at areas obstructed during construction and install materials when obstructions are removed.

(c) Tolerances :-

i. Provide anchor adjustment capability for the full range of specified tolerances for the building structure and to accommodate construction tolerances and short term building movements (i.e. concrete column settlement).

ii. Work of this section shall be within the following tolerances.

- Deviation from plumb, level or dimensioned angle shall not exceed 3.0 mm per 3600 mm of length of any member, 6.0 mm in any total run in any line.
- Deviation from theoretical position in plan or elevation, including deviation from plumb, level or dimensioned angle, shall not exceed 10.0 mm total at any location.Change in deviation shall not exceed 3.0 mm per 3600 mm run in any direction.
- Maximum offset from alignment between two consecutive members placed end to end shall not exceed 1.5 mm.
- Maximum offset between glass framing members at corners of glazing pocket shall not exceed 0.8 mm.

(d) Anchorage :-

i. Anchor component parts securely in place by bolting.
ii. Welding may be used if prior approval is obtained from the Engineer. Install slip pads between moving parts.

iii. Provide non-corrosive separators between dissimilar materials.

iv. Remove weld slag and apply prime paint over welds. Touch up hot dip galvanizing that is damaged by welding or other causes.

v. Where slots or oversize holes are provided for adjustment only, secure the connection after final adjustment.

vi. Interlocking serrations in extruded aluminium brackets and washers shall be acceptable. Steel weld washers with 6.0 mm minimum thickness shall be acceptable with steel brackets.

vii. Special washers or nuts which rely on friction and/or surface indentation of the fastened partshall not be acceptable.

viii. Bolts shall be double nutted, have an acceptable spring washer or be painted/coated with a lock-tight liquid to prevent bolts from loosening.

ix. All fixings shall be concealed when the work is completed.

(e) Clean surfaces shall be sealed. Install backers, bond breakers, primers and sealants in accordance with drawings, test results and manufacturer recommendations. Tool sealants as a separate operation after application. Immediately remove any masking.

(f) Install thermal insulation, vapour barrier and fire-safing insulation with specified supports.

(g) Adjustment :-

i. Adjust operating windows and doors for proper fit within fixed frame.

ii. Adjust weather-strips for continuous contact and seal in closed position.

iii. Adjust hardware for proper operation from closed and locked position to fully open position.

2.1.10.6.11 Glazing

(a) Glazing shall be to **BS 6262** and in accordance with the manufacturer's recommendations.

i. Glazing shall be carried out from inside the building whenever possible.

(b) Glass and glazing materials shall be compatible with each other and the glass shall be protected from damage and staining of any kind.

i. The weather seal at glass perimeters shall be a combination of sponge and dense gaskets. Gaskets shall be hot melt injection molded at corners where compatible with installation procedure. Where gasket joints occur, tightly butt ends and seal with a compatible sealant. Gasket joints shall not occur at locations other than corners.

ii. Glass shall be new. Glass shall be of the specified type and quality with cleanly cut edges and sharp corners. Inspect glass before installation. Do not install defective glass.

iii. Before setting glass, inspect frame for proper dimensions and squareness. Adjust frame and/or glass size as required to meet specified requirements for glass bite dimensions and glass edge clearance.

iv. Except as otherwise specified, comply with **BS 6262**. Provide a minimum nominal glass bite of 13 mm. Where joint movement shall result in variable glass bite, increase nominal bite to provide 10.0 mm minimum bite and 6.0 mm minimum edge clearance. In no case shall the front and back clearances be less than 5.0 mm.

v. Thoroughly clean glazing pocket before setting glass. Solvents shall be compatible with finished aluminum, glass and glazing materials.

vi. Setting blocks shall be equidistant from the glass centreline.

vii. Location of setting blocks at glass quarter points is acceptable. The distance from the vertical glass edge to the nearest edge of the setting block shall not be less than 150 mm, or 0.125 times glass width, whichever is greater. Side blocks shall be located between the midheight and top corner of the glass. Side blocks, setting blocks and chairs shall be positively retained in position.

viii. Fasteners shall not penetrate glazing pockets.

ix. Remove and replace stops and apply sealants as required for a complete glass installation.

x. Defer glazing of openings which are obstructed during construction.Glaze such opening when obstructions are removed.

xi. Leave glass in crates until just prior to installation. Replace any glass which breaks or sustains edge damage, surface damage or damage to reflective coating as defined in Clause 2.1.10.5.4..

xii. Clean, prime and mask at structural silicone joints within 8 hours before applying the silicone.

xiii. Temporarily clamp glass during cure of structural silicone. After sufficient cure, remove clamps and fill any gaps in silicone.

xiv. Mask glass and aluminium during application of structural silicone. Remove masking immediately after tooling sealant.

xv. Structural silicone shall not be applied to edges of insulating glass units, or to edges of laminated glass units. Sealants used as weather seals shall not be adhered to, or placed against, the edge of a laminated glass unit inter-layer

2.1.10.6.12 Stone fabrication

(a) Fabrication tolerances for exposed surface of individual pieces of stone shall be as follows :-

i. Length and height (or width): 1.0 mm.

ii. Depth of a saw cut: 2.0 mm.

iii. Depth of a drilled hole: 3.0 mm.

iv. Deviation from flat plane in 1200 mm, any direction: 2.0 mm.

v. Deviation from square: 2.0 mm difference in diagonals.

vi. Deviation from nominal thickness: 2.0 mm.

vii. Position of kerf cut relative to outdoor face ±1.0 mm.

(b) Fabrication tolerances for exposed surface of one stone system assembly with stone anchored to a support system shall be as follows:-

i. Sealant joint width between pieces of stone: ±25% of nominal. (Joints which absorb thermal and building movements shall require stricter tolerance.)

ii. Overall length and height (or width), stone edge to stone edge: 3.0 mm.

iii. Offset (in/out) between adjacent stone edges: 1.5 mm maximum.

iv. Deviation from flat plane for overall length: 5.0 mm.

v. Deviation from flat plane for overall height (or width): 3.0mm.

vi. Difference in overall diagonals measured to outside corners of stone: 5.0 mm maximum.

i. Deviation from straight line along entire length of vertical edge: 2.5 mm maximum.

ii. Deviation from straight line along entire length of horizontal edge: 2.5 mm maximum.

iii. Offset (in plane) between adjacent granite corners: 3.0 mm maximum (distance between parallel horizontal or vertical lines through corners).

iv. Window opening dimension: 6.0 mm.

v. Where more than one tolerance applies, the stricter tolerance shall govern.

2.1.10.6.13 Mock-ups erection and tests

(a) Fabricate and erect within 60 days of the agreement by the Engineer of shop drawings, the following mock-up samples for the Engineer's approval prior to fabrication of the bulk :-

i. Furnish labour and materials to build and test mock-ups as shown on drawings. Mock-ups shall accurately represent job conditions including joints, sealants, glass, glazing, stone panels, anchors and finishes. Install sufficient fire-safing insulation to demonstrate details of installation. Install sufficient thermal insulation to demonstrate details of installation. Delay installation of fire –safing and thermal insulation until completion of air, water and structural tests.

ii. Each mock-up shall be glazed with one consistent set of gaskets. The use of multiple gasket profiles and/or thicknesses at the Contractor's discretion shall not be permitted.

iii. Prior to tests, remove and reglaze selected glass units, using the details and procedures intended for glass replacement on the actual building. Reglazed units shall satisfy test criteria.

iv. Provide at least one extra light of glass for each type and size on mock-ups. Glass which breaks during testing shall be replaced with new glass and the tests continued. Repeated glass breakage shall constitute failure.

v. Construct mock-ups in strict accordance with approved mock-up shop drawings. Deviations from or additions to details shown on Drawings shall be subject to approval.

vi. Construct mock-up with the exterior side facing outward.

vii. The testing laboratory shall be responsible for conducting and reporting the tests, and shall state in the report whether or not the test specimen is as specified, and shall specifically note deviations therefrom.

viii. If failures occur, revise and retest mock-ups until satisfactory test results are achieved. Modifications shall be realistic in terms of job conditions, shall maintain standards of quality and durability, and shall be subject to approval.

ix. Mock-up testing shall be done at an independent laboratory to be approved by the Engineer. If dynamic water infiltration test is specified,laboratory shall have capability to conduct dynamic testing as specified. Submit detailed information on laboratory facilities and test equipment for approval.

x. Mock-ups shall be subject to observation by the Engineer throughout their construction and testing. Provide minimum two week notice before beginning construction of mock-ups. Provide materials and personnel for prompt continuous construction of mock-ups. The Contractor shall coordinate chamber availability, shipping schedules and mock-up construction schedules directly with the laboratory.

(b) The testing laboratory shall not do any of the following :-

i. Act as consultant to the Contractor for the Works.

ii. Modify performance requirements.

iii. Modify mock-up configuration.

iv. Dismantle mock-ups until notified that no further testing is required.

(c) Undocumented tests shall not be permitted. All test results and all remedial work shall be documented in the laboratory report.

(d) Mock-up configuration is shown on Drawings. The mock-up design pressures and maximum test pressures shall be as specified.

2.1.10.7 Protection and Cleaning

2.1.10.7.1 Protection

(a) Provide protective sheeting or tape to aluminium or stainless steel members and ancillaries. Package and store materials in a manner that shall prevent surface damage or contamination, distortion breakage or structural weakening.

(b) Remove sheeting or tape as soon as practical so as not to stain and/or leave an adhesive residue on the relevant substrates.

(c) Protect glass against damage, discolouration or staining. Replace damaged or broken glass, regardless of the cause.

2.1.10.7.2 Labels

(a) No labels shall be adhered to glass other than those of the glass manufacturer which shall be adhered with a non-alkaline adhesive. Remove labels from glass after glazing

2.1.10.7.3 Cleaning

(a) Thoroughly wash and clean the work immediately prior to hand-over. No alkali washes or other patent cleaning solutions shall be used which may stain, mark or otherwise harm the installation.

(b) Periodically remove from the site debris, excess materials and unused tools and equipment resulting from this work. At the conclusion of construction, leave the premises in a clean condition

2.1.10.7.4 Ironmongery

(a) All hinges, locks, opening devices etc., shall be properly adjusted and in perfect working order. Hand over two sets of keys for each lock to the Engineer on completion.

2.1.10.7.5 Maintenance manual

(a) The Contractor shall provide a maintenance manual for the completed works which shall include, but not be limited to the following information :-

i. The name, address and telephone number of each firm and/or sub-contractor involved in the supply of components for the curtain wall.

ii. The manual shall include a clear, concise description of the construction methods

used to form the various areas of the curtain wall for the particular project.

iii. The manual shall include copies of material and component certification, as well as, test reports as required herein.

iv. The manual shall include a method statement covering the procedures for the replacement of damaged or otherwise defective components such as glass lights, stone panels, aluminum panels and/or components or anchors.

v. The manual shall include specific recommendations for routine maintenance, cleaning procedures, suitable cleaning agents as well as the frequency of inspections and adjustments that may be necessary.

vi. The manual shall include a full/complete set of Drawings, modified to incorporate any omissions and/or additions to the Works.

vii. The manual shall indicate the terms and periods of any guarantees and/or warranties.

2.1.10.7.6 Maintenance access

(a) The Contractor shall submit proposals whereby the curtain wall can be cleaned and maintained.

2.1.10.8 References and Standards

BS EN 10029 (2010): Hot-rolled steel plates 3 mm thick or above. Tolerances on dimensions and shape

BS EN 10048 (1997): Hot rolled narrow steel strip. Tolerances on dimensions and shape.

BS 952-1 (1995): Glass for glazing.Classification.

BS 952-2 (1980): Glass for glazing.Terminology for work in glass.

BS EN ISO 1461 (2009): Hot dipped galvanised coatings on fabricated iron and steel articles. Specifications and test methods.

BS 6262 (2005): Glazing for building.

BS 5713 (1979): Specification for hermetically sealed flat double glazing units

BS EN 10263-1(2001): Steel rod, bars and wire for cold heading and cold extrusion. General technical delivery conditions

BS EN 10263-5 (2001): Steel rod, bars and wire for cold heading and cold extrusion. Technical delivery conditions for stainless steels

BS 4320 (1968:1998): Specification for metal washers for general engineering purposes. Metric series.

BS 4464 (1969:1998): Specification for spring washers for general enegineering and automobile purposes.

BS 1473 (1972): Specification for wrought aluminium and aluminium alloys for general engineering purposes-rivet, bolt and screw stock.

BS 4873 (2009): Aluminium alloy windows and doorsets. Specification.

BS 6375 (2009): Performance of windows and doors.

BS 3987 (1991): Specification for anodic oxidation coatings on wrought aluminium for external architectural applications.

BS 4842 (1984): Specification for liquid organic coatings for application to aluminium alloy extrusions, sheet and preformed sections for external architectural purposes, and for the finish on aluminium alloy extrusions, sheet and preformed sections coated with liquid organic coatings

BS 6496 (1984): Specification for powder coatings for application and storing to aluminium alloy extrusions, sheet and preformed sections for external architectural purposes, and for the finish on Aluminium alloy extrusions, sheet and preformed sections coated with powder organic coatings

. BS EN 1999-1-1 (2007+A1:2009): Eurocode 9. Design of aluminium structures. General structural rules

BS 8200 (1985): Code of practice for design of non-loadbearing external vertical enclosures of buildings

BS 499-1 (2009): Welding terms and symbols. Glossary for welding, brazing and thermal cutting

BS EN 1011-4 (2000): Welding. Recommendations for welding of metallic materials. Arc welding of aluminium and aluminium alloys.

BS EN 1320 (1997): Destructive tests on welds in metallic materials. Fracture tests

BS EN 1321 (1997): Destructive test on welds in metallic materials. Macroscopic and microscopic examination of welds

BS EN ISO 3506 (2009): Mechanical properties of corrosion resistant stainless steel fasteners.

ASTM C1048-04 (2004): Standard Specification for Heat-Treated Flat Glass - ;Kind HS, Kind FT Coated and Uncoated Glass

ASTM C864-05 (2011): Standard Specification for Dense Elastomeric Compression Seal Gaskets, Setting Blocks, and Spacers

ASTM C509-06 (2011): Standard Specification for Elastomeric Cellular Preformed Gasket and Sealing Material

ANSI Z97.1 (2004): Safety Glazing Materials Used in Buildings - Safety Performance Specifications and Methods of Test

BS EN ISO 11600 (2003+A1:2011): Building construction. Jointing products. Classification and requirements for sealants

BS EN 1011-1 (2009): Welding. Recommendations for welding of metallic materials. General guidance for arc welding

BS EN 1011-2 (2001): Welding. Recommendations for welding of metallic materials. Arc welding of ferritic steels

BS EN ISO 4136 (2012): Destructive tests on welds in metallic materials. Transverse tensile test

BS EN ISO 5173 (2010+A1:2011): Destructive tests on welds in metallic materials. Bend tests

2.1.11 CARPENTRY AND JOINERY

2.1.11.1 Generally

2.1.11.1.1 Generally

(a) Timber generally shall be to **BS EN 942** and to be of mature growth, properly seasoned and sawn square.

(b) Timber shall be free from wood wasp holes, large loose or dead knots, splits or other defects that will reduce its strength.

(c) Pin holes and worm holes may be permitted to a slight extent in a small number of pieces, subject to the acceptance of the Engineer, provided that there is no active infestation of the materials, that the strength of the member is not impaired and that they do not appear on the finished faces of joinery work.

2.1.11.1.2 Timber for external use

(a) Species: Timber shall be either hardwood or softwood suitable for external use.

(b) Approved softwood may be cypress, pine, cedar or fir. Approved temperate hardwoods may be camphor, oak, teak or mahogany. Submit the species to be used to the Engineer's for approval

(c) Source of Supply: Obtain timber either softwood or hardwood from a sustainable forest or plantation.

(d) Seasoning: Moisture content to be in accordance with Clause 2.1.11.1.4

(e) Maintain the specified moisture content of the timber until preservative treatment described
below is applied.

(f) Preservative: Clear colourless copper chrome arsenic to **BS 4072** or other suitable approved preservative.

2.1.11.1.3 Storage

(a) Store timber in a dry, well ventilated place, and protect from the weather.

2.1.11.1.4 Moisture

(a) Calculate moisture content at the time of fabrication by the following formula :-

[Wet (or supplied) Mass – Dry Mass] / Dry Mass x 100 = Moisture Content (percentage)

(b) The dry mass shall be determined by drying in an oven at a temperature of 103^{o}C ± 2^{o}C until the weight is constant.

(c) The maximum permissible moisture content in timber to be incorporated into the work shall be as follows :-

i. Internal timber for use in Air Conditioned space 12%

ii. Internal timber generally 16%

iii. Timber with one face to the exterior of the building and one face to the interior (e.g. window frames) 18%

iv. External timber (e.g. fencing etc.) 20%

(d) If these percentages cannot be attained due to local circumstances of supply and availability, the Engineer' s attention must be drawn to the fact.

2.1.11.2 Materials

2.1.11.2.1 Softwood

(a) Submit samples of timber for joinery for approval where the grain shall be left exposed or where the surfaces shall be varnished or similarly treated.

(b) Softwood for carpentry to be Cypress, Pine, Cedar, Spruce or Fir or other species approved by the Engineer. All timber shall be appropriately stamped or marked to identify origin and grade. All timber shall be kiln dried and vacuum impregnated to international standards, with Copper Chrome Arsenate, or as directed otherwise by the Engineer.

2.1.11.2.2 Hardwood

(a) Hardwood shall only be used in special circumstances under the direction of the Engineer.

(b) Density of hardwood shall be 720 kg/m^3 (minimum) at 15% moisture content.

(c) Submit to the Engineer the following information:

(d) The species and country of origin.

(e) Teak, which is only permitted to be specified in special circumstances, shall have a density of 650 kg/m^3 (minimum) at 15% moisture content. They shall be accredited with a certificate from the Approved Authority.

2.1.11.2.3 Flooring

(a) Softwood or hardwood species used for timber flooring shall comply with Clause 2.1.11.2.1 and Clause 2.1.11.2.3.

(b) Boarded or strip flooring shall be selected and approved hardwood, as specified, or as submitted to the Engineer for selection. Finished thicknessshall be 20 mm (minimum).

(c) Wood block flooring shall be approved high density resin bonded fibreboard flooring or other approved hardwood as specified. Finished thickness shall be 20 mm (minimum). Blocks shall be 300 mm x 50 mm in size and colour matched.

(d) Wood parquet flooring blocks shall be 120 mm x 25mm in size and 8 mm thick, and shall be tongued & grooved.

2.1.11.2.4 Weather boarding

(a) Hardwood weather boarding shall be 150 mm wide and tapering from 25 mm to 10 mm thick and shall be :-

i. Sawn boarding or boarding wrot on one face and two edges with horizontal joints lapped 30 mm.

ii. Boarding as (a) but with wider edge rebated with joints lapped 20 mm.

2.1.11.2.5 Plywood

(a) Plywood shall be to **BS EN 636** and of the following grades, as specified :

i. "Grade 1 veneer" - hardwood faced, as specified, for natural finish.

ii. "Grade 2 veneer" - luan faced for painting.

(b) Generally the bonding adhesive between veneers shall be resin adhesive classified as moisture and weather resistant (M.R.) in **BS 1203**.

(c) Nominal standard thicknesses of plywood shall be 3, 4, 5, 6, 9, 12, 15, 18 and 25 mm.

(d) Plywood containing hardwoods of unknown species or from unidentified sources are expressly prohibited from use.

(e) Marine plywood shall be to **BS 1088-1:2003** and **BS 1088-2:2003** bonded with Type W.B.P. adhesive between plys.

2.1.11.2.6 Blockboard

(a) Blockboard shall be Grade 2 veneer for painting, and bonded with Type M.R. adhesive .

2.1.11.2.7 Hardboard

(a) Hardboard shall be to **BS EN 120** . "Standard" (Types SHA, SHB and SHC) or "tempered" (Type THE and THN) as specified.

2.1.11.2.8 Insulating board

(a) Insulating board (Softboard) shall be to **BS EN 120** .

2.1.11.2.9 Wood chipboard

(a) Wood chipboard shall be unsanded or sanded board to **BS EN 120**. Veneered chipboard shall be an approved proprietary.

(b) Melamine-faced chipboard shall be to **BS 7331:1990**. All wood chipboards shall be low formaldehyde emission chipboard (Class E1) unless permitted otherwise by the Engineer, or polyurethane - based chipboard with zero formaldehyde emission.

(c) Any boarding shall be used in wet areas such as kitchens or bathrooms shall be High Moisture Resistant board to **BS EN 120 :1992**.

2.1.11.2.10 Medium Density Fibreboard (MDF)

(a) Board type shall be moisture resistant grade (MDFMR) with density in excess of 600 kg/m^3 to **BS EN 120** .

2.1.11.2.11 Glass fibre

(a) Glass fibre insulating quilt shall be light-weight bonded mat weighing 12 kg/m3 uncompressed.

(b) Glass fibre insulating board shall be semi -rigid resin-bonded glass fibre weighing 45-48 kg/m^3.

2.1.11.2.12 P.V.C. or acrylic sheet

(a) PVC or acrylic sheet shall be clear, translucent or coloured, as specified, and to be approved by the Engineer.

2.1.11.2.13 Laminated plastic sheet

(a) Laminated plastic sheet shall be to **BS EN 438**. Class HG (Horizontal-General Purpose) or VG (Vertical-General Purpose) as specified.

2.1.11.2.14 Acoustic tiles

(a) Acoustic tiles shall be of an approved proprietary brand meeting the requirements of **BS EN 13964** manufactured from the following materials:-

(b) Wood or other organic fibre insulating board to **BS EN 120** , 12 mm (Minimum) thick for 300 mm x 300 mm tiles and 15 mm (minimum) thick for 400 mm x 400 mm tiles.

(c) Mineral fibre or wool insulating board 12 mm (minimum) thick for 300 mm x 300 mm tiles and 15 mm (minimum) thick for 400 mm x 400 mm tiles.

(d) Approved multi-purpose, dimensionally stable building board 6 mm (minimum) thick.

(e) Tiles shall have a plain, perforated or fissured surface with a factory applied decorative finish. The edges shall be square, bevelled, or bevelled and grooved to suit the suspension system.

2.1.11.2.15 Nails

(a) Nails shall be steel nails to **BS 1202:Part 1**, with "bright" finish, unless otherwise specified.

(b) Nail lengths shall be not more than the total thickness of sections to be joined less 5 mm, or not less than twice the thickness of section through which nails are driven.

(c) Where the thickness of the outer section through which nails are being driven is less than half that of the section to which nailing is being done, the depth of penetration of the nails into the latter shall be not less than 10 diameters of the nails being used.

2.1.11.2.16 Screws

(a) Wood screws shall be brass, stainless steel, alloy or other non-corroding metal to **BS 1210** with countersunk heads, unless otherwise specified. Steel screws shall only be used for temporary work. The proper dedicated screws shall be used for all Particle-board fixing.

(b) Screw lengths shall be not more than the total thickness of sections to be joined, less 5 mm, or not less than one and a half times the thickness of section through which screws are driven.

(c) Where the thickness of the outer section being screwed is less than half that of the section to which screwing is being done, the depth of penetration of the screwing into the latter shall be not less than the thickness of the outer section.

(d) Screw cups shall be brass cups or stainless steel.

2.1.11.2.17 Masonry nails

(a) Do not use masonry nails or drive pins without approval.

2.1.11.2.18 Explosive cartridge fixings

(a) Obtain approval before using explosive cartridge operated fixings. All fixings shall be in accordance with the BS 4078-1 & BS 4078-2. Use tools, normally of the indirect acting type, plus pins and cartridges which correspond with the manufacturer's specifications for that tool. A tool shall only be used by a person holding a certificate of competency specifying the maker and model of the tool on which he has been successfully trained.

2.1.11.2.19 Plugs

(a) Plugs for fixing to hard materials shall be proprietary plugs of plastic, soft metal, fibre or similar.

(b) Fixing to friable materials, plasterboard and the like shall be proprietary fixings specially designed for that situation.

(c) The use of wood plugs shall not be permitted.

2.1.11.2.20 Adhesive

(a) Adhesive for wood shall be as follows:-

i. For internal use; synthetic resin adhesive classified as moisture resistant and moderately weather-resistant (M.R.) in **BS 1204: Part 1**.

ii. For external use or internal use under very damp conditions:synthetic resin adhesive classified as weather-proof and boil-proof (W.B.P.) in **BS 1204:Part 1**.

(b) Adhesive for fixing laminated plastic sheet shall be synthetic resin adhesive classified as weather-proof and boil-proof (W.B.P.) in **BS 1204: Parts. 1 and 2.**

(c) Where the temperature exceeds 25°C, a "warm-setting" grade of adhesive shall be used.

(d) The use of animal glues shall not be permitted.

2.1.11.2.21 Resin for MDF panels

(a) All urea formaldehyde bonded MDF panels and MUF mouldings shall be manufactured with low emission resins conforming to European E1 emission standard of 9mg/100g (minimum).

2.1.11.2.22 Wood preservative

(a) Wood preservative shall be an approved proprietary brand exterior grade where completely concealed or not decorated, and colourless, coloured or suitable for overpainting where likely to be exposed or in contact with a painted finish.

2.1.11.2.23 Wood preservative to external timber

(a) Preparation: Timber shall be free from dirt and surface moisture.

(b) Application of Preservative: Apply by pressure impregnation in accordance with **BS 1281:1975**.

(c) Apply preservative in a manner that is not hazardous to health. Adhere strictly to the manufacturer's instructions.

(d) Cutting and Machining : Whenever possible, all cutting, planning, boring, drilling, notching or
Any other machining or manual operation shall be completed prior to preservative treatment.

(e) Incising : For certain timbers such as Douglas Fir which are difficult to impregnate, make 20 mm deep incisions coverage of 650 per m^2 in the direction of the grain all in accordance with BS 913. This method shall only be used on timber sections exceeding 80 mm thickness.

(f) Creosote Application : For timber where impregnation is not suitable and a paint finish is not required, when approved apply 2 coats of creosote in accordance with the manufacturer's instructions.

(g) Guarantee : : Obtain a guarantee of 30 years for timber components against rot, insect attack and fungal decay.

(h) Mosquito gauze shall be one of the following :-

i. Plastic covered glass fibre 7 x 7 mesh per 10 mm square.

ii. Copper wire 11 x 11 mesh per 10 mm square.

2.1.11.3 Workmanship

2.1.11.3.1 Generally

(a) Workmanship generally shall be to **BS EN 942.**

2.1.11.3.2 Dimensions

(a) Cut timber to required sizes and lengths as soon as practicable after the Works are begun, and store dry under cover so that the air can circulate freely around it.

(b) Dimensions of sections shown on the drawings are finished sizes. Allow for planing and sanding faces to finished sizes.

(c) Check site dimensions before prefabricating joinery fittings.

2.1.11.3.3 Framed joints

(a) Plane timber for joinery on all faces. Finish exposed faces to a fine glasspapered surfaces and round arrises to 1 mm radius.

(b) Faces of framed joints shall be square and shall be driven together to give a close, accurate fit.

(c) Prepare and frame up joinery work with dry joints and store until required for fixing. Before fixing open up all joints, put together with approved glue and wedge up. Replace any sections that have warped or developed shakes or other defects.

(d) Running bonded joints shall be cross-tongued, using approved tongues. For work over 40 mm thick, use double tongues.

(e) Protect from damage or discolouration joinery shall be left with clear finish. Submit proposals for protection for approval

2.1.11.3.4 Prototypes

(a) Prepare prototypes and obtain approval for repetitive fittings before starting fabrication.

(b) Plug and screw or secure timber sections to the backing by approved means.

(c) Check location of buried services before fixing to walls and other surfaces.

2.1.11.3.5 Nailing

(a) Nail timber sections securely to the backing and ensure that the nails do not split the timber. Split timbers shall be removed and replaced.

(b) Punch nail heads below timber surfaces visible in completed work.

(c) Nail weather boarding to wood framing with not less than two corrosion proofed nails in the width of each board at each framing member.

2.1.11.3.6 Wood preservative

(a) Apply wood preservative to all unexposed surfaces of timber including framing fillets etc. and backs of frames, skirtings etc.

(b) Do not fix laminated plastic sheet to timber with moisture content of more than 16%.

(c) Fix acoustic tiles and the like to timber battens or direct to sub-base by means of an approved adhesive used in accordance with the manufacturer's recommendations.

2.1.11.3.7 Boarded or strip flooring

(a) Heading joints shall be cross-tongued, and staggered not less than two board widths apart.

(b) Cramp flooring, to ensure a tight and accurate fit along the whole length of the joint.

(c) Fix flooring with galvanised, sheradised or cadmium-plated wire nails.

(d) Face nail square edged flooring not more than 100 mm wide, use two nails. Stop nail heads and finish flush.

(e) Secret-nail tongued and grooved flooring at each support with one nail placed just above the tongue and driven on skew. Punch nail heads flush.

2.1.11.3.8 Fixing battens

(a) On concrete, cast in or lay at 350 mm centres 50 mm x 40 mm twice splayed fixing battens pre-treated with wood preservative. Where laid on concrete bed, level in cement mortar (1:3), continuous support being provided for all batten lengths.

(b) Fill space between battens with lightweight concrete. Allow to dry out thoroughly.

(c) Apply one coat of approved bitumen/rubber latex emulsion at the rate of 1litre/m^2. Check and refix battens after drying-out as may be required.

2.1.11.3.9 Doors & frames general

(a) Door frames shall not be used as formers for door opening construction unless with the permission of the Engineer, and never when proprietary door sets are required in the Contract. In all such circumstances, templates or formers must be used.

2.1.11.3.10 Door with board finish

(a) Construct hardwood ledged doors with 20 mm (minimum) vertical tongued and grooved boarding in about 150 mm widths. V-jointed on face side with ledges 5 mm thicker than boarding thickness and 100 mm wide for top ledge and 175 mm wide for middle and bottom ledges. Nail boarding to ledges and screw ends of ledges to boarding.

2.1.11.3.11 Ledged and braced

(a) Construct hardwood ledged and braced doors as Clause 2.1.11.3.10 but with 100 mm wide diagonal braces of similar thickness to ledges. House braces to ledges and screw ends to boarding.

2.1.11.3.12 Framed, ledged and braced doors

(a) Construct framed, ledged and braced doors of 45 mm (minimum) thickness with 115 mm wide stile and top rail, 225 mm wide middle and bottom rail, and 100 mm wide braces. Fill in with vertical boarding as Clause 2.1.11.3.10.

2.1.11.3.13 Panelled doors

(a) Construct hardwood panelled doors 40 mm (minimum) thick, with 100 mm wide stiles, top rail and muntins and 200 mm wide middle and bottom rails. Flat panels shall be 20 mm thick. Groove rebate or leave open framing, as specified, for panels or glass.

2.1.11.3.14 Flush doors

(a) Stiles and rails generally shall be 75 mm wide. For doors exceeding 900 mm side or 2000 mm high stiles to be 100 mm wide.

(b) Infill for hollow core doors shall be 20 mm horizontal battens at 150 mm centres. Block out for lock fixing, door closers, or other ironmongery as specified, or composition board core approved by the Engineer.

(c) Infill for solid core doors shall be 25 mm vertical battens tightly cramped together with the covering fully bonded both sides.

(d) Cover both sides of the door with the following as specified :-

i. 3 mm standard hardboard

ii. 5 mm Plywood for painting

iii. 5 mm selected Hardwood faced plywood for clear finish

iv. Class HG laminated plastic bonded to 5 mm plywood

v. Other board finish accepted by the Engineer.

(e) Provide 12 mm selected hardwood lipping pinned and glued to all edges.

(f) Lipping to meeting edges of folding doors and meeting edges and heels of swinging doors shall be 25 mm thick, rebated or rounded.

(g) When specified, fit the bottom edge of doors with a 12 mm selected hardwood removable carpet strip screwed to the lipping.

2.1.11.3.15 Cupboard doors

(a) Construct cupboard doors as follows, as specified :-

i. MDF oxford cherry rounded at edges, or

ii. Hollow core doors as Clause 2.1.11.3.14 (b).

iii. Melamine Faced and lipped chipboard as Clause 2.1.11.2.9 (a).

2.1.11.3.16 Openings in flush doors

(a) Frame openings with 12 mm (minimum) selected hardwood lipping. Rebate lipping for glazing, if required.

(b) Provide glazing beads to match surrounding timber. Mitre at angles. Fix with screws and cups, where specified. Glazing beads shall not be less than 12 mm thick.

2.1.11.3.17 Half-hour fire resisting doors

(a) Half-hour fire doors to be 50 mm solid core flush door as described above, and shall be certified as having been tested in accordance with **BS 476**.

(b) Hinges with nylon bearings shall not be permitted in fire-resisting door assemblies.

2.1.11.3.18 One-hour fire resisting doors

(a) One hour fire doors shall be approved proprietary fire doors tested in accordance with **BS 476: Part 20-23.**

(b) Folding or swing fire doors shall incorporate proprietary smoke seals and intumescent strips where necessary to attain the requirements of **BS 476: Part20-23**.

2.1.11.3.19 Acoustic doors

(a) Acoustic doors shall be solid core doors with air-tight seals to all junctions with frames and threshold. Seal types shall be submitted to the Engineer for approval unless specified in the Contract.

2.1.11.3.20 Doors and window frames

(a) Construct doors and window frames with properly framed joints and fix using cramps or bolts and secure the bottom of door frames with dowels.

2.1.11.3.21 Bedding and pointing

(a) Bed frames in cement mortar, leaving no gaps. For external doors, rake out external face 10 mm deep, and point with an approved sealant.

2.1.11.3.22 Architraves

(a) Architraves shall be one length between angles. Mitre architraves at angle joints.

2.1.11.3.23 Drawers

(a) Construct drawers with 20 mm thick front, as specified, 15 mm thick back and sides, as specified, dovetailed and framed together and 5 mm thick bottom housed on three sides. Set drawers to slide on proprietary runners. Submit ironmongery for approval.

2.1.11.4 References and Standards

BS EN 942 (2007): Timber in joinery. General requirements

BS 4072 (1999): Copper/chromium/arsenic preparations for wood preservation.

BS 4078-1 (1987): Powder actuated fixing systems. Code of practice for safe use

BS 4078-2 (1989): Powder actuated fixing systems. Specification for tools

BS EN 636 (2012): Plywood. Specifications.

BS 1203 (2001): Hot-setting phenolic and aminoplastic wood adhesives. Classification and test method.

BS 1088-1 (2003): Marine plywood. Requirements.

BS EN 120 (1992): Wood based panels. Determination of formaldehyde content. Extraction method called the perforator method.

BS 7331 (1990): Specification for direct surfaced wood chipboard based on thermosetting resins.

BS EN 13964 (2004+A1:2006): Suspended ceilings. Requirements and test methods

BS 1202-1 (2002): Specification for nails. Steel nails

BS 1210 (1963): Specification for wood screws

BS 1204 (1993): Specification for type MR phenolic and aminoplastic synthetic resin adhesives for wood.

BS EN 14411 (2012): Ceramic tiles. Definitions, classification, characteristics, evaluation of conformity and marking

BS 476: Fire tests on building materials and structures.

BS 1088-2 (2003): Marine plywood. Determination of bonding quality using the knife test

BS EN 438-9 (2010): High-pressure decorative laminates (HPL). Sheets based on thermosetting resins (usually called laminates). Classification and specifications for alternative core laminates

2.1.12 IRONMONGERY

2.1.12.1 Materials

2.1.12.1.1 Dowels for fixing door frames

(a) Dowels shall be 16 mm diameter galvanised steel rod 75 mm long.

2.1.12.1.2 Fixing cramps

(a) Fixing cramps for door frames, and the like fixed in brick or block walls shall be 30 mm x 3 mm galvanised steel flat 250 mm girth, turned up at one end and twice drilled to suit No. 12 gauge screws and flanged at the other end.

2.1.12.1.3 Fixing bolts

(a) Unless otherwise specified, fixing bolts for door frames, and the like fixed to concrete shall be not less than 10 mm diameter proprietary expanding anchor bolts 120 mm long overall, with nut and washer.

2.1.12.1.4 Water bar

(a) Water bar shall be galvanised steel, stainless steel, aluminium plate or brass flat bars as specified.

2.1.12.1.5 Curtain track

(a) Curtain track shall be an approved proprietary brand complete with matching fittings of the same make, as follows :-

i. Rigid UPVC 'T' box section track with nylon slides.

ii. Regular of double duty enamelled steel 'C' section track with nylon runner.

iii. Regular of double duty enamelled steel 'C' section track complete with cord operation.

2.1.12.1.6 Curtain rail

(a) Curtain rail shall be stainless steel heavy duty hollow tube as Clause 2.1.16.1.9 with matching purpose-made end flanges, all to the dimensions specified.

2.1.12.1.7 Towel rail

(a) Towel rail shall be stainless steel heavy duty hollow tube as Clause 2.1.16.1.9 with matching purpose-made end flanges.

2.1.12.1.8 Timber connectors

(a) Steel connectors for timbershall be galvanised, round, tooth-plate type to **BS EN 912:2011**Table 3.

2.1.12.2 Workmanship

2.1.12.2.1 Metal dowels

(a) Fix dowels 40 mm into bottom of door frame jambs, etc., with a tight push fit, and bed the other end in floor in cement mortar.

2.1.12.2.2 Fixing cramps

(a) Fix cramps to frames at 900 mm (maximum) centres with the upper and lower cramps 300 mm (maximum) from the end of the jamb , using two 12 SG screws and build-in the other end.

2.1.12.2.3 Fixing bolts

(a) Secure frames to concrete walls with bolts at 900 mm (maximum) centres with the upper and lower bolts 300 mm (maximum) centres from the ends of the jamb as fixed in accordance with the manufacturer's recommendations.

2.1.12.2.4 Water bar

(a) Bed water-bar in water proofing cement mortar leaving no gaps.

2.1.12.2.5 Curtain track

(a) Fix curtain track in accordance with the manufacturer's recommendations including runners at the rate of 13 Nos. per metre and all other accessories including bracket, stopped ends and overlap set. When specified, install cord sets and leave in proper working order.

2.1.12.2.6 Curtain rail

(a) Plug and screw end flanges of curtain rail to brick or concrete wall with stain less steel screws.

2.1.12.2.7 Towel rail

(a) Plug and screw end flanges or brackets of towel rail to brick or concrete wall with stainless steel screws.

2.1.12.3 Architectural ironmongery

2.1.12.3.1 Source

(a) Standard items of ironmongery may be supplied by the Employer except when it is specified that ironmongery shall be supplied by the Contractor.

2.1.12.3.2 Contractor's supply

(a) Supply ironmongery in accordance with the Contract documents. All ironmongery is shall be approved before orders are placed and shall be obtained from an approved manufacturer for that item and for the use intended.

2.1.12.3.3 Certification and samples

(a) Supply fully detailed catalogues, certificates of compliance or other documentary evidence to the satisfaction of the Engineer that the ironmongery complies with the specifications.

(b) Submit samples of all items of ironmongery for approval before placing order.

2.1.12.3.4 Ironmongery schedule

(a) Supply a door-by-door ironmongery schedule, including all other separate ironmongery items when samples have been approved. All components shall be identified by manufacturers' name and reference number and country of origin and cover the requirements of smoke stop and fire-rated doors, detail door thicknesses, handing, suiting and master keying. Upon approval, this schedule shall form the basis for confirming the requirements for ironmongery. No alteration to this schedule shall be permitted without prior approval.

2.1.12.3.5 Compatibility

(a) Ironmongery shall be properly matched, suited and obtained from one source.

2.1.12.3.6 Manufacturer's Instructions

(a) Provide one complete set of manufacturer's fixing and maintenance instructions prior to delivery.

2.1.12.3.7 Packing

(a) Supply ironmongery suitably boxed and delivered in sets where appropriate and marked in a manner to suit site installation requirements. When ironmongery is delivered in sets, each set shall be bagged and labelled with the door number to which it shall be fixed. Supply all items with appropriate fixing screws of a length and pattern to suit the construction to which the items shall be fixed. Screws shall be cross headed and packaged with their components.

2.1.12.3.8 Keys

(a) Provide a minimum of two keys for each lock, each fitted with a stainless steel split ring and a 25 mm diameter x 1.5 mm thick plastic disc engraved with the number of the lock or room number in figures a minimum of 5 mm high.

(b) Arrange with the Engineer for the safe storage and handling of keys and ensure their receipt by the Engineer on completion of the Contract. When master keying is specified the master keys shall be forwarded direct to the Engineer.

2.1.12.3.9 Materials and finishes

(a) Materials and finishes as specified shall comply with the following standards :-

i. Stainless Steel shall be to **BS EN 10029**.

ii. Electroplated coatings of nickel and chromium shall be to **BS EN ISO 1456:2009**

iii. Anodic oxidation coating on aluminium shall be to **BS EN ISO 7599:2010** Grade AA 10.

iv. Electroplated coatings of cadmium and zinc on iron or steel shall be to **BS EN ISO 2081:2008 and BS EN ISO 2082:2008.**

v. Phosphate treatment of iron and steel shall be to **BS EN 12476**.

vi. All concealed components including lock bodies shall be protected by the manufacturer's standard finish which shall, where applicable, comply with the above standards.

vii. Screws shall be stainless steel, brass or aluminium to **BS 1210** with countersunk heads unless otherwise specified to match the ironmongery being fixed.

2.1.12.3.10 Hinges

(a) Hinges shall be as follows :-

1. Class A1 - Extra heavy duty hinges shall be as follows :-

i. 4.50 mm nickel plated, brass butts with a stainless steel pin made non-removable by a set screw and complete with four permanently attached ball bearings.

ii. 3.30 mm satin finish stainless steel, 18/9 quality, with four sets of anti-friction bearings and non-removable stainless steel pin.

2. Class A - Heavy duty hinges shall be as follows :-

i. 3.90 mm brass butts to **BS EN 1935** with four sets of stainless steel washers and non-removable stainless steel pin finished as specified.

ii. 2.50 mm satin finish stainless steel, 18/9 quality, at least two sets of anti-friction bearings and non-removable stainless steel pin.

3. Class B - Standard duty hinges shall be as follows :-

i. 3.9 mm brass butts as Class A.

ii. 3.9 mm brass lift off, or removable pin hinge finished as specified.

iii. 2.0 mm satin finish stainless steel, 18/9 quality with four nylon bushed bearings.

iv. Special hinges i.e. falling or rising butts, parliament or other hinges shall be from the supplier's range manufactured in solid brass or stainless steel or anodized aluminium with hardened bearing surfaces finished as specified.

4. Class C - Light duty hinges shall be as follows :-

i. 2.35 mm brass butts shall be to **BS EN 1935** with four sets of stainless steel washers, stainless steel pin and finished as specified.

ii. 1.6 mm satin finish stainless steel, 18/9 quality.

iii. Special hinges i.e. backflap hinges, continuous or other hinges shall be from the supplier's product range manufactured in solid brass or stainless steel finished as specified.

2.1.12.3.11 Floor springs

(a) The thickness of hinges shall be measured adjacent to the knuckle.

(b) Hinges shall be countersunk drilled and fixed with matching screws as follows :-

i. Hinges Class A1, A & B - Each hinge shall be drilled to take eight 12 SG screws with the screw holes staggered for fixing to timber of template drilled for fixing to metal frames and doors. Where required, hinges may be drilled half for metal screws and half for wood screws. Hinges shall be supplied complete with 12 SG matching screws 32 mm long for wood fixing and 12.5 mm long for fixing into metal. A smaller gauge screw will be acceptable for 2 mm thick hinges.

ii. Hinges Class C - Each hinge shall be drilled to take six 6 SG screws with the screw holes staggered or template drilled as required. Hinges shall be supplied complete with 6 SG matching screws of a length to suit the fixing application. No hinges using nylon or plastic washers or bearings may be used in fire doors or access panels with fire rated requirements.

(c) Single and double action floor springs shall be hydraulic check spring mechanisms sealed into an oil or hydraulic fluid box complete with a loose protected steel box for fixing within a concrete floor, a detachable cover plate with waterproof seal. Adjustment within the box shall provide full horizontal movement for door alignment, final positioning and height adjustment.

(d) The position of the floor spring within the loose box shall be adjustable after installation. The non-adjustable bottom strap shall be designed to suit the type, size and weight of the door but shall not be less than 160 mm long with holes for four screws. The top centre for double action floor springs shall be adjustable. If specified, a hydraulic back check shall be incorporated effective for the opening angle of the floor spring.

(e) On single action floor springs, the bottom strap and top centre shall be offset.

(f) Where floor springs shall be fitted to a fire door, the floor spring shall have been tested in conjunction with an appropriate fire door and passed the integral fire door test in accordance with **BS 476:Part 22**.

(g) In the event that the spring is to be fitted to metal doors, the specification shall be the same exc ept that a non-ferrous strap shall be provided to suit the profile of the bottom rail of the door and the top centre shall suit the top rail of the door.

- Class A - Floor springs shall be certified as tested to 500,000 cycles.
- Class B - Floor springs shall be certified as tested to 300,000 cycles.

Sizes of floor springs shall relate to the minimum closing moment expressed in Table 2.1.12.1.

Table 2.1.12.1: Minimum closing moments for floor springs and door closers

Nominal closer size	Minimum Closing Moment (Nm)	
	15.75 mm	90 degree
2	10	2.5
3	17	5
4	27	9
5	37	13
6	48	17

(h) Exposed parts shall be finished to the same standard as the rest of the ironmongery unless stated otherwise in contract requirements. The top plate shall be satin finish stainless steel, 18/10/3 quality unless stated otherwise in contract requirements.

2.1.12.3.12 Overhead door closers

(a) Overhead door closers shall be capable of being fitted on either hand of the door and shall close the door positively. Regulation of the closing speed and latch angle shall be undertaken by one or more control valves. The closing speed of the closer through the latch angle (50-300 mm from the fully closed position) shall be capable of being adjusted independently to the closing speed.

(b) Ensure that Pull-to fittings are installed where space limitations could hinder standard operation.

(c) Where the door closer shall be fitted to a fire door, minimum rating half hour, the closer shall have been part of a door and door frame and ironmongery which successfully passed the test in accordance with **BS 476: Part 22**.

(d) All closers shall be of the horizontal pattern from the manufacturer's standard range and shall be fitted with a regular arm for face fixing with all parts and fixings of closer arms in stainless steel, unless specified otherwise.

i. Class A - Shall be certified as tested to 500,000 cycles, minimum angle of opening 175 degrees, capable of controlling the door from a minimum opening angle of 115 degrees down to the closed position.

ii. Class B - Shall be certified as tested to 500,000 cycles, minimum angle of opening 90 degrees, capable of controlling the door from a minimum opening angle of 70 degrees down to the closed position.

iii. Class C - Shall be certified as tested to 300,000 cycles, minimum angle of opening 90 degree and control the door from a minimum opening angle of 45 degrees down to the closed position. Regulation of the closing speed and latch angle shall be undertaken by one or mo re control valves. The closing speed of the closer through the latch angle (50 mm - 300 mm from the fully closed position) shall be capable of being adjusted independently to the closing speed.

(e) Certification shall be made that testing has been undertaken in accordance with **BS EN 1154**. If testing has been undertaken in accordance with different standards, then these shall be submitted in English for assessment along with material samples.

(f) Sizes of door closers shall relate to the minimum closing moment expressed in Table 2.1.12.1:.

(g) Closers shall be finished as follows:-

a. Finish 1: The body and arm shall be finished to the same standard as the rest of the door ironmongery. Where closers are supplied with a separate cover, the cover shall be of steel
protected against rust, plated and finished to the same standard as the rest of the door ironmongery. Where covers are supplied, the body may be to the manufacturer's standard finish.

b. Finish 2: As Finish 1 except that the arm may be to the manufacturer's standard finish. Subject to the agreement and acceptance of the Engineer.

2.1.12.3.13 Security locks

(a) Security locks shall have a minimum of five levers or, if pin or disc, mechanisms shall have a minimum of six pin or disc tumblers or more than one row of pins and rollers, such rows shall not be in the same plane.

(b) Forends shall be of double thickness and each lock shall be capable of being fitted to fully rebated doors with 12.5 mm or 25 mm deep rebate by the addition of a rebating set.

(c) Keys shall be registered in the name of the Employer and duplicates only obtainable through the manufacturer. Prior to ordering, agree with the Engineer the method of ordering, supplying and fixing to ensure the maintenance of security. Master keying shall not be permitted.

(d) Class A - Security locks shall be to **BS 3621**.

(e) Class B - Locks manufactured in accordance with the requirements of **BS 3621** but have, in addition to the security bolt, other features which come within the scope of **BS EN 12209** shall comply with the relevant performance requirements of Category B of BS EN 12209. Note: - the addition of a Turn on the inside invalidates certification to BS 3621 but will be acceptable on the grounds of ease of escape in case of fire.

(f) Exposed parts shall be satin finish stainless steel 18/10/3 quality. Rebating set shall be nickel plated brass to match.

2.1.12.3.14 Locks and latches

(a) Locks and latches shall be to **BS EN 12209**.

(b) Lever locks shall have a minimum of 3 levers and 2,000 differs. Cylinder locks shall have at least standard section 5 pin cylinders.

(c) Locks shall be capable of being fitted to fully rebated doors with 12.5 mm or 25 mm deep rebates by the addition of a rebating set.

(d) Locks shall be stamped with the lock number as agreed with the Engineer.

(e) Locks and latches requiring lever or knob furniture to complete the function shall be compatible with **BS EN 1906**, Category 1. If the springing system within the lock is incapable of sustaining the requirements of **BS EN 1906** then the handles shall be spring loaded. If, in order to attain the requirements of **BS EN 1906**, the handles require bolting through the lock, then the lock shall be holed at 38 mm horizontal or vertical centres to accommodate these bolts.

(f) Where specified, locks shall be master keyed.

(g) Class A - Locks and latches shall conform to **BS EN 12209**, Category B, meeting the performance specifications up to 500,000 operations for locks and 1,000,000 operations in conjunction with lever handles.

(h) Class B - Locks and latches shall conform to **BS EN 12209**, Category A, and shall meet the performance specification of 300,000 operations for locks, latches, bored locks or latch sets and 150,000 operations for cylinder rim night latches. They shall meet the dimensional standards set out in **BS EN 12209**.

(i) Locks and latches shall be finished as follows:-

i. Forend and strike plate shall be satin stainless steel 18/10/3 quality. Rebating set shall be satin finished stainless steel or nickel plated brass.

ii. Plated and finished to the same standard as the rest of the ironmongery.

2.1.12.3.15 Lock and latch fittings

(a) Lock and Latch fittings shall be knobs or lever handles with rose or backplate to standards to **BS EN 1906**.

(b) The knobs or lever handles shall be spring loaded to return the fitting to its original position after use, without the assistance by the lock or latch spring unless the lock is specially designed or adapted to meet the above standards.

(c) Centres for keyholes and spindle shall be 57 mm. The spindle shall be 7.6 mm or 8 mm square and shall project a minimum of 12 mm into each lever or knob.

(d) Unless the spindle system is satisfactory by itself for transmitting loads described within **BS EN 1906**, the fitting shall be bolted through the door and lock at 38 mm centres.

(e) Knob or lever handles shall be fixed to fire rated doors, minimum half hour fire rating, shall be fitted with aluminium or similar low-melting alloy inserts for fixing, or spindle housings to prevent the spread of fire by the melting of the insert to prevent the lever or knob operating and the door being opened accidentally.

(f) The style of the lock or latch furniture shall be as specified from an approved standard range.

(g) Class A - Lock and latch furniture shall be to **BS EN 1906**, suitable for heavy duty use and shall have been successfully tested to a min imum of one million operations.

(h) Class B - Lock and Latch furniture shall be to **BS EN 1906**, Category 2, suitable for general residential use and shall have been successfully tested to a minimum of 300,000 operations.

(i) Knob or lever handles shall be finished as follows:-

i. Stainless steel 18/10/3 quality.

ii. Satin anodised aluminium.

(j) Other finishes specified in the Contract and/or to the requirements of the Engineer.

2.1.12.3.16 Knobsets

(a) Knobsets shall be to **BS EN 12209**.

(b) Knobsets shall have a minimum backset of 70 mm but, if specified, this shall be increased to 127 mm by use of an adaptor. Knobsets shall be designed to suit the door thickness and blocking out shall not be permitted. Knobsets with latches shall have an anti-thrust action (automatic deadlocking) in the latch. The style of the knobs shall be as specified from an approved standard range.

(c) Class A - Knobsets shall conform to **BS EN 12209**, Category B meeting the performance specification of up to 500,000 operations.

(d) Class B - Knobsets shall conform to **BS EN 12209**, Category A meeting the performance specification of up to 300,000 operations.

(e) Finishes on exposed parts shall be as follows:-

i. Satin finish Stainless steel 18/10/3 quality.

ii. Satin anodised aluminium.

2.1.12.3.17 Panic bolts and latches

(a) Panic fittings shall be provided ensuite to match the door hardware.

(b) Panic fittings shall include appropriate locksets and handles for key access from the other side of the door unless specified otherwise.

(c) All panic fittings shall comply with **BS EN 1125** with the activating bar horizontally across the inside face of the door operating when pushed anywhere along its effective length in the direction of the exit and/or moved in a downwards arc. Where panic fittings have vertical shoots, they shall have an automatic catch holding the bolts in a withdrawn position when the doors are opened and automatically releasing the bolts on the closing of the door. Panic fittings where capable of being opened from the other side of the door, anywhere locked, the locking operation shall not interfere with exit from the inside. Panic fittings shall be complete with anti-thrust devices to prevent operation by other means than those described above.

i. Class A - For use on fire rated doors, shall be certified by the manufacturer as suitable for use on fire doors.

ii. Class B - For use on other doors.

(d) Panic fittings shall be finished as follows :-

i. Satin finished stainless steel, 18/10/3 quality.

ii. Satin anodised or silver enamelled aluminium bolt box, bar pivot boxes, guides and locking attachment. Steel push bars and bolt shoots sprayed and stoved silver finish.

(e) Ancillary fittings and trim hardware shall be provided ensuite to match the door hardware in a co-ordinated range.

1. Pull handles and push plates shall be secured as follows :-

   i. Face fixed with a minimum of four screws per handle.

   ii. Bolted through by 6 mm diameter (minimum) bolts and stabilised by a face fixing or semi-recessed washer on one side of the door.

   iii. Fixed in pairs by bolting through the door.

2. Flush or surface bolts - shall be supplied with either a holed shoot, plate or keeper at the head and dust-excluding socket at the floor. In wet areas, easy clean floor sockets shall be used. Surface bolts shall be straight barrel bolts. Flush bolts shall be lever action. Bolts shall have a 9.5 mm (minimum) diameter shoot.

3. Indicating bolts - shall allow for emergency operation by coin.The indicator shall be red/green.

4. Push plates, kick plates - shall be manufactured to allow not more than 4 mm gaps to the edge of the door or door frame. Satin stainless steel plates shall not be less than 1.6 mm thick. Satin anodised aluminium plates shall not be less than 3 mm thick. Plates shall be drilled and countersunk at not less than 225 mm centres for 8 gauge screws for kick plates and 6 gauge screws for push plates. Plates shall have corners radiused and all sharp arrises removed. Kick plates shall be 400mm high.

5. Door stops - Floor mounted door stops shall have more than one fixing or plug within the floor to prevent rotation or bending of single fixing point. Wall mounted door stops shall be concealed fixing and project sufficiently to prevent damage to doors and applied ironmongery.

6. Door Holders - shall be floor mounted and allow for replacement of the spring mechanism and be capable of opening for cleaning.

7. Cabin Hooks - shall have the staples properly welded or brazed to backplates.

8. Limit Stays, Friction Stays - shall be capable of limiting the opening of the door and retaining it in the open position.

9. Door selectors - the size of selector shall suit the depth of rebate and width of door leaves. On external doors opening outward, screwed under the frame pattern shall be used.

10. Door chains - shall be in stout metal complete with No. 10 x 30 mm wood screws to match, two number screws to chain plate, four number screws to anchor plate. The chain assembly shall be secured by a bridged plate passing through the end link of the chain. The device in the fixed position shall be capable of withstanding a gradually applied tensile load of 2KN so that when tested, the staple and chain are subject to direct tension and the anchor plate to shear where the staple and plate are securely screwed to Grade 'A' timber in pre-bored partly drilled holes.

11. Door viewers - shall have viewing angle not less than 180 degrees.

12. Hat and coat hooks - shall be fixed with a minimum of two screws.

13. Indicating sign plates - shall be as for push plates, but satin anodised aluminium plates shall not be less than 1.6 mm thick. Self-luminous exit signs to comply with **BS 5499: Part 2**.

14. Fire safety signs, notices and graphic symbols - shall be as for push plates, manufactured to the standards laid down in **BS 5499: Part 1**.

2.1.12.3.18 Fittings to drawers and cupboards

(a) Fittings to drawers, cupboards and other joinery fittings shall be of a quality to match the door hardware in a co-ordinated range.

i. Hinges shall be stainless steel or chromium plated brass as Clause 2.1.12.3.10 Class C.

ii. Standard drawer locks shall be cast zinc with a brass, or chromium plated brass cap approximately 22 mm diameter with a four tumbler cylinder and a 4 mm thick brass bolt. Locks for cash drawers shall be fitted with a brass spring loaded bolt.

iii. Flush or surface bolts shall have a minimum of a 6 mm diameter shoot.

iv. Bales catches shall have a 9.5 mm diameter ball mounted in a face plate complete with matching striking plate.

v. Magnetic door catches shall have a plastic casing with overall length not less than 45 mm.

vi. Flush pulls shall be 100 x 50 x 18 mm deep fixed with four countersunk screws.

vii. Drawer pulls shall be 7.5 mm diameter rod twice bent to form handle 100 x 25 mm overall each leg fitted with 3 mm threaded rod one end drilled and tapped at least 15 mm into the leg and the other end fitted with two flat washers and a nut.

(b) Fittings shall be finished as follows :-

i. Stainless steel

ii. Satin anodised aluminium

iii. Chromium plated brass

(c) Ironmongery shall be fitted and fixed in accordance with the manufacturer's recommendations.

(d) All morticing of doors and frames shall be carefully done to ensure that mortices are not oversize and that items are securely fitted, especially items morticed into half hour doors and frames where their fire-rated performance may be invalidated. Items morticed into one hour doors and frames must be protected by intumescent materials. For locks and latches, this protection shall comprise a layer of approved intumescent sheet on each side of the lock or latch case; any other morticed items shall be painted with intumescent paint before being fitted.

(e) Screws shall be properly inserted to drilled pilot holes with a correctly sized screwdriver. Screws must not be hammered even part of the way in.

(f) Items when fixed where the screw head is burred shall have the screws replaced. Where required, screw or bolt threads shall be plugged to suit the construction to which the item is fixed.

(g) Ironmongery shall be oiled and adjusted where required and left in perfect working order.

2.1.12.4 References and Standards

BS EN 10029 (2010): Hot-rolled steel plates 3 mm thick or above. Tolerances on dimensions and shape

BS EN ISO 1456 (2009): Metallic and other inorganic coatings. Electrodeposited coatings of nickel, nickel plus chromium, copper plus nickel and of copper plus nickel plus chromium

BS EN ISO 7599 (2010): Anodizing of aluminium and its alloys. General specifications for anodic oxidation coatings on aluminium

BS EN 12329 (2000): Corrosion protection of metals. Electrodeposited coatings of zinc with supplementary treatment on iron or steel.

BS EN ISO 2082 (2008): Metallic coatings.Electroplated coatings of cadmium with supplementary treatments on iron or steel.

BS EN 12476 (2000): Phosphate conversion coatings of metals. Method of specifying requirements.

BS 1210 (1963): Specification for wood screws

BS EN 1935 (2007+A2:2012): Building hardware. Single-axis hinges. Requirements and test methods

BS 476: Fire tests on building materials and structures

BS EN 1154 (1997): Building hardware. Controlled door closing devices. Requirements and test methods.

BS 5499-10 (2006): Safety signs, including fire safety signs. Code of practice for the use of safety signs, including fire safety signs

BS 3621 (2007+A2:2009): Thief resistant lock assembly. Key egress

BS EN 12209 (2003): Building hardware. Locks and latches. Mechanically operated locks, latches and locking plates. Requirements and test methods

BS EN 1906 (2012): Building hardware. Lever handles and knob furniture. Requirements and test methods

BS EN 1125 (2008): Building hardware. Panic exit devices operated by a horizontal bar, for use on escape route. Requirements and test methods.

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BS EN 912 (2011): Timber fasteners. Specifications for connectors for timbers

BS EN ISO 2081 (2008): Metallic and other inorganic coatings. Electroplated coatings of zinc with supplementary treatments on iron or steel

BS EN ISO 2082 (2008): Metallic coatings. Electroplated coatings of cadmium with supplementary treatments on iron or steel

2.1.13 BS EN ISO 9717 (2013): Metallic and other inorganic coatings. Phosphate conversion coating of metals.MASONRY

2.1.13.1 Materials

2.1.13.1.1 Stone

(a) Stone for masonry shall be local granite of consistent colour, free from defects and ferrous materials that will will adversely affect the strength or appearance and comply **BS EN 1996-1, BS EN 1996-2 & BS EN 1996-3**.

2.1.13.1.2 Mortar

(a) Cement mortar for masonry shall be as stated in Clause 2.1.8.2.1

2.1.13.1.3 Wall ties

(a) Wall ties between masonry walls and concrete shall be copper, bronze or stainless steel complying to **BS EN 845-1(2003:2008);** the ties shall be at least 40 mm wide, 3 mm thick and 150 mm long and shall be fanged at both ends.

2.1.13.1.4 Damp proof course

(a) Damp proof course for masonry shall be as stated in Clause 2.1.9.2.5.

2.1.13.2 Submissions

2.1.13.2.1 Samples of materials

(a) Samples of the following proposed materials for masonry shall be submitted to the Engineer for approval of the source and type of each material at least 14 days before the masonry work starts:

i. each type of stone,

ii. wall ties, and

iii. damp proof course.

2.1.13.3 Trial panels

2.1.13.3.1 Trial panels

(a) A trial panel shall be constructed for each type of masonry as stated in earlier for brickwork and blockwork.

2.1.13.4 Handling and storage of stone

2.1.13.4.1 Handing and storage of materials

(a) Stone for ashlar stone walling shall be transported with the minimum amount of handling and shall be stacked in the vehicle using packing pieces to prevent damage.

(b) The stone shall be stored in stacks on battens and protected from exposure to rain.

(c) Provide adequate lifting plant to unload and handle stones into position.

2.1.13.5 Rubble stone walling

2.1.13.5.1 Preparation of stone for rubble stone walling

(a) Stones for random rubble walling shall be irregular in shape and roughly cut to between 75 mm and 300 mm high, at least 75 mm deep and between 75 mm and 600 mm long on bed. The length or depth on bed of each stone shall be greater than the height.

(b) Stones for squared rubble walling shall be trimmed roughly square to between 75 mm and 300 mm high, varying in 75 mm stages. Each stone shall be between 100 mm and 150 mm deep and between 100 mm and 600 mm long on bed. The length or depth on bed of each stone shall be greater than the height.

(c) Stones for square coursed rubble walling shall be trimmed roughly square as stated in (b) to suit courses of regular height varying from 150 mm to 250 mm.

2.1.13.5.2 Laying and jointing rubble stone walling

(a) Stones in rubble stone walling shall be laid dry on a full even bed of cement mortar; all joints shall be filled and shall be between 5 mm and 15 mm wide.

(b) Stones of random shapes and sizes in random rubble walling shall be bonded together over each face of the wall. Stones shall be selected and rough dressed to keep joint widths to a minimum. At least one bonding stone of minimum size 450 mm x 150 mm shall be provided and carried through the full thickness of the wall per square metre. Not more than 3 stones shall be provided adjacent to a vertical joint.

(c) Roughly squared stones of random sizes in square rubble walling shall be bonded together with continuous straight horizontal joints. The number of vertical joints shall be kept to a minimum.

(d) Roughly squared stones in square coursed walling shall be laid as stated above but brought up to courses at centres not exceeding 750 mm to line up with quoin and jamb stones.

(e) Squared rubble walling exceeding 300 mm thick and faced one side shall be constructed in accordance with the following requirements:

(f) Roughly squared stone at least 300 mm thick shall be provided with a backing of random rubble.

(g) At least two bonding stones per square metre shall be regularly spaced and carried through the full thickness of the wall or at least 450 mm into the backing, whichever is less.

(h) Squared rubble walling exceeding 300 mm thick and faced both sides shall be constructed in accordance with the following requirements:

(i) Roughly squared stone at least 150 mm thick shall be provided with a core of random rubble.

(j) Bonding stones shall be provided as stated above but shall be carried through the full thickness of the wall or 450 mm into the core.

2.1.13.5.3 Pointing rubble stone walling

(a) Joints in rubble stone walling shall be raked out to a depth of 15 mm as the work proceeds. The joints shall be pointed in cement mortar on completion with a flush, weathered or recessed joint as required.

2.1.13.6 Ashlar stone walling

2.1.13.6.1 Preparation of stone for ashlar stone walling

(a) The exposed faces and joint faces of each stone for ashlar stone walling shall be dressed square and true, free from hollows or rough areas.

(b) Exposed faces shall be finished to a finely squared dressed surface. Stones shall be at least 300 mm high. Each stone shall be clearly marked to indicate its position in the finished work.

2.1.13.6.2 Laying and jointing ashlar stone walling

(a) Stones in ashlar stone walling shall be laid on a full, even bed of mortar consisting of cement and fine crushed stone in the proportions 1:3 by volume. All joints shall be filled and shall be 5 mm wide. Stones shall be laid to bond together throughout the wall, and to the backing, using projecting bonding stones.

2.1.13.6.3 Pointing ashlar stone walling

(a) Joints in ashlar stone walling shall be raked to a depth of 15 mm as the work proceeds and shall be pointed with a flush joint on completion using bedding mortar.

2.1.13.7 Protection of masonry

2.1.13.7.1 Protection of masonry

(a) Newly erected masonry shall be protected from exposure to conditions which may adversely affect the masonry. Arrises, projections and similar features shall be covered with protective sheeting lapped and securely held in position. Facework shall be kept clean at all times.

2.1.13.8 Wall ties for masonry

2.1.13.8.1 Wall ties for masonry

(a) Wall ties in masonry which is to face an existing or newly constructed wall shall be fixed at a rate of 5 per m^2. Ties shall be fixed 100 mm into the wall and 75 mm into the masonry.

(b) Wall ties shall be fixed between the ends of walls and concrete or brickwork at centres of at least 450 mm vertically and shall project 250 mm into the masonry.

2.1.13.9 Tolerances

2.1.13.9.1 Tolerances masonry

(a) Rubble stone walling shall comply with the following requirements:

i. The position on plan shall be within 25 mm of the specified position.

ii. The length shall be within 25 mm of the specified length.

iii. The height shall be within 25 mm of the specified height.

iv. The level of bed joints shall be within 25 mm of the specified level in any 5 m length.

v. The walling shall be straight to within 25 mm in any 5 m length.

vi. The walling shall be vertical to within 20 mm in any 3 m height.

(b) Ashlar stone walling shall comply with the following requirements:

i. The position on plan shall be within 15 mm of the specified position.

ii. The length shall be within 15 mm of the specified length.

iii. The height shall be within 10 mm of the specified height.

iv. The level of bed joints shall be within 10 mm of the specified level in any 5 m length.

v. The walling shall be straight to within 15 mm in any 5 m length.

vi. The walling shall be vertical to within 15 mm in any 3 m height.

2.1.13.10 References and Standards

BS EN 845-1 (2013): Specification for ancillary components for masonry. Ties, tension straps, hangers and brackets

BS EN 1996-1-2 (2005): Eurocode 6. Design of masonry structures. General rules. Structural fire design

BS EN 1996-2 (2006): Eurocode 6. Design of masonry structures. Design considerations, selection of materials and execution of masonry.

BS EN 1996-3 (2006): Eurocode 6. Design of masonry structures. Simplified calculation methods for unreinforced masonry structures.

2.1.14 WATER PROOFING

2.1.14.1 Materials

(a) All products that are recommended by manufacturer are to be fully compatible with indicated substrates, including modification by bituminous additives (asphalt as needed) and similar proven compounding provisions.

(b) In addition to primary waterproofing materials, provide the following:

Surface Conditioner: A cut back solvent type asphaltic primer complying with **ASTM D41/D41-11(2010)** specifically recommended for use in conjunction with system by the membrane manufacturer.

Flashing: Manufacturer's recommended 1.524 mm (60 mil) uncured neoprene flashing.

Bonding Adhesive: Manufacturer's one-component neoprene base contact adhesive specifically recommended for applying sheet flashing to vertical surfaces.

Splicing Cement: Manufacturer's synthetic rubber-base polymer adhesive specifically recommended for securing vertical laps in sheet flashing.

Lap Seal: Manufacturer's EPDM or synthetic rubber sealant specifically recommended for sealing lap joints in sheet flashing.

Water Block Mastic: Manufacturer's recommended mastic for bedding flashing anchors.

Protection Course: Premolded, 6.35 mm thick, semirigid board consisting of mineral-stabilized asphalt core sandwiched between layers of asphalt-saturated felt, surface-coated with asphalt and sealed to core under heat and pressure, and provided with polyethylene film facings.

(c) Accessories:

Counterflashings and Reglets.

Cap Bars: Type 302 or 304 stainless steel, 3.18 mm thick minimum, predril or punched 200 mm o.c. for mechanical fastener attachment to substrate.

Flashing Pipe Clamping Rings: Waterproofing membrane manufacturer approved, stainless steel adjustable wormgear pipe clamping rings; size appropriate to installation.

(d) Reinforcing Fabric: Continuous filament needle-punched spun bond polyester bonded with an acrylic binder; or other product as recommended by the roofing membrane manufacturer complying with the above as a minimum and accepted by Engineer.

2.1.14.2 Workmanship

2.1.14.2.1 General

(a) Do not proceed with waterproofing work during inclement weather (or when weather forecasts are unfavorable) unless manufacturer's require ents and instructions will be complied with, and unless warranties for the work will be provided without additional reservations.

(b) Concrete substrates shall be completely cured and free of all moisture detrimental to the placing of waterproofing. Drying required due to wetting of substrate by inclement weather and/or adjacent wet construction shall be in accordance with waterproofing manufacturer's recommendations.

(c) Proceed with waterproofing operations only after substrate construction and penetrating work have been completed. Placing of waterproofing shall constitute acceptance of substrate conditions.

(d) Deliver materials in manufacturer's original unopened containers clearly labeled with manufacturer's name, brand name, instructions for use and all identifying numbers. Store materials in a clean, dry area protected from water. Replace materials which have been damaged or are otherwise unfit for installation.

(e) Protect the building during waterproofing construction period from damage resulting from spillage, dripping and dropping of materials. Prevent waterproofing materials from entering and clogging drains and rain water conductors. Repair and restore or replace other work which is soiled or damaged in connection with the placement of the waterproofing work.

(f) Upon completion of each major area of waterproofing work, provide proper procedures for surveillance and protection of waterproofing work during the remainder of the construction period, so that the waterproofing will be without any indication of deterioration or damage at the time of acceptance by the Engineer.

(g) Contractor must submit a 2-year warranty agreeing to repair or replace defective work (materials or workmanship) which has failed to provide a watertight system signed by the Contractor and waterproofing installer. Upon notification of such defective work, within the warranty period make the necessary repairs and replacements at the convenience of the Employer. Repairs and replacements shall include all necessary removal and replacement of finish materials, without cost to Employer.

Manufacturer's Warranties:

1. Prior to commencing work submit manufacturer's letters of intent stating that upon their review of the waterproofing system they agree to warrant their respective materials for a period of five (5) years as follows:

    i. Membrane, to remain watertight and not to deteriorate or fail in any way.

. Upon completion of the work submit waterproofing membrane manufacturer's warranty agreeing to warrant their respective materials for a period of five (5) years as follows:

ii. Membrane, to remain watertight and not to deteriorate or fail in any way.

2.1.14.2.2 Execution

(a) Clean substrate of debris and deleterious materials which would impair the Work.

(b) Do not proceed with the installation of the waterproofing work until all defects have been corrected and the following have been completed:

i. All curbs, drains, and other penetrations through the deck have been completed and flashed.

ii. All surfaces are dry, smooth, free of depressions, spalled areas, laitence, voids (holes, cavities, and honeycombs), clean and free of unapproved curing compounds, form release agents and other surface contaminants. Voids shall be filled and struck flush in accordance with manufacturer's directions utilizing materials recommended by the manufacturer of the waterproofing membrane system to be applied thereon. All high spots shall be cut off and ground smooth.

(c) Thoroughly sweep the horizontal substrates to receive the hot fluid applied waterproofing. After sweeping blow substrates clean of remaining loose debris using an air compressor.

(d) Protect adjoining surfaces outside of the areas to receive the waterproofing work from overspray or spillage of liquid components of the waterproofing membrane systems.

(e) Install the hot fluid applied waterproofing membrane system in accordance with the manufacturer's instructions, except where more stringent requirements are shown or specified.

(f) Apply surface conditioner to all surfaces indicated to receive hot fluid applied waterproofing
membrane in accordance with the recommendations of the hot fluid applied waterproofing membrane manufacturer. Surface conditioner shall tan the surface, not blacken it. Allow surface conditioner to thoroughly dry prior to the membrane application.

Do not apply surface conditioner to previously installed hot fluid applied waterproofing unless otherwise permitted by the hot fluid applied waterproofing membrane system manufacturer.

(g) Heat membrane in a double jacketed, oil bath melter with mechanical agitation, specifically designed for the preparation of a rubberized asphalt membrane. Heat membrane in accordance with the membrane manufacturers recommendations.

(h) Provide treatment at control joints, cracks, and penetrations and with such materials and designs specified, and shown, unless more stringent requirements are recommended by the
manufacturer of the hot fluid applied waterproofing membrane system.

(i) Install specified flashing materials and accessories and tie into the hot fluid applied waterproofing membrane.

(j) Set metal flanges in hot fluid applied waterproofing membrane. Prime flanges of metal accessories, strip flange with specified flashing materials and tie into hot fluid applied waterproofing membrane.

(k) Extend hot fluid applied waterproofing membrane down to the flashing ring on drains, and onto concrete deck a minimum of 300 mm. Over the hot fluid applied waterproofing membrane install flashing extending a minimum distance of 150 mm onto the concrete deck and centered over drain flashing ring. Install drain clamping ring. Cut out center of flashing over drain bowl. Cover the flashing with hot fluid applied waterproofing membrane.

(l) Install flashing at all joints and cracks, exceeding 1.5 mm, as recommended by the membrane manufacturer. Use longest lengths of flashing practicable at all joints and cracks. Flashing shall be placed while membrane is still hot and shall extend a minimum of 150 mm on either side of joint and lap at ends a minimum of 75 mm. After placing flashing, apply a second coat of membrane 3.18 mm thick over sheet and carried 100 mm beyond edge of sheet.

(m) Install flashing to vertical surfaces, allowing 150 mm of flashing to extend onto concrete deck. Nail at top with stainless steel roofing nails into cap bars at 200 mm o.c. Adhere flashing to vertical surfaces by applying bonding adhesive from 75 mm above the deck to the full height of flashing. Vertical laps in flashing shall be 100 mm minimum, secured with
splicing cement. Seal edge of lap seam with continuous bead of lap seal.

i. The unbonded flashing on the vertical and horizontal surfaces shall be placed into the hot fluid applied waterproofing membrane while it is still hot. After placing flashing, apply a second coat of membrane 3.18 mm thick over the horizontal flashing surface.

(n) Pipe Penetrations: Flash all pipes, conduits, sleeves, and other projections passing through membrane and provide tight construction throughout. Use prefabricated boots or field fabricated boots, fitted coverings, and other accessories as required. Where pipes or conduits pass through areas to be waterproofed or where drains occur in such areas, apply hot fluid applied waterproofing membrane only after flashing around pipes, conduits and drains is in place. Lap pipe penetration flashing into the membrane.

(o) Apply the fluid applied waterproofing membrane at a rate to provide a continuous, monolithic, coating having a uniform minimum thickness of 2.29 mm (90 mils). Fully embed a layer of reinforcing fabric while membrane is still hot, followed by a second layer of fluid applied waterproofing membrane with a minimum thickness of 3.17 mm (125 mils); resulting in a total minimum fluid applied waterproofing membrane system thickness of 5.46 mm (215 mils) at any location. Overlap adjoining reinforcing fabric sheets a minimum of 50 mm.

(p) Embed protection course, with asphalt-saturated felt side down, into all applications of hot fluid applied waterproofing membrane while it is still hot. Form a continuous protective layer for the hot fluid applied waterproofing membrane. Butt edges tightly, stagger end joints and cut to fit at all intersecting surfaces and penetrations.

(q) No membrane shall be permitted to remain exposed at the conclusion of any working day.

2.1.14.3 Special project warranties

2.1.14.3.1 General

(a) The Contractor should submit a 2 year warranty agreeing to repair or replace defective work (materials or workmanship) which has failed to provide a watertight system signed by the Contractor and waterproofing installer. Upon notification of such defective work, within the warranty period make the necessary repairs and replacements at the convenience of the Employer. Repairs and replacements shall include all necessary removal and replacement of finish materials, without cost to the Employer.

(b) Prior to commencing work submit manufacturer's letters of intent stating that upon their review of the waterproofing system they agree to warrant their respective materials for a period of five (5) years as follows:

i. Membrane, to remain watertight and not to deteriorate or fail in any way.

Upon completion of the work submit waterproofing membrane manufacturer's warranty agreeing to warrant their respective materials for a period of five (5) years as follows:

ii. Membrane, to remain watertight and not to deteriorate or fail in any way.

2.1.14.3.2 Quality Assurance

(a) Employ only skilled tradesmen who are thoroughly trained with the materials and equipment to be used in the work. Maintain a full time supervisor/foremen who is on job site during times that waterproofing work is in progress and who is trained in installing waterproofing systems similar to type and scope required for this Project.

(b) The manufacturer shall provide evidence indicating that the specified hot fluid applied waterproofing membrane materials have been manufactured by the same source and successfully utilized on a yearly basis for a minimum of 10 years on projects of a similar scope to that shown and specified for this Project.

(c) Obtain primary waterproofing materials of each type required from a single manufacturer. Provide secondary products as recommended by manufacturer of primary products to use with the waterproofing systems selected.

(d) As soon as possible after award of hot fluid applied waterproofing work, but no later than 2
weeks before the installation of the waterproofing work, meet with Contractor and Engineer.

(e) Review foreseeable methods and procedures related to waterproofing substrates, including but not limited to, the following:

i. Tour representative areas of waterproofing substrates, inspect and discuss condition of substrate, slope, drainage, membrane application, flashing details, drains, curbs, penetrations, and other preparatory work.

ii. Review structural loading limitations of the structural deck.

iii. Review waterproofing system requirements: drawings, specifications, and other contract documents.

iv. Review required submittals, both complete and incomplete.

v. Review required inspection, testing, and certification procedures.

vi. Review weather and forecasted weather conditions and procedures for coping with unfavorable conditions.

vii. Discuss waterproofing system protection requirements for construction period extending beyond waterproofing installation.

(f) Record discussion and furnish copy of recorded discussions to each attendee.

2.1.14.4 References and Standards

ASTM D41/D41M – 11 (2010): Standard Specification for Asphalt Primer Used in Roofing, Dampproofing, and Waterproofing

2.1.15 ROOFING AND RAINWATER DISPOSAL

2.1.15.1 Coverings and flashing

2.1.15.1.1 Materials

(a) Sheet lead shall be to **BS EN 12588**, 1.8 mm thick Code No. 4, Colour Blue.

(b) Sheet copper shall be to **BS EN 1172, BS EN 1652, BS EN 1653** and **BS EN 1654**.

(c) Sheet aluminium shall be to **BS EN 485**, 0.9 mm thick grade S199.99.

2.1.15.1.2 Workmanship

(a) Fix sheet lead shall be in accordance with **BS 6915**.

(b) Flashings shall be let into walls a minimum of 25 mm, secured with lead wedges and pointed in cement mortar. Flashing shall be lapped a minimum of 100 mm and the lower edge secured with lead tacks at 750 mm centres.

(c) Fix sheet copper shall be in accordance with **CP 143: Part 12**.

(d) Fix sheet aluminium shall be in accordance with **CP 143: Part 15**.

(e) Flashings shall be let into walls a minimum of 25 mm, provided with a turn back, secured with folded aluminium wedges and pointed in cement mortar.
Flashings shall be lapped and single lock welted and the lower edge folded under for additional stiffness.

(f) Aluminium in contact with mortar shall be coated with bituminous paint after bending.

(g) Avoid contact in the completed work between the following metals:-

- Aluminium alloys and copper alloys, nickel, lead or stainless steel.
- Iron or steel and copper alloys.
- Zinc (including galvanising) and copper alloys or nickel.

(h) Where unavoidable, coat contact surfaces with bituminous paint, protective tape or other approved means.

2.1.15.2 Bitumen felt built-up roofing

2.1.15.2.1 Materials

(a) Bitumen felt shall be in accordance with **BS EN 13707**, and shall be as follows :-

(b) Underlayer to consist of one or more layers, as specified, of fine granule surface felt Type 1B (nominal weight 1.8 or 2.5 kg/m^2).

(c) Top layer shall be one of the following :-

- mineral surfaced felt Type 3E, (nominal weight 2.8 kg/m^2).
- fine granual surfaced felt Type 1B (nominal weight 2.5 kg/m^2) with surface dressing.

(d) Rolls shall be delivered to Site bearing the trade mark and certification as to BS type.

(e) Bitumen primer shall be selected to suit the type of bonding compound.

(f) Bonding compound shall be bitumen based.

(g) Bitumen dressing compound shall be cut-back bitumen to **BS 3690**, grade 50 secs.

(h) Stone chippings shall be light coloured, hard and free from brown or partially decomposed stone. Chippings shall be graded from 5 mm to 3 mm.

(i) Nails for fixing felt to timber decks shall be galvanised steel or non-ferrous metal with 3 mm diameter shank and 11 mm diameter clout head and 20 mm long.

2.1.15.2.2 Workmanship

(a) Lay bitumen felt roofing generally in accordance with **BS 8217** and **BS 8218**.

(b) Lap felt 75 mm at joints and 100 mm at ends of length. Lay successive layers to break joint.

(c) Provide thermometers to check the work and do not heat any layers or material to more than 220^{o}C. Lay evenly at a sufficiently high temperature to obtain a satisfactory bond (normally 180^{o} to 200^{o}C).

(d) Bonding compound shall be used in accordance with the manufacturer's recommendations. The Contractor shall ensure that workers are protected against the risk of exposure to substances considered to be hazardous to health. Toxicological information, exposure control, personal protection and first aid measures extracted from the manufacturer's material safety data sheets shall be kept in a register on the Site.

(e) Ensure that the base is clean and dry, before starting work.

(f) Rolls of felt shall be laid in the following directions.

- On flat roofs, lay the first layer of felt starting at, and parallel to, the lower edge or eaves.
  Lay subsequent layers in a similar manner to ensure that the laps in the built up roofing do not obstruct the flow of water.

- On sloping roofs, lay the felt in the direction of the slope. Lap sheets with the exposed laps away from the prevailing wind.

(g) Lay bitumen felt roofing as follows :-

- On concrete roofs, brush on a coat of bitumen primer, and allow to dry.

- Partially bond the first layer to the base at the perimeter and in spots or strips, with hot bonding compound at the rate of 0.5 kg/m^2. Roll with a 70 kg (minimum) roller while the bonding compound is still hot. Remove any surplus compound squeezed out at the edge.

- Fully bond subsequent layers with a continuous even coating of hot bonding compound applied to the previous layer at the rate of 1.5 kg/m^2. Roll and remove any surplus compound as specified above.

- On timber roofs, nail the first layer at 50 mm centres along the laps, 20 mm in from the edges with additional nails in rows at 150 mm centres staggered at 300 mm centres.

(h) Secure subsequent layers by full bonding as specified in Clause 2.1.15.2.1 (a).

(i) Dress surface with bitumen compound applied at the rate of 3 kg/m^2 dressed immediately with stone chippings, lightly rolled in at the rate of 15 kg/m^2.

(j) Remove any loose chippings.

(k) Provide skirtings as follows :-

- To concrete roofs, provide a triangular cementitious internal angle fillet at bottom 75 mm wide on splay. Carry up underlayers of felt to form skirting 150 mm (minimum) high above roof level. Cover with a mineral felt flashing (Type 3E) with one edge tucked into 25 mm groove in wall, wedged at 600 mm centres and pointed with mastic and seal to face of skirting with bonding compound.

- To timber roofs, provide a 200 mm timber upstand with angle fillet at bottom fixed securely to roof deck and carry up roofing felt over it. Provide a lead apron flashing over. The lead flashing code and weight shall be confirmed by the Engineer.

(l) At verges, gutters and the like :-

- Provide and fix a non-ferrous trim fixed with compatible screws or nails, bonded between layers of built up roofing to form drip or dressed into gutter.

- Form a welted drip.

(m) All roof falls shall be aligned to direct water towards outlets :-

- Dress all layers into proprietary roof outlets and seal with bonding compound.

- Provide and fix 1.8 mm lead slate size 450 mm x 450 mm perforated for and with a 150 mm long outlet soldered on to suit the bore of the pipe and dress between layers of built up roofing.

(n) Cut and fit roofing around pipes passing through roof, dress flange or collar between second and third layers, and seal in hot bonding compound, using :-

- Lead slate size 450 mm x 450 mm perforated for and with 150 mm high collar soldered on to suit bore of pipe.

- Proprietary moulded plastic or rubber collar.

2.1.15.3 Bituminous emulsion roofing

2.1.15.3.1 Materials

(a) Bituminous emulsion for roofing shall be "Flintkote" or other approved compound. Use in accordance with the manufacturer's recommendations.

(b) Glass fibre membrane shall be a woven material with a thread count of 8 x 8 mm per 10 mm square (minimum).

2.1.15.3.2 Workmanship

(a) Ensure that the base is clean and dry before starting work. Wire brush rust patches on steel sheet roofing.

(b) Apply bituminous emulsion evenly by brush. Ensure that previous coat is dry before applying the next coat.

(c) Wash coat to consist of "Bitumen Emulsion No. 3" and water 1:1 by volume.

(d) Priming coat to consist of "Bitumen Emulsion No. 3" and water 5:1 by volume.

(e) Lap glass fibre membrane 75 mm at joints. Press into last coat of emulsion while still wet.

(f) Treat concrete flat roofs as follows :-

- Apply wash coat and priming coat.

- Apply one coat of "Bitumen Emulsion No. 3" at the rate of 0.7 litre/m^2.

- Apply one layer of glass fibre membrane.

- Apply three coats of "Bitumen Emulsion No. 3" at the rate of 0.5 litre/ m^2 per coat.
- Apply two coats of "Bitumen Emulsion No. 3" at the rate 0.5 litre/ m^2 per coat.

(g) Treat cracks in existing felt covered roofs as follows :-

- Cut out cracks exceeding 5 mm wide, where ordered.
- Apply wash coat and primer to grooves.
- Fill grooves with compound consisting of "Bitumen Emulsion No. 3" and sand 1:3 by volume.

(h) After making good cracks, treat the entire roof area as follows:-

- Apply "PF 4 Solution" at the rate of 0.2 litre/ m^2 .
- Apply two coats of "Bitumen Emulsion No. 5" at the rate of 0.7 litre/ m^2 per coat.

(i) Treat joints of steel corrugated sheet roofing in a strip 150 mm wide to cover the joint, as follows :-

- Point joint with "Bitumen Emulsion No. 7".
- Apply "PF 4 Solution" at the rate of 0.14 litre/ m^2.
- Apply "Bitumen Emulsion No. 3" at the rate of 0.7 litre/ m^2.
- Apply one layer of glass fibre membrane.
- Apply two coats of "Bitumen Emulsion No. 3" at the rate of 0.7 litre/ m^2 per coat.

(j) Finish surface with :-

- A dressing of clean, sharp sand.
- Two coats of "Alubit" protective coating at the rate of 0.11 litre/ m^2 per coat.
- Two coats of "Decoralt" coloured finish at the rate of 0.16 litre/ m^2 per coat.
- One coat of compound consisting of cement, "Bitumen Emulsion No. 3" and sand 1:8:32 by volume, trowelled on 3 mm or 5 mm thick, as specified.

2.1.15.4 Tile roofing

2.1.15.4.1 Materials

(a) Tiles shall be red in colour, sound, well-burnt unglazed clay, whole, and free from cracks and blemishes. Approximate sizes shall be :-

- Plain tiles 225 mm x 225 mm
- Roll tiles 165 mm long, and tapered
- Valley tiles 300 mm x 225 mm

(b) A sample of the tiles shall be approved before ordering and comply to BS EN 490 (concrete tiles) and **BS 5534** (clay tiles).

(c) Mortar shall be cement/lime mortar, as Clauses 2.1.8.2.1 .

(d) Nails shall be aluminium or galvanised steel nails at least 2 mm diameter 30 mm long and with plain heads.

(e) Roll tiles to be left exposed shall be specially selected and semi circular in section. Glazed tiles shall be obtained from an approved manufacturer.

2.1.15.4.2 Workmanship

(a) Lay tiles to roofs as follows :-

- A single layer of plain tiles to the gauge specified with roll tiles to 120 mm gauge.
- A double layer, each layer as (a) above.

(b) Lay Plain tiles to a gauge exceeding 75 mm and not exceeding 115 mm.

(c) Bed corners of tiles in mortar dabs. Lay roll tiles to lap 50 mm, bed both edges in mortar, and cover with similar mortar 15 mm (minimum) thick, trowelled smooth.

(d) On wood battened roofs, drive nails into battens and leave projecting 15 mm as key for mortar dabs and neatly point underside if exposed.

(e) Finish with a mortar fillet, trowelled smooth.

(f) Form ridge or hips with rows of inverted tiles, with rows of roll tiles over.

(g) Lay valley tiles up the valley to the gauge specified. Cut roof tiles to rake and finish both sides with mortar, trowelled smooth.

(h) Single layer tiling - finish eaves with double course of tiles where specified.

(i) Double layer tiling - finish eaves with roll tiles or tile slips placed centrally between rolls to form weep hole, and fill edge with mortar, trowelled smooth.

(j) Cut and fit tiling at abutments and around pipes, etc., and finish with a mortar fillet, trowelled smooth.

(k) Roll tiles to be left exposed shall be bedded and pointed in cement mortar.

(l) Glazed tiles shall be fixed in accordance with the manufacturer's recommendations.

2.1.15.5 Mastic asphalt (rock asphalt) roofing

2.1.15.5.1 Generally

(a) Mastic asphalt (rock asphalt) roofing shall not be used for new works.

(b) All asphalt roofing for repair works to existing asphalt roofs shall be laid and executed complete by an approved contractor for asphalt roofing or tanking.

2.1.15.5.2 Material

(a) Mastic asphalt shall be as follows :-

- Mastic asphalt (limestone aggregate) to **BS 6925**, type R988 manufactured with asphaltic cement specified under Table 1 column B (100% Bitumen)

- Mastic asphalt (limestone aggregate) to **BS 6925**, type R988 manufactured with asphaltic cement specified under Table 1 column T25 75% Bitumen and 25% Lake Asphalt.

(b) Sampling and testing shall be carried out in accordance with BS 5284. Deliver samples to the approved laboratory as directed by the Engineer. Results shall be in accordance with **BS 6925**.

(c) Black sheathing felt shall be to **BS EN 13707**, Class 4A(i) and weighing not less than 17 kg per roll 25 mm long.

(d) Bitumen dressing compound shall be cut back bitumen to **BS 3690**, Grade 25 secs. or other approved grade.

(e) Sand finishing shall be fine, clean and the particles of which must mostly pass a 600 □m mesh BS sieve and be retained on a 300 μm mesh BS sieve.

(f) Granite chippings shall be best quality grey granite free from brown and partially decomposed stone graded to pass a 5.00 mm mesh BS sieve and be retained on a 2.36 mm mesh BS sieve.

(g) Reflective paint shall be approved bituminous based aluminium paint or an approved paint compatible with bituminous surfaces.

(h) Reinforcement shall be bitumen coated "plain expanded" metal lathing to **BS EN 13658-1** and not less than 10 mm short way of mesh and not lighter than 0.46 mm thickness.

2.1.15.5.3 Workmanship

(a) Lay mastic asphalt roofing in accordance with **BS 8218**.

(b) Break the blocks into pieces of suitable size, carefully stack in an approved cauldron or mixer and gradually heat to a temperature at no time exceeding 230°C. Whilst heating agitate the asphalt continuously to prevent local over-heating. Remove the asphalt from the cauldron or mixer by means of buckets which have been coated with a fine inert dust or cement. Do not use ashes or oil for this purpose.

(c) The Contractor shall provide suitable thermometers to ensure that the asphalt is heated to correct temperature.

(d) Cauldrons shall be sited so as to cause minimum inconvenience and nuisance to occupied premises considered to be air sensitive receivers as determined under EPD's guidelines for air quality assessment.

(e) Lay black sheathing felt lapped 75 mm at joints, laid dry and not sealed to the structure on all surfaces not exceeding 30° from the horizontal.

(f) Skirtings, covering to curbs and the like on concrete exceeding 300 mm high sloping surface sand all finishes on timber shall be reinforced with metal lathing securely plugged and stapled.

(g) Lay asphalt with coats breaking joint at least 150 mm, on a perfectly clean and dry base. Lay horizontal asphalt to wood or metal gauges to ensure the correct thickness of each coat. Thickness shall be as follows :-

- Horizontal roof surfaces and on slopes not exceeding 30^{o} - two coats of equal thickness to a total thickness of not less than 20 mm.
- Skirtings, upstands and drips and on slopes exceeding 30^{o} - two coats of equal thickness to a total thickness of not less than 13 mm.
- Skirting, upstands and drips higher than 300 mm, three coats of equal thickness to a total thickness to a total thickness of not less than 20 mm.

(h) Should "blows" be formed whilst laying, due to the entrapment of moisture or air, pierce the affected part and make good whilst the surrounding asphalt is warm.

(i) Form internal angles between horizontal and vertical surfaces with stout asphalt fillets, in two coat work, not less than 50 mm on face and continuous with those surfaces.

(j) Maintain the full thickness of asphalt specified at external angles between horizontal and vertical surfaces or between sloping surfaces.

(k) Unless otherwise required, form skirtings not less than 150 mm high above roof finish with top edge splayed and tucked into a groove not less than 25 mm deep.

(l) Neatly dress asphalt roofing into rainwater outlets including sealing as necessary. Prior to applying asphalt prime flanges of roof outlets with bitumen solution.

(m) Flashings to rainwater outlets shall be carefully embedded in the first coat of the asphalt and the second coat dressed over it.

(n) Neatly dress asphalt reinforced as Clause 2.1.15.5.3 (f) 150 mm (minimum) high around sleeves to pipes passing through roofs with a stout asphalt angle fillet at bottom. Prior to apply asphalt thoroughly clean metal surfaces and prime with bitumen solution.

(o) Expansion joints shall be constructed strictly as indicated on the drawings.

(p) Pointing shall be in accordance with the specification in Clause 2.1.8.15

(q) Flashings and coverings shall be in accordance with the specification for leadwork in Clauses 2.1.15.1.1 (a) and (b).

(r) Immediately after the completion of laying, rub roof surfaces well with a clean wood float using fine clean sand.

(s) Solar protection shall be provided as indicated.

- Dress surface with bitumen compound applied at the rate of 3 kg/m^2 dressed immediately with stone chippings lightly rolled in at the rate of 15 kg/m^2, remove any loose chippings.
- Apply two coats of reflective paint at rates recommended by the manufacturer.
- Lay precast concrete or insulating tiles in accordance with the specification for Rigid Tile or Slab Finishes in Clauses 2.1.17.7.

2.1.15.6 Steel sheet roofing and cladding

2.1.15.6.1 Materials

(a) Steel corrugated sheets shall be hot-dipped galvanised corrugated sheets to BS 3083 and to be at least 0.6 mm thick, with corrugations 76 mm wide and 19 mm deep.

(b) Profiled steel sheets to **BS 5427** shall be obtained from approved manufacturer of profile, thickness, finish and colour as specified.

(c) Accessories for steel sheets shall be made from 0.6 mm (minimum) thick galvanised steel sheet or to be approved proprietary fittings. Accessories for colour coated sheets shall be obtained from the approved manufacturer of the sheets.

(d) Hook bolts and nuts, drive screws, washers, self-tapping screws, roofing bolts, nuts and clips, roofing screws and sheeting clips shall be galvanised steel to **BS 1494:Part 1** or electro -plated to **BS 7371** and of the sizes and finishes specified.

Alternatively, recommended specialist fixings from an approved manufacturer of the roofing sheets.

Bolts and screws shall be fitted with large washers compatible with sheets and shall be capable of withstanding up-lift under typhoon conditions.

Where coloured roofing sheets are used, fixing heads shall be covered with plastic caps to match the colour of the sheets.

Rivet fixings may only be used with the permission of the Engineer, and then only for vertical flashings

2.1.15.6.2 Workmanship

(a) Fix steel sheeting generally in accordance with **CP 143: Part 10**.

(b) Drill fixing holes in the crown of corrugations for roofing, and in the trough of corrugations for cladding. Drill holes 2 mm larger than bolts or screw, and not less than 40 mm from edges of sheets .

(c) Remove all drilled cast material from around holes, leaving holes flat and smooth prior to any bolt or other fixing.

(d) Make good damage to zinc coatings and galvanising, treat cut ends of galvanized sections with two coats of metallic zinc-rich priming paint as Clause 2.1.15.1.

(e) Lay sloping sheets with minimum end laps of 150 mm. Vertical sheets shall be fixed with minimum laps of 75 mm. All laps shall be located over a supporting member.

Lay sheets with side laps of one and a half corrugations.

Where specified, seal laps with approved lap sealant.

Fix to steelworks with stainless steel self tapping screws designed for fixing to steel. Fix to timber with self tapping screws designed for fixing to timber.

Fixings for two rows around the perimeter of the roof, to any projecting areas, verges or open areas and at all end lapsshall be at 300 mm (maximum) centres.

Cut, fit and dress steel sheet accessories to fit corrugations or profiles and fix with approved fixings in accordance with the manufacturer's recommendations.

Provide movement joints in all lengths of roofing or cladding over 45 m, with one joint for lengths up to 75 m and one for every additional 30 m.
Cover with a movement joint cover fixed to sheets at one side only.

Fix sheets in accordance with the manufacturer's recommendations. Sheets shall be sheared and not cut with circular saws or abrasive wheels. Make good damages as Clause 2.1.15.2.2 (l).

(f) Sheets required shall be bent to a radius for use on curved roofs shall be bent by means of a proper profiling or crimping machine.

(g) Treat joints of steel corrugated sheet roof according to Clause 2.1.15.3.2 (i).

2.1.15.7 Aluminium sheet roofing and cladding

2.1.15.7.1 Materials

(a) Aluminium corrugated and profiled sheets shall be to **BS 4868**. Corrugated sheets shall be at least 0.6 mm thick with corrugations 76 mm wide and 19 mm deep. Profile sheets shall be of the profile, thickness, finish and colour as specified.

(b) Accessories for profiled aluminium sheets shall be made from aluminium flat sheet at least 0.6 mm thick and of similar finish and colour to the profiled sheets or to approved proprietary fittings. Accessories for colour coated sheets shall be obtained from the approved manufacturer of the sheets.

(c) Fixings for aluminium profiled sheets as Clause 2.1.15.6.1.

2.1.15.7.2 Workmanship

(a) Fixing of aluminium sheet shall be similar to that for steel sheeting. See Clauses 2.1.15.6.2.

(b) To prevent electro-chemical corrosion, direct contact with other metals (particularly copper) shall be avoided. Fixings must be of, or compatible with, aluminium. Where unavoidable, coat contact surfaces with bituminous paint, protective tape or other approved means.

2.1.15.8 Profiled glass-fibre reinforced plastic (GRP) sheets

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2.1.15.8.1 Materials

(a) Profiled glass-fibre reinforced plastic (GRP) sheets shall be to **BS 4154**. The resin system, as regards physical properties, shall be to **BS 3532**. The profile, thickness, translucency and colour shall be as specified.

(b) Where fire protection requirements apply, the GRP sheets shall be tested in accordance with **BS 476:Part 3** and Part 7 and the fire performances achieved by the samples shall be stated.

(c) The sheets shall be marked with the name or trademark of the manufacturer, the **BS 4154** and the designation of the test samples of the translucent sheet in accordance with **BS 476:Part 3**, where so claimed by the manufacturer.

(d) Fixings for glass-fibre reinforced plastic sheets as Clauses 2.1.15.6.2..

2.1.15.8.2 Workmanship

(a) Fixing of glass-fibre reinforced plastic sheets shall be similar to that for steel sheeting. See Clause 2.1.15.6.2.

2.1.15.9 Profiled unreinforced rigid pvc sheets

2.1.15.9.1 Materials

(a) Profiled unreinforced rigid PVC sheets shall be **BS 4203**. The profile, thickness, colour and transparency shall be as specified. The sheets shall be marked with the name or trademark of the manufacturer, the date of manufacture and the number of the BS and the type.

(b) Fixings for PVC sheets as Clause 2.1.15.6.2.

2.1.15.9.2 Workmanship

(a) Fixing of PVC sheets shall be similar to that for steel sheeting. See Clause 2.1.15.6.2.

(b) Lay sloping sheets with minimum end laps of 225 mm. Vertical sheets shall be fixed with minimum laps of 75 mm. All laps shall be located over a supporting member.

(c) Lay sheets with side laps of one and a half corrugations.

(d) Where specified, seal laps with approved lap sealant.

2.1.15.10 Profiled compressed particle sheets

2.1.15.10.1 Materials

(a) Profiled compressed particle sheets and accessories shall be as specified and not to contain asbestos materials of any kind.

(b) Fixings for compressed particle sheets as Clauses 2.1.15.6.2.

2.1.15.10.2 Workmanship

(a) Fixing of compressed particle sheets shall be similar to that for steel sheeting. See Clause 2.1.15.6.2.

2.1.15.11 Proprietary roofing systems

2.1.15.11.1 Generally

(a) Proprietary roofing systems shall be laid by specialist contractors included as agents or applicators on the list of Acceptable Specialist Roofing Materials Contractors.

2.1.15.11.2 Materials

(a) All waterproof Roofing Covering Materials shall be materials of the acceptable specialist's roofing system and which are subdivided into four groups as follows :-

- Type 'A1' Roofing Sheet Material requiring Protection.
- Type 'A2' Roofing Sheet Materials with self finishes.
- Type 'B1' Liquid Applied Roofing Materials requiring Protection.
- Type 'B2' Liquid Applied Roofing Materials with self finishes.

(b) Submit samples of the roofing materials which shall be installed and copies of the manufacturer's technical data and instructions to the Engineer for approval.

(c) Before commencing work, the contractor shall demonstrate on Site that all adhesives and materials are fully compatible and shall be certified by the suppliers/manufacturers in writing.

2.1.15.11.3 Workmanship

(a) Lay the roofing system comprising the approved roofing material, insulation and roof finishes onto the roof, including priming, sealing, crack filling and other preparation where necessary all in accordance with the manufacturer's specification and recommendations, and in accordance with the details and sequence as approved by the Engineer.

(b) Particular care shall be taken to ensure that all junctions, joints around pipes, rainwater outlets and the like are properly executed.

(c) Take necessary measures when carrying out the works so that disturbances, including noise and vibration, to the occupants and users of the premises are kept to the minimum. Noisy works, which in the opinion of the Engineer, will affect the occupants and users will not be permitted.

(d) Chutes for removal of Construction and Demolition waste shall be erected at approved locations, designed to withstand high winds, with hopper heads to ensure that no materials fall outside the chutes, and discharge at low level, preferably into skips or bunkers, to prevent the spread of debris and to minimize dust generation. Chutes shall be demolished and removed off the Site after use and all disturbed areas and surfaces shall be made good to match existing.

(e) Prevent dust arising from debris generated by removal of existing roofing systems by approved dust control methods. Debris shall be regularly removed from the Site.

(f) Prior to laying of the roofing system inspect and repair as required to provide proper surfaces to receive waterproofing.

Remove all contaminants such as grease, oil, etc., from the surfaces. Clean surfaces to remove dust, dirt, loose stone and debris.

(g) High pressure water cleaning of substrates shall not be permitted.

(h) When specified for repair or maintenance work, take up and remove existing tiles, existing layers of felt or other protective covering, to expose existing asphalt or roof membrane; lay a cement and sand screed, minimum 25 mm thick or self-leveling screed as approved by the Engineer, to produce an even surface to approved falls to receive the new roofing system. The Contractor shall take the responsibility for repairing and making good the existing roof slab.

(i) No work shall be carried out when there is surface moisture.

(j) The whole roof shall be left watertight when no work is in hand.

Where coverings have been removed and not yet replaced, the Contractor shall provide covering (ropes and hold-fasts to hold down the coverings) by means of tarpaulin or other sheeting to cover all areas of roofs. Overlaps must be sealed with tape and sheets effectively dressed into outlets.

Other methods of protection may be employed as approved by the Engineer.

During working hours, all roofing outletsshall be protected to prevent debris falling into rainwater pipes. The outlets shall be opened and cleared at the end of the working day and the roof swept clean to ensure effective drainage.

Protect all pipework, ducting and other services running on top of the existing roof, including provision of new pipe supports as necessary.

Any accidental damage to water supply pipes shall be reported to the Engineer immediately.

(k) Adhesive, if required, shall be applied strictly in accordance with the manufacturer's recommendations. All manufacturer's data about the shelf-life of adhesives shall be noted, and no attempt shall be made to use materials which are no longer fit for use. The spreading of adhesive over large areas and subsequent setting before placing of sheets shall be prohibited.

Ensure that workers are protected against the risk of exposure to substances considered to be hazardous to health. Toxicological information, exposure control, personal protection and first aid measures extracted from the manufacturer’s material safety data sheets shall be kept in a register on the Site.

(l) If bubbles form in the membrane, the affected area shall be cut open and made good as far as the manufacturer's technical literature specifically allows. Otherwise, the whole area shall be stripped, cleared and the surface shall be prepared again and the work shall be re-executed.

(m) When specified, apply a light-reflective paint or similar finish applicable to the particular roofing system.

(n) When specified, the roofing system shall be designed to allow for increased wear due to frequent foot traffic or shall be protected by precast concrete tiles, (laid on cement and sand mortar) or other materials approved by the Engineer.

(o) Do not allow traffic on roof until 4 days after completion of tiling and subsequently permit only light traffic for a further 10 days.

(p) When specified, position and fix approved proprietary roof vents in accordance with the manufacturer's recommendations and ensure that the roofing contractor or specialist makes good the roof covering up to and around them.

(q) Insulation shall either have integrally bonded hard surfaces on both sides or be protected by inert hard sheeting or reinforced screed.

(r) Moisture testing equipment shall be available on Site to monitor the moisture content of the roof structure and the various elements of the roof system; all necessary precaution shall be taken to ensure the full integrity of the roofing system.

(s) Records of tins of adhesive, liquid membrane or amount of sheeted membrane material shall be kept upon their arrival on site. The number consumed per day and the number cleared away shall be evaluated to check the actual spreading rate of the proprietary material against the manufacturer's technical data. Tins and packages may be marked on arrival and again when consumed.

(t) Keep a register of all dangerous substances including those hazardous to health, which are delivered to and stored for use on the Works. The register shall include information on physical and chemical properties, hazards, safe handling and storage, precautionary measures to be taken, first aid measures, disposal of containers and surplus or waste materials, and measures to be taken in case of accidents.

(u) Inform the Engineer upon the completion of each layer of the roofing system for an inspection before the execution of next layer.

2.1.15.12 Non-destructive test

(a) The test shall include sealing all outlets and if necessary constructing dams to compartmentalize large roofs. Flood the roof for 24 hours. After flooding, all outlet blockages and dams shall be removed to drain the roof. Do not permit any debris to enter into the drainage pipework.

(b) At a period between 24 and 48 hours from release of the water, an infra-red scan shall be carried out by an independent specialist contractor to establish if there has been penetration through the membrane. The report shall be sent directly by the infra -red scanning contractor to the Engineer.

2.1.15.13 Warranty

(a) Upon completion of the work, submit one maintenance manual, identified with project name, location and date, type of coating system applied and surface to which system was applied, and sketches where necessary.

(b) Recommendations for periodic inspections, care and maintenance shall also be included. Identify common cause of damage with instructions for temporary patching until permanent repair can be made.

(c) Duly executed warranty shall be submitted by the Contractor in accordance with the Contract. The completed installation shall be guaranteed against defects of materials and

workmanship by the Contractor for a period of 10 years from the date of completion stated in the certificate of completion with respect to the Works for use as an exposed roof membrane in Kenya.

(d) The system shall be designed to withstand the conditions of the Kenya climate. The warranty shall cover the roofing system in its entirety. The warranties shall be extended to cover all aspects of the roofing project executed by the Contractor including adhesion and structural integrity of materials used.

2.1.15.14 References and Standards

BS EN 13707 (2004+A2:2009): Flexible sheets for waterproofing. Reinforced bitumen sheets for roof waterproofing. Definitions and characteristics

BS EN 490 (2011): Concrete roofing tiles and fittings for roof covering and wall cladding. Product specifications

BS 5534 (2003+A2:2010): Code of practice for slating and tiling (including shingles)

BS 8217 (2005): Reinforced bitumen membranes for roofing. Code of practice

BS 8218 (1998): Code of practice for mastic asphalt roofing.

BS EN 12588 (2006): Lead and lead alloys. Rolled lead sheet for building purposes.

BS 6915 (2001): Design and construction of fully supported lead sheet roof and wall coverings.Code of practice.

CP 143-10 (1973):Code of practice for sheet roof and wall coverings. Code of practice for sheet roof and wall coverings. Galvanized corrugated steel. Metric units

CP 143-12 (1970): Code of practice for sheet roof and wall coverings. Code of practice for sheet roof and wall coverings. Copper.Metric units.

CP 143-15 (1973): Code of practice for sheet roof and wall coverings. Code of practice for sheet roof and wall coverings. Aluminium.Metric units.

BS EN 1172 (2011): Copper and copper alloys. Sheet and strip for building purposes.

BS EN 1652 (1998): Copper and copper alloys. Plate, sheet, strip and circles for general purposes.

BS EN 1653 (1998): Copper and copper alloys. Plate, sheet, strip and circles for boilers, pressure vessels and hot water storage units.

BS EN 1654 (1998): Copper and copper alloys. Strip for springs and connectors.

BS EN 485-1 (2008+A1:2009): Aluminium and aluminium alloys. Sheet, strip and plate. Technical conditions for inspection and delivery

BS 6925 (1988): Specification for mastic asphalt for building and civil engineering (limestone aggregate):.

BS 3690-3 (1990): Bitumen for building and civil engineering. Specification for mixtures of bitumen with pitch, tar and Trinidad lake asphalt

BS EN 13658-1(2005): Metal lath and beads. Definitions, requirements and test methods. Internal plastering

BS 1494-1(1964): Specification for fixing accessories for building purposes. Fixings for sheet, roof and wall coverings.

BS 5427-1 (1996): Code of practice for the use of profiled sheet for roof and wall cladding on building. Design

BS 7371-12 (2008): Coatings on metal fasteners. Requirements for imperial fasteners

BS 4868 (1972): Specification for profiled aluminium sheet for building.

BS 4154-2 (1985): Corrugated plastics translucent sheets made from thermo-setting polyester resin (glass fibre reinforced).Specification for profiles and dimensions.

BS 3532 (1990): Method of specifying unsaturated polyester resin systems.

BS 4203-1 (1980): Extruded rigid PVC corrugated sheeting. Specification for performance requirements

BS EN 490 (2011): Concrete roofing tiles and fittings for roof covering and wall cladding. Product specifications

BS 5534 (2003+A1:2010): Code of practice for slating and tiling (including shingles)

BS 4203-2 (1980): Extruded rigid PVC corrugated sheeting. Specification for profiles and dimensions

2.1.16 METAL WORK

2.1.16.1 Materials

2.1.16.1.1 Steel

(a) Steel shall be as generally described for Structural steel. See Section 2.1.19.

2.1.16.1.2 Galvanized steel sheet and coil

(a) Hot dipped galvanized plain steel sheet and coil shall be to **BS EN 10143**.

2.1.16.1.3 Steel mesh

(a) Welded wire mesh shall be steel wire of the specified diameter welded to form a square or oblong mesh as specified and shall be hot dip galvanized after manufacture as specified.

(b) Expanded steel mesh shall be to **BS 405**.

2.1.16.1.4 Steel tubing

(a) Steel tubing shall be to **BS EN 10255:2004** "medium" grade and galvanized.

2.1.16.1.5 Slotted steel angle

(a) Slotted steel angle shall be self-finished angle to **BS 4345**. Fittings to be cadmium plated steel.

2.1.16.1.6 Cast iron

(a) Cast iron shall be grey cast iron to **BS 1561** Grade 150.

2.1.16.1.7 Aluminium alloy

(a) Aluminium alloy plate; sheet and strip shall be to **BS EN 485**, **BS EN 515**, **BS EN 573-3:2009, BS EN 573-1:2004** and **BS EN 573-5:2007**of required alloy designation.

(b) Aluminium alloy bars, extruded tube sections and hollow sections shall be to **BS EN 573-3:2009** alloy designation 6063.

(c) Aluminium sections for structural purposes shall be to **BS 1161**.

(d) Aluminium alloy drawn tubes shall be to **BS EN 515**, **BS EN 573-3:2009, BS EN 573-1:2004 and BS EN 573-5:2007** and **BS EN 754** alloy designation 6063.

2.1.16.1.8 Brass rods and sections

(a) Brass rods and sections shall be to **BS EN 12163**, **BS EN 12164**, **BS EN 12167** designation CZ 106 condition M.

2.1.16.1.9 Stainless steel

(a) Stainless steel plate, sheet and strip shall be of grade 316 or 304 to **BS EN 10029 and BS EN ISO 18286: 2010** mill finish and polish finish, or otherwise as required. Where welding is required, the steel shall be grade 316S13 or 304S11. The chemical composition of the steel as determined by cast analysis, shall comply with the following table:

	Grade 304	**Grade 316**
Chromium content	17% to 19%	16.5% to 18.5%
Nickel content	8% to 12%	10.5% to 14.5%
Carbon content	0.07% max	0.07% max
Manganese content	2% max	2% max
Molybdenum content	0%	2% to 3 %
Phosphorus content	0.045% max	0.045% max
Sulphur content	0.03%	0.03% max.
Silicon content	1% max max	1% max.

(b) Stainless steel tubes for structural and general engineering purposes shall be to **BS EN 10296**, composition and finish shall be as above.

(c) Stainless steel fasteners to follow steel grade of members shall be connected and to **BS EN 10263-1 & BS EN 10263-5**.

(d) Stainless steel anchors and inserts shall be of grade 316S31, A4 to **BS EN ISO 3506**.

2.1.16.1.10 Fixings generally

(a) Fixings generally shall be of the same material and finish as the material to be fixed.

2.1.16.1.11 Metal insert channels for concrete

(a) Concrete insert channel shall be an approved galvanised steel channel, with expanded polystyrene temporary filler. Provide matching sliding fixing devices.

2.1.16.1.12 Adhesive for metal

(a) Adhesive for bonding metal to metal shall be an approved proprietary brand.

2.1.16.2 Workmanship

2.1.16.2.1 Samples

(a) Submit samples for approval, as required.

2.1.16.2.2 Prototypes

(a) Obtain approval of prototypes before starting fabrication of repetitive components.

2.1.16.2.3 Fabricating generally

(a) During fabrication, protect all surfaces that shall be visible in the finished work.

(b) Mitre junctions of identical sections.

(c) Assemble moving parts to move freely and without binding.

(d) Remove all burrs and sharp arrises which shall be visible after fixing or a hazard to the user.

2.1.16.2.4 Welding generally

(a) Remove grease, dirt, moisture, oxide and scale from the edges to be welded.
Ensure accuracy, using clamps or jigs where practicable. Use tack welds for temporary attachment where jigs are not practicable.

(b) Joints shall be fully fused throughout with no holes, pores or cracks.

(c) Prevent weld splutter falling on self-finished surfaces visible in the completed work.

(d) Butt welds, visible in completed work, shall be ground smooth and flush and fillet welds to be ground smooth, if required.

(e) Ensure complete removal of flux residue and slag.

(f) Welding of aluminium alloy shall be by inert-gas arc welding to **BS EN 1011-4** or other method subject to approval.

(g) Welding of steel shall be by manual metal-arc we lding to **BS EN 1011-2**. Welding of stainless steel shall be by inert-gas arc welding to **BS EN 1011-3** or other method subject to approval.

2.1.16.2.5 Brazing

(a) Brazing shall be to **BS EN 14324: 2004.**

2.1.16.2.6 Metal articles

(a) Metal articles which are to be coated shall be designed in accordance with the recommendations of **BS 4479**.

2.1.16.2.7 Finishing to steel

(a) Finishes to steel shall be as follows :-

i. Bare to receive painted finish.

ii. Electroplated coating of zinc shall be to **BS EN 12329** and **BS EN ISO 2082**.

iii. Zinc sprayed coating shall be to **BS EN IS0 2063 –** nominal thickness 0.2 mm unless otherwise specified.

iv. Galvanising shall be hot-dip galvanising to **BS EN ISO 1461** with a minimum thickness of 85µm. Components shall be galvanised after fabrication, if required.

v. No zinc sprayed coated or hot-dip galvanised items shall be welded or drilled and any subsequent cutting is defined as damage which shall be subsequently made good after coating or galvanising.

vi. Make good damage to zinc coatings and galvanising, treat cut ends of galvanised sections with two coats of metallic zinc-rich priming paint to **BS 4652** Type 2.

2.1.16.2.8 Finishes to aluminium

(a) Finishes to aluminium alloy shall be as follows :-

i. Mill.

ii. Polished.

iii. Polished and treated with a protective lacquer.

(b) Clear anodised shall be to **BS EN 12373-1** and of the thickness grade and surface texture as follows:-

(c) Interior work AA/15.

(d) Exterior work AA/20.

(e) Colour anodised shall be to **BS 3987** average 25 □m thick.

(f) Approved proprietary hardcoat anodic finish with better wearing qualities than standard anodising of the required thickness.

2.1.16.2.9 Chromium plating

(a) Chromium plating shall be to **BS EN 1254**, for "service condition No. 3", with "bright", "dull" or "satin" finish.

2.1.16.2.10 Protection

(a) Protect all decorative finishes to metalwork against damp, scratching and other damage. Apply a strippable coating or masking tape to all stainless steel, anodised aluminium or similar surfaces and only remove as and when necessary for construction or just prior to inspection for handover. Remove surplus adhesive with non-damaging solvent and wash down.

2.1.16.2.11 Contact of aluminium and concrete etc.

(a) Avoid contact in the completed work between aluminium and concrete, mortar, plaster, or similar materials. Where unavoidable, paint one coat of bituminous paint on aluminium surfaces, or use approved tape.

2.1.16.2.12 Contact of dissimilar metals

(a) Avoid contact in the completed work between the following metals :-

i. Aluminium alloys with copper alloys, nickel, lead or stainless steel.

ii. Iron and steel with copper alloys.

iii. Zinc (including galvanizing) with copper alloys or nickel.

(b) Where unavoidable, coat contact surfaces with bituminous paint, protective tape or other approved means

2.1.16.2.13 Galvanized steel tubing

(a) Carefully notch, fit and weld galvanized steel tubing to produce accurate joints which shall be ground smooth and treated with two coats of zinc rich priming paint to **BS 4652** Type 2.

2.1.16.2.14 Castings

(a) Castings shall be sound free from bubbles, cracks or other defects and to include the construction of patterns and moulds as required.

2.1.16.2.15 Slotted steel angle

(a) Cut slotted steel angle square and securely bolt together using nuts bolts and washers and angle braces as necessary.

2.1.16.2.16 Fixing steel mesh

(a) Fix steel mesh at 75 mm centres as follows:-

i. To steel framing by,

- Tack welding.
- Tying with 2 mm galvanised tying wire.

ii. To wood framing with 1.8 x 25 mm galvanised staples.

2.1.16.2.17 On completion

(a) Lubricate and adjust moving components, and leave in perfect working order on completion.

2.1.16.3 Metal windows and doors

2.1.16.3.1 Steel windows and doors

(a) Steel windows and doors shall be obtained from an approved manufacturer and constructed to **BS 6510** and in accordance with the following :-

i. When fixed in position, windows and doors shall be designed to withstand a wind load calculated in accordance with the **BS 6399-2** with a minimum pressure of 3kPa and a permissible maximum deflection of 1/180th of the length of the member under consideration. Calculations shall be required to be submitted for approval.

ii. Frames shall be square and flat with mitred, welded corners and with glazing bars machine tenoned and/or welded to frames.

iii. Water bars shall be welded to the frames for the complete width of the windows or doors.

iv. When weather bars are specified, weld same to the frames for the complete width of the windows or doors.

v. Provide all slotted adjustable lugs and screws necessary for building in the windows and doors and ensure that lugs project 60 mm (minimum) beyond the metal frames.

vi. Provide loose mullions and transomes of total length to suit window or door openings together with additional 75 mm at each end for building in.

vii. Provide sufficient mastic and bolts for assembly of all composite units and assemble same at Site, including bedding mullions and transomes in mastic with all interstices completely filled.

viii. Windows and doors shall be suitable for external glazing unless otherwise specified. Provide rolled steel heavy channel section glazing beads size as specified for windows and doors, mitred at corners and fixed with galvanised mild steel flat headed countersunk screws at 225 mm centres (maximum) and tap frames to receive screws.

ix. All members shall be hot-dip galvanized or zinc sprayed as specified in Clause 2.1.25.2.2 (a) and Clause 2.1.16.2.7(iii).

x. When specified, provide an approved chloroprene rubber or polyvinyl chloride weatherstrip securely fixed into the dovetail groove in the section to provide a continuous contact between the opening casement and the fixed frame.

xi. Window and door fittings and furniture shall be approved and as follows:-

xii. Steel hinges with brass pins and welded or riveted to frames. Projecting hinges to side-hung casements where windows shall be cleaned from the inside.

xiii. All fittings including friction grip pivots, casement fasteners, spring catches, brackets, slide arms, shoes, slip bolts, cabin hooks and eyes and handles, all of manganese brass with bronze finish. All to retain the opening parts rigidly in both the open and closed positions.

xiv. Handle plates, round headed stay brackets welded to the fixed frames with interchangeable handles and stays.

xv. Windows and doors shall be hung to open as indicated and fitted with the following fittings and furniture:-

- Side-hung casement and vertically centre-hung ventilator – a two-point nose fastener or a two throw casement fastener with mild steel adjustable connecting rod and a 250 mm peg stay or bronze sliding stay, as specified.

- Projecting casement - bronze sliding shoes, pivots and friction side arms and one spring catch with ring for hand or pole operation and two square-shank barrel bolts.

- Top-hung ventilator - 200 mm peg stay with round-headed stay bracket welded to the fixed frame and with a second peg to secure the stay firmly and horizontally against the first peg when the ventilator is closed.

- Bottom-hung ventilator - a spring catch and fanlight roller stay to limit opening and to permit the ventilator to swing free for cleaning.

- Horizontally centre-hung ventilator with a spring catch, with ring and eye for cord or pole operation.

- Doors - sliding bolts of suitable length, striking plates at top and bottom, cabin hooks and eyes of suitable length, three-lever mortice lock with two

keys, lever handles and escutcheon plates, as specified.

xvi. When specified, provide extruded aluminium flyscreens having plastic covered fibre -glass mosquito gauze with 7 x 7 mesh per 10 mm square.

xvii. Where flyscreens are provided, side hung casements shall have a locking handle and an opening and closing mechanism consisting of a bronze cam handle and bronze roto operator, and top hung casements to have bronze "through-the-frame" type stays.

xviii. When specified, high openable windows in inaccessible locations shall be fitted with remote control gear.

xix. Provide temporary steel clamps at the top and bottom of all opening lights of casements prior to transportation from factory till fixed in position.

xx. Paint surfaces: as specified in Section 2.1.17.11. Metal windows and doors shall be delivered to site unprimed.

2.1.16.3.2 Aluminium windows and doors

(b) Aluminium windows and doors shall be obtained from an approved manufacturer and constructed in accordance with the following: -

i. When fixed in position, windows and doors shall be designed to withstand a wind load calculated in accordance with the **BS 6399-2** with a minimum pressure of 3 kPa and a permissible maximum deflection of 1/180th of the length of the member under consideration. Where necessary use mild steel cores, anchors, brackets, etc. as stiffeners. Calculations shall be required to be submitted for approval. Cores, anchors and brackets etc. shall be finished to Clause 2.1.16.3.2 (xvi)

ii. Sections shall be extruded aluminium alloy to **BS EN 485**, **BS EN 515,BS EN 573-3:2009, BS EN 573-1:2004 and BS EN 573-5:2007** British alloy designation 6063 with a minimum wall thickness of 2.0 mm and dovetail grooved for weatherstrip.

iii. Aluminium sections shall be as follows:-

Clear anodised to **BS EN 12373-1** AA/20.

Colour anodised to **BS 3987** average 25ɑm thick.

Approved proprietary hardcoat anodic finish with better wearing qualities than the above.

iv. Frames shall be mechanically jointed of mortice and tenon construction to provide rigid and secure connections. Mechanically joint and mitre sash members to develop the full strength of members using solid block angle pieces and provide a neat weather-tight joint. Provide adequate drainage in bottom members.

v. Provide galvanized steel fixing lugs spaced at 300 mm centres (maximum) for outer frames of each unit. Where specified, fix lugs with rag bolts or approved proprietary stud anchors fixing bolts.

vi. Provide water bars of galvanized steel for the complete width of the windows or doors where the design of the window requires.

vii. Assemble all composite units at Site, including provision of all necessary bolts, screws etc. and sealing all joints with an approved sealant.

viii. Unless otherwise specified, provide an approved chloroprene rubber, polyvinyl chloride or nylon pile weatherstrip securely fixed into the dovetailed groove in the window or door sections to provide a continuous contact between each opening part and its fixed frame.

ix. Windows and doors shall be suitable for internal glazing unless otherwise specified. Provide an approved glazing system and aluminium beads. Securely clip beads to the frame or use beads which shall be an integral part of the frame.

x. Use aluminium alloy, stainless steel or nylon for all exposed fixings including screws, nuts, bolts, washers and rivets and match up with finish where possible. Use galvanized on cadmium-plated steel for all concealed fastening devices.

xi. Window and Door fittings and furniture shall be approved and as follows:-

1. Friction pivots and sliding stays - stainless steel. To provide a maximum opening of 100 degree and a minimum clearance of 100 mm between frame and window for cleaning purposes.

2. Casement fasteners, locking handles, spring catches, casement stays, brackets, slip bolts and the like:-

   - diecast zinc alloy to **BS EN 1774** suitably coloured to match the anodised window or door metal.

   - Moulded stainless steel with satin finish.

3. Locks cadmium plated steel with stainless steel or brass shoots etc.

4. Pull handles anodized aluminium.

5. Rollers, guides etc. cadmium plated steel with nylon or brass rollers to suit weight of door or window. To be adjustable after installation.

xii. Remote control gear shall be hand operated shaft and lever or conduit and cable remote control system with bronze or diecast zinc alloy bevel gear boxes, adjustable arms and keyed shafts.

xiii. Windows and doors shall be hung to open as indicated and fitted with the following fittings and furniture:-

xiv. Side and top hung windows - Friction pivots and sliding stays and casement fastener (dual if necessary) or pull handle and locking handle (dual if necessary).

xv. When flyscreens are specified, they shall be located on the inside.
The frames shall be extruded aluminium with plastic covered mosquito gauze of 7 x 7 mesh per 10 mm square. Screens shall be fixed to window frames by turn buckles. The windows shall be fitted with locking handles and an opening and closing mechanism comprising cam handles and roto operator.

xvi. Prime with zinc chromate primer and paint two coats of bituminous paint on all

steel framework, cores, anchors and brackets.

xvii. Paint one coat of bituminous paint on concealed aluminium or stainless steel surfaces which may come into contact with wet mortar, cement, plaster or similar materials.

xviii. Apply a strippable coating or masking tape to all exposed aluminium or stainless steel surfaces. (NOTE: The anodised surface may be permanently damaged by contact with wet cement and plaster) Wrap all window and door units and other associated materials in stout waterproof paper or polythene to protect against damp and scratching and do not make premature delivery to Site.

xix. Return to site on completion of building work, carefully remove protective coating and leave clean.

2.1.16.3.3 Fixing metal windows and doors

(a) When fixing metal windows and doors :-

i. Avoid distortion during handling and storage.

ii. Ensure tightness and clearance between sash and frame of all opening lights which shall be fixed until glazed.

iii. Avoid having construction access through window openings and/or placing scaffolding, boards etc. directly onto the window frames. If window openings must be used, then window frames at that opening location shall not be fixed until after completion of the related internal works and the through-route is no longer required.

iv. Assemble composite units including the provision of all necessary bolts screws etc. and seal joints with an approved one pack gun type polysulphide sealant to **BS EN ISO 11600**.

v. Position, plumb, level and square.

vi. Form pockets in heads, jambs, cills etc. to receive fixing lugs, build in lugs and made good and screw to frames or plug and screw frames using packing pieces where necessary. Do not distort frames when tightening fixings.

vii. Bed steel frames in mortar as used for adjacent work, leaving no gaps.

viii. Bed aluminium frames in butyl mastic bedding compound, leaving no gaps.

ix. Rake out the joints around external edge of steel window and door frames to the approval of the Engineer and point with an approved oil based mastic sealant to form a smooth, flat joint. Remove excess sealant from adjoining surfaces and leave clean. Mask adjoining surfaces which would be impossible to clean if smeared with sealant.

x. Rake out the joints around external edge of aluminium window and door frames to the approval of the Engineer and point with an approved one-pack gun type polysulphide sealant to **BS EN ISO 11600**, sealant to form smooth, flat joint. Remove excess sealant from adjoining surfaces and leave clean. Mask adjoining surfaces which would be impossible to clean if smeared with sealant.

xi. Avoid contact with concrete, mortar, plaster, or similar materials.

2.1.16.3.4 Adjustable steel louvre frames

(a) Fixed louvres and frames shall be all hot-dip galvanized unless permitted otherwise by the Engineer. Adjustable metal louvre frames and weatherstrips shall be obtained from an approved supplier and constructed in accordance with the following :-

i. Frames and clips shall be of 1.2 and 0.9 mm (minimum) steel sheet respectively. Clips shall be suitable for receiving 100, 150 or 230 mm wide and 6 mm thick glass blades, as required. Aluminium frames and aluminium or plastic clips may be supplied subject to approval.

ii. Frames shall be designed for hand or pole operation, as required, with single control and to automatically lock when closed.

iii. Weatherstrips shall be shaped metal strips of an approved design and thickness.

iv. Steel frames, clips and weatherstrips shall be hot-dip galvanized or electro-zinc plated on all surfaces prior to assembly.

v. Where specified, provide 45 x 10 mm galvanized steel sub-frames for single side louvre frames, with necessary slotted adjustable lugs and screws for building in.

vi. Provide matching rustless screws, bolts and spacers etc. for coupling adjacent frames to form mullions, where required.

vii. Provide samples and obtain approval.

(b) State manufacturer's name and country of origin.

(c) Fix adjustable steel louvre frames as follows :-

i. Avoid distortion during handling and storage.

ii. Position plumb, level and square.

iii. Where required, form pockets to receive fixing lugs, build in lugs and
iv. screw to sub-frames or plug and screw sub-frames using packing pieces where necessary.

v. Bed sub-frames in mortar as used for adjacent work, leaving no gaps.

vi. Where required, screw single side louvre frames to sub-frames at 225mm centres. Do not distort frames when tightening fixings.

vii. Where required, plug and screw louvre frames and weather strips.

2.1.16.3.5 Roller shutters and doors

(a) The design of roller shutters and doors, including boxes, hoods, guides and all other parts shall be carried out by the Contractor in accordance with the requirements stated in the Contract.

(b) The following particulars of the proposed materials and methods of construction for metal windows and doors shall be submitted to the Engineer:

- name and address of manufacturer,

- manufacturer's literature, and
- tree sets of working drawings.
- The particulars shall be submitted to the Engineer at least 14 days before fabrication of the window or door starts.

(c) Samples of materials for metal windows and doors, including fittings and furniture, shall be submitted to the Engineer at the same time as particulars of the windows or doors are submitted. Details of the samples to be provided shall be as agreed by the Engineer.

(d) Two copies of instruction manuals shall be provided for motorised roller shutters and doors. The manuals shall include detailed operating and maintenance instructions, including wiring and schematic drawings, a schedule of component parts and a priced list of recommended spares. The manuals shall be provided at the same time as the particulars of the roller shutters and doors are submitted.

2.1.16.3.6 Vehicle access doors

(a) Vehicle access doors to be sectional, electrically operated overhead doors, Plastisol HP200 colour coated externally. Colour – Grey.

i. The door leaf shall be constructed from individually hinged composite panels in 600 mm high sections. The panel shall be galvanized steel inner and outer face infilled with high density polyurethane foam.

ii. Sizes shall be as indicated on the drawings.

iii. All doors shall be complete with draught/weather seals all round and cable breakage systems.

iv. All doors to be complete with external locking system and internal shoot bolt. Hardware to be galvanised steel withy nylon track rollers.

v. A single row of double glazed, acrylic vision panels 600mm high shall be provided where indicated.

(b) Submittals

i. Product Data: Submit manufacturer's product data, roughing-in diagrams, and installation instructions for each type and size of overhead coiling door. Provide operating instructions and maintenance information, inclusive of parts lists.

ii. Shop Drawings: Submit shop drawings for special components and installations which are not fully dimensioned or detailed on manufacturers data sheets.

iii. Guarantee: Submit copies of a written guarantee, signed by the Manufacturer agreeing to repair or replace all component parts of the doors which have shown defects or failure of manufactured product, shall be rectified without cost to the Employer for a period of 1 year from the date of acceptance of the project.

(c) Quality assurance

i. Furnish each overhead coiling door as a complete unit produced by one manufacturer, including hardware, accessories, mounting and installation

components.

ii. Each overhead coiling door shall be provided in place and in full operative condition by an Installer trained in the type of installation required.

iii. Inserts and Anchorages: Furnish inserts and anchoring devices which must be set in concrete or built into masonry for installation of units. Provide setting drawings, templates, instructions and directions for installation of anchorage devices. Coordinate delivery with other work to avoid delay.

iv. See concrete and masonry sections of these specifications for installation of inserts and anchorage devices.

(d) Product handling

i. Deliver doors and accessories completely identified for installation procedure. Use care in handling to prevent damage. Store all equipment clear of grade and protected from damage and deterioration.

(e) Products

i. Manufacturer: The drawings and specifications indicate the minimum clearances and performance requirements of the following product lines (Basis of Design) manufactured by **Kaba Door Systems**, other products and manufacturers will be considered subject to the acceptance of the Engineer.

ii. Door Curtain: Fabricate overhead coiling door curtain of interlocking slats designed to withstand required wind loading, of continuous length for width of door without splices. Unless otherwise indicated, provide slats of material thickness recommended by door manufacturer for performance, size, and type of door indicated, and as follows:

iii. Steel Counter Door Curtain Slats: Structural quality, cold-rolled galvanized steel sheets complying with **ASTM A653/A653M** with G90 zinc coating, and phosphate treated before fabrication.

- Furnish manufacturers standard F-128 "flat face" slats
- Slat Thickness: Not less than 0.7 mm thick.

iv. Endlocks: Malleable iron castings galvanized after fabrication, secured to curtain slats with galvanized rivets. Provide locks on alternate curtain slats for curtain alignment and resistance against lateral movement.

v. Bottom Bar for Counter Door: Consisting of 1 angle, galvanized.

vi. Curtain Jamb Guides for Counter Door: Fabricate curtain jamb guides of extruded aluminum box type with sufficient depth and strength to retain curtain loading.

vii. Locking Mechanism: Provide manufacturer's standard cylinder locking mechanism, operable from inside only, to provide positive locking of doors.

viii. Counterbalance doors by means of adjustable steel helical torsion spring, mounted around a steel shaft and mounted in a spring barrel and connected to door curtain with required barrel rings. Use grease-sealed bearings or self-lubricating graphite bearings for rotating members.

ix. Counterbalance Barrel: Fabricate spring barrel of hot-formed structural quality carbon steel, welded or seamless pipe, of sufficient diameter and wall thickness to support roll-up of curtain without distortion of slats and limit barrel deflection to not more than 0.8 mm per 300 mm of span under full load.

x. Provide spring balance of one or more oil-tempered, heat-treated steel helical torsion springs. Size springs to counterbalance weight of curtain, with uniform adjustment accessible from outside barrel. Provide cast steel barrel plugs to secure ends of springs to barrel and shaft.

xi. Provide extended life (100,000 cycle) springs for all doors.

xii. Fabricate torsion rod for counterbalance shaft of case-hardened steel, of required size to hold fixed spring ends and carry torsional load.

xiii. Provide extra heavy duty shaft and bearings at all doors.

xiv. Brackets: Fabricate brackets of minimum 4.76 mm thick steel plate with sufficient depth and strength to support counterbalance, curtain and hood, galvanized after fabrication. Secure to wall framing as recommended by door manufacturer.

xv. Hood: Form to entirely enclose coiled curtain and operating mechanism at opening head. Contour to suit end brackets to which hood is attached. Roll and reinforce top and bottom edges for stiffness. Provide closed ends for surface-mounted hoods, and any portion of between-jamb mounting projecting beyond wall face. Provide intermediate support brackets as required to prevent sag.

xvi. Fabricate steel hoods for doors of not less than 0.5 mm thick hot-dip galvanized steel sheet with G 90 zinc coating, complying with **ASTM A653/A653M**. Phosphate treat before fabrication.

xvii. Shop clean and prime ferrous metal and galvanized surfaces, exposed and unexposed, except faying and lubricated surfaces, with door manufacturer's standard rust inhibitive primer.

(f) Execution

i. Do not begin installation until openings have been properly prepared.

ii. Verify wall openings are ready to receive work and opening dimensions and tolerances are within specified limits.

iii. Verify electric power is available and of correct characteristics.

iv. If preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

v. Clean surfaces thoroughly prior to installation. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

vi. Install door and operating equipment complete with necessary hardware, jamb and head mold strips, anchors, inserts, hangers, and equipment supports in accordance with final shop drawings, manufacturer's instructions, and as specified herein.

vii. Coordinate installation with adjacent work to ensure proper clearances and allow for maintenance.

viii. Anchor assembly to wall construction and building framing without distortion or stress.

ix. Securely brace door tracks suspended from structure. Secure tracks to structural members only.

x. Fit and align door assembly including hardware.

xi. Coordinate installation of electrical service. Complete power and control wiring from disconnect to unit components.

xii. Upon completion of installation including work by other trades, lubricate, test and adjust doors to operate easily, free from warp, twist or distortion and fitting weathertight for entire perimeter.

(g) Protection

i. Do not permit construction traffic through overhead door openings after adjustment and cleaning.

ii. Protect installed products until completion of project.

iii. Touch-up, damaged coatings and finishes and repair minor damage before Practical Completion.

2.1.16.3.7 Sound reduction

(a) Sound reduction performance reqirements for doorsets between a noise source and a sensitive area shall be as follows:

Adjacency Mean	**Sound Level Difference**
Normal Offices	N/A
Private Offices	30 - 35 dB

Element	**Maximum (MSLD)**
Standard Door	25 - 30 dB
Up rated door with seals	30 - 35 dB
Up rated door with seals	35 - 40 dB

Space	**Desired (MSLD)**
Meeting Rooms, Offices	35 dB
Toilet & Shower facilities	35 dB
Food prep facilities	28 dB
Reception spaces	28 dB
Office Corridors	28 dB
Workshops/ Stores	28 dB

2.1.16.4 References and Standards

BS EN 10143 (2006): Continously hot-dip metal coated steel sheet and strip. Tolerances on dimensions and shape.

BS 405 (1987): Specification for uncoated expanded metal carbon steel sheets for general purposes.

BS EN 10255 (2004): Non-alloy steel tubes suitable for welding and threading. Technical delivery conditions

BS 4345 (1968): Specification for slotted angles.

BS 1561(1966): Specification for silver anodes and silver salts for electroplating.

BS EN 485-1 (2008+A: 2009): Aluminium and aluminium alloys. Sheet, strip and plate. Technical conditions for inspection and delivery.

BS 4479 (1990): Design of articles that are to be coated.

BS EN 12329 (2000): Corrosion protection of metals. Electrodeposited coatings of zinc with supplementary treatment on iron or steel.

BS EN ISO 2082 (2008): Metallic coatings.Electroplated coatings of cadmium with supplementary treatments on iron or steel.

BS EN ISO 1461 (2009): Hot dipped galvanised coatings on fabricated iron and stell articles. Specifications and test methods.

BS 4652 (1995): Specification for zinc-rich priming paint (organic media).

BS 1474 (1987): Specification for wrought aluminium and aluminium alloys for general engineering purposes: bars, extruded round tubes and sections.

BS 1161 (1977): Specifiication for aluminium alloy sections for structural purposes.

BS EN ISO 7599 (2010): Anodizing of aluminium and its alloys. General specifications for anodic oxidation coatings on aluminium

BS 3987 (1991): Specification for anodic coatings on wrought aluminium for external architectural applications.

BS EN ISO 1456 (2009): Metallic and other inorganic coatings. Electrodeposited coatings of nickel, nickel plus chromium, copper plus nickel and of copper plus nickel plus chromium

BS 6510 (2010): Steel-framed windows and glazed doors.Specification

BS EN 10029 (2010): Hot-rolled steel plates 3 mm thick or above. Tolerances on dimensions and shape

BS EN 10296-1 (2003): Welded circular steel tubes for mechanical and general engineering purposes. Technical delivery conditions. Non-alloy and alloy steel tubes

BS EN 10263-1(2001): Steel rod, bars and wire for cold heading and cold extrusion. General technical delivery conditions

BS EN 10263-5 (2001): Steel rod, bars and wire for cold heading and cold extrusion. Technical delivery conditions for stainless steels

BS EN ISO 3506 (2009): Mechanical properties of corrosion-resistant stainless steel fasteners.

BS EN 1011-1(2009): Welding. Recommendations for welding of metallic materials. General guidance for arc welding

BS EN 1011-2 (2001): Welding. Recommendations for welding of metallic materials. Arc welding of ferritic steels

BS EN 1011-3 (2000): Welding. Recommendations for welding of metallic materials. Arc welding of stainless steels

BS EN 1011-4 (2000): Welding. Recommendations for welding of metallic materials. Arc welding of aluminium and aluminium alloys

BS EN ISO 11600 (2003+A1:2011): Building construction. Jointing products. Classification and requirements for sealants

BS EN 515 (1993): Aluminium and aluminium alloys. Wrought products. Temper designations.

BS EN 573-3 (2009): Aluminium and aluminium alloys. Chemical composition and form of wrought products. Chemical composition and form of products

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BS EN 12163 (2011): Copper and copper alloys. Rod for general purposes.

BS EN 12164 (2011): Copper and copper alloys. Rod for free machining purposes.

BS EN 1774 (1997): Zinc and zinc alloys. Alloys for foundry purposes. Ingot and liquid

BS EN ISO 2063 (2005): Thermal spraying. Metallic and other inorganic coatings. Zinc, aluminium and their alloys

BS EN 754 (2008): Aluminium and aluminium alloys. Cold drawn rod/bar and tube.

BS EN 1991-1-4 (2005+A1:2010): Eurocode 1. Actions on structures. General actions. Wind actions

ASTM A653/A653M- 11 (2011): Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process

BS EN 573-1 (2004): Aluminium and aluminium alloys. Chemical composition and form of wrought products. Numerical designation system

BS EN 573-5 (2007): Aluminium and aluminium alloys. Chemical composition and form of wrought products. Codification of standardized wrought products

BS EN 12167 (2011): Copper and copper alloys. Profiles and bars for general purposes

BS EN ISO 18286 (2010): Hot-rolled stainless steel plates. Tolerances on dimensions and shape

BS EN 14324 (2004): Brazing. Guidance on the application of brazed joints

2.1.17 BS EN ISO 2081 (2008): Metallic and other inorganic coatings. Electroplated coatings of zinc with supplementary treatments on iron or steelFINISHES

2.1.17.1 Materials

2.1.17.1.1 Materials

(a) Ordinary Portland Cement shall be to **BS EN 197-1:2000**

(b) Water shall be as of Clause 2.1.1.19

(c) Sand for mixes not incorporating lime shall be clean hard durable crushed rock or clean sand free from salt to conform to the grading limits set out in Table 2.1.17.1

Table 2.1.17.1

Grading

B.S. Sieve	Percentage by weight passing B.S. Sieve
5.00 mm	100
2.36 mm	90 - 100
1.18 mm	70 - 100
0.60 mm	40 - 80
0.30 mm	5 - 40
0.15 mm	5 - 40

(d) Sand for mixes incorporating lime shall be clean natural sand free from salt to conform to the
grading limits set out in the Table 2.1.17.2

Table 2.1.17.2

Grading

B.S. Sieve	Percentage by weight passing B.S. Sieve
2.36 mm	100
1.18 mm	90 - 100
0.60 mm	55 - 100
0.30 mm	5 - 50
0.15 mm	0 - 10

(e) Lime shall be hydrated lime to **BS EN 459**, delivered in sealed bags bearing the manufacturer's name or brand.

(f) Lime putty shall be prepared as **PD CEN/TR 15123, BS 8481 & BS EN 13914-2** by adding hydrated lime to water, and mix to a thick, creamy consistency. Leave undisturbed for 16 hours (minimum) before use.

(g) Pigments for colouring cement and concrete shall comply with **BS EN 12878,**.

(h) Accelerators, retarders, normal water-reducing admixtures and combinations of these shall comply with **BS EN 480 (1-12)**.

(i) Bonding agent shall be compatible with background and finish, designated to be suitable for internal or external use and shall be an approved proprietary brand.

(j) The approved proprietary bonding agent shall be used in strict accordance with the manufacturer's technical specifications and recommendations, including and not limited to the valid shelf life of the product. The expiry date shall be clearly indicated with label and stamp for necessary inspection by the Engineer.

2.1.17.2 Workmanship

2.1.17.2.1 Generally

(a) Mix mortar or plaster shall be as Clause 2.1.9.2.7 (g)

(b) Provide sample panels of approximately 2 m^2 for textured or coloured finishes and tile or slab finishes including pointing and obtain approval before starting work. Apply these finishes to sample areas of the work as directed.

(c) Protect existing work with boards, dust sheets, and the like. Droppings on finished work shall be cleaned off immediately.

(d) Keep plant and tools clean and free of traces from previous mixes.

(e) Do not use mechanical coating methods of application without approval.

(f) Hack off extraneous concrete projections and fins.

(g) Remove efflorescence, laitance, oil, grease, all traces of release agents, dirt, and loose material by dry brushing or scraping.

(h) Protect surfaces from weather and ensure that they are completely compatible with the finish to be applied before starting work.

(i) At junctions between dissimilar solid backgrounds in the same plane which are to receive the same applied finish, fix a strip of steel galvanized lathing as Clause 2.1.17.3.1 (a) extending 150 mm (minimum) in width each side of the junction, nailed with 40 mm nails or stapled to plugs at 100 mm centres on both edges.

(j) Clean all laitance, dust, oil or any other such substances from the concrete surface.

(k) Spatterdash to consist of (1:2) cement : coarse sand with an approved bonding agent such as a styrene-butadiene rubber (SBR) latex, an ethyl vinyl acetate (EVA) emulsion or an acrylic emulsion.

(l) Apply spatterdash to concrete vertical surfaces and soffits within 48 hours after striking formwork.

(m) The mixture shall be applied by dashing it on the wall by a hand scoop or a trowel to give a complete coverage with a rough texture not exceeding 5 mm thickness. The surface shall be maintained moist for 24 hours.

(n) Allow to cure and harden for at least two days before applying rendering / bedding screed.

2.1.17.2.2 Preparation of hardened or existing concrete

(a) Where finish or screed shall be bonded to hardened or existing concrete wall or base:-

i. Shortly before applying finish or screed, thoroughly hack concrete to remove laitance and expose coarse aggregate.

ii. Thoroughly clean and wet surface before applying finish or screed and remove surplus water.

iii. Brush neat cement slurry into damp surface immediately before applying finish or screed, or Apply approved proprietary bonding agent in accordance with the manufacturer's recommendations.

2.1.17.2.3 Preparation of base for monolithic finish

(a) Where finish or screed shall be laid monolithically on concrete base:-

i. Spray surface with water and brush with a stiff broom whilst concrete is green to remove laitance and loose aggregate.

ii. Lay finish or screed within 3 hours of laying base.

2.1.17.2.4 Surface finishes

(a) Surface finishes shall be either:-

i. Smooth finish :- finish with a steel trowel or power float to a smooth surface, free from blemishes.

ii. Wood float finish :- finish with a dry wood float to give an even overall surface.

iii. Textured finish :- finish by stippling, scraping or other means to produce an approved textured surface.

iv. Rough cast finish :- throw onto the undercoat a wet mix of aggregate and cementitious material.

v. Machine applied textured finish :- apply in accordance with the manufacturer's recommendations.

2.1.17.2.5 Accuracy for wall and ceiling finishes

(a) Finish wall and ceiling finishes to a true plane and to correct line and level. Maximum deviation permitted in surfaces shall be 3 mm from a 1800 mm straight edge. Angles and corners shall be right angles unless otherwise required, with walls and reveals plumb and square.

(b) Prevent excessively rapid or localised drying out of wall and ceiling finishes by an approved means.

2.1.17.2.6 Curing of floor finishes

(a) Immediately after laying, protect surface of floor screeds or in-situ finishes from wind and sunlight.

(b) Cover surface, as soon as it is sufficiently hardened, with canvas, waterproof sheeting, mats, or a 50 mm layer of damp sand. Unless otherwise agreed by the Engineer, keep covered for 4 days.

2.1.17.2.7 Movement joints

(a) Movement joints shall be constructed at a maximum 4m centres in each joints direction equally spaced as directed by the Engineer to accord with dimensioned requirements.

2.1.17.2.8 Protection

(a) Protect screeds from wear and other damage until the floor finish is laid. Protect all finishes from discolouration or damage until completion.

2.1.17.3 Plastering and Rendering

2.1.17.3.1 Materials

(a) Steel lathing shall be to **BS EN 13658-1** from an approved manufacturer:-

i. Plain expanded type of 6 mm short way mesh coated with tight coat galvanising and weighing not less than 1.6 kg/m^2

ii. Ribbed expanded type similarly coated and weighing not less than 2.25 kg/m^2.

(b) Galvanised steel corner beads, plaster stops and mo vement joint beads shall have expanded metal wings and be from an approved manufacturer.

(c) Plastic corner beads shall be used if approved by the Engineer.

(d) Wire netting shall be to **BS EN 10223-2**, of 0.9 mm galvanised wire and 50 mm mesh.

(e) Staples to be galvanised steel wire staples.

(f) Tying wire shall be 1.25 mm annealed steel wire, galvanised to **BS EN 10244** .

(g) Gypsum plaster shall be Retarded hemihydrate gypsum plaster to **BS 13279-1 & 2**, Class B of the following types:-

Undercoat Plaster

Type a - 1 Browning plaster
2 Metal lathing plaster

Final Coat Plaster
Type b - 1 Finish plaster
2 Board finish plaster

(h) Gypsum plaster shall be delivered in sealed containers. Store in weather tight structures with a raised floor. Store different types of consignments separately, and use in the order of their delivery.

(i) Plasterboard shall be to **BS EN 520:2004+A1:2009**, "gypsum lath" or "gypsum baseboard" with square edges.

(j) Nails for "lath" or "baseboard"shall be 30 x 2.6 mm plasterboard galvanized steel nails, jagged shank type to **BS 1202:Part 1**.

i. 30 x 2.65 mm for plasterboard not exceeding 12.7 mm thick

ii. 40 x 2.65 mm for plasterboard 19 mm thick

(k) Reinforcement for joints in plasterboard shall be jute scrim cloth not less than 90 mm wide.

(l) Carry plasterboard on edge. Stack plasterboard flat on level surface, properly supported to prevent sagging or bending of boards off the ground and inside a building. Keep plasterboard dry, prevent mould growth, and programme deliveries to ensure that storage periods on site are kept to a minimum during periods of high humidity.

(m) Acoustic plaster shall be an approved proprietary brand free from asbestos, mixed and applied in accordance with manufacture's recommendations.

(n) Stone chippings for exposed aggregate rendering shall be granite, white stone or marble chippings, graded from 3 to 5 mm, and free from dust.

(o) Resin, epoxy, urethane and acrylic based decorative finishes shall be approved proprietary products applied by approved specialist contractors.

2.1.17.3.2 Workmanship

(a) Plastering and rendering generally shall be in accordance with **BS PD CEN/TR 15123, BS 8481 & BS EN 13914-2** and **BS EN 13914-1:2005** respectively**.**

(b) Dub out if necessary to correct any inaccuracies, in layers 10 mm (maximum) thick in same mix as the first coat. Allow to dry out before the next coat is applied. Total thickness of dubbing out or levelling shall not exceed 25 mm. Cross scratch each coat to provide key.

(c) Fix steel lathing as follows:-

i. Fix taut with the largest dimension of mesh running perpendicular to direction of supports.

ii. Apply one coat of bituminous paint to cut ends.

iii. Fix at 100 mm centres to wood with staples, to brickwork or concrete and to steelwork with tying wire at 75 mm centres.

iv. Lap 25 mm (minimum) generally, and 50 mm where end laps occur between supports. Secure laps with tying wire at 75 mm centres.

(d) Plasterboard fixing generally shall be to **BS 8212**.

Fix plasterboard to wood bearers as follows:-

i. Nail boards at each support, at 150 mm centres working out from the centres of the board, and 15 mm (minimum) from edges.

ii. Provide gap of 3 to 5 mm between edges.

(e) Treat joints, etc. in plasterboard as follows:-

i. Fill all joints, nail holes and other imperfections with board finish plaster.

ii. Press strips of joint reinforcement into the plaster, trowel flat and allow the plaster to set, but not dry out before general plastering commences.

(f) Allow 3 days for undercoats to dry out thoroughly before applying next coat. Cross scratch undercoats to provide key for next coat.

(g) Apply cement rendering consisting of cement and sand 1:3 with surface finish required as follows:-

i. Rendering not exceeding 10 mm thick in one coat.

ii. Rendering exceeding 10 mm thick in two coats, with finishing coat 5 mm thick.

(h) Apply external rendering to spatterdashed surfaces consisting of cement and sand in two coats as follows:-

i. Undercoat 10 mm (minimum) thick --- mix 1:3

ii. Finishing coat 10 mm (maximum) thick --- mix 1:3, with textured finish. Total thickness of spatterdash & external rendering shall not exceed 20 mm.

Undercoat shall be thoroughly dry before application of the finishing coat.

Pulverised Fly Ash (PFA) shall not be used for external rendering.

(i) Apply internal lime plaster in two coats on solid backgrounds as follows:-

i. Undercoat shall be 1:3 cement : sand mix

ii. Finishing coats use lime plaster gauged (cement:lime: sand 1:2:6) with not more than 25% by volume of lime putty. Addition of paper-pulp is not allowed.

iii. Thickness of undercoat shall not exceed 10 mm to walls and 5 mm to soffits.

iv. Thickness of finishing coat to walls and soffits shall be at least 3 mm.

v. The drying out time for undercoats before the application of finishing coats shall be as specified in the Clause 2.1.17.3.2 (f).

vi. Metal plaster corner beads and stops shall be provided where specified shall be followed as Clause 2.1.17.3.2 (o).

Total thickness of plaster shall not exceed 15 mm to walls and 10 mm to soffit.

Pulverised Fly Ash (PFA) shall not be used for internal plastering.

(j) Apply internal lime plaster in three coats on steel lathing as follows:-

i. First and second coats, consisting of cement, lime and sand 1:2:6.

ii. Finishing coat shall be as Clause 2.1.17.3.2 (a) and (b).

Total thickness of plaster shall not exceed 13 mm measured from the outer face of the lathing.

(k) Apply gypsum plaster generally in two coats as follows:-

i. First coat consisting of Browning plaster and sand 1:2 or cement and sand 1:3.

ii. Finishing coat of neat finish plaster, or finish plaster with up to 25% of lime putty added, with smooth finish 5 mm max.

Total thickness of plaster shall not exceed 15 mm.

If approved by the Engineer, proprietary gypsum plaster can be used in strict accordance with the manufacturer's technical specifications and recommendations.

Where specified, bonding agents for use with gypsum plaster shall be as **BS 5270:Part 1**.

(l) Apply gypsum plaster in three coats on steel lathing as follows:-

i. First coat consisting of metal lathing plaster and sand 1:1.5.

ii. Second and finishing coats - as for first coat and finishing coat as Clause 2.1.17.3.2 (k) (i)-(ii)

Total thickness of plaster shall not exceed 13 mm measured from the outer face of the lathing.

(m) Apply gypsum plaster as one finishing coat 5 mm (maximum) thick on plasterboard trowelled to a smooth surface using as little water as possible.

(n) Arrises shall be square or pencil rounded, as required.

(o) Metal beads for internal plastering and dry lining shall be to **BS EN 13658-1(2005).**

Provide and fix metal corner beads, plaster stops and movement joints when specified including nailing, stapling or fixing with plaster dabs and trowel the finishing coat flush with the bead.

(p) Coved or moulded cornices shall be either:-

i. Formed with a backing of cement and sand 1:3 with finishing coat of same plaster used for adjacent surfaces, finished with a steel template to a smooth finish.

ii. Preformed cornices from an approved manufacturer fixed in accordance with manufacturer's recommendations.

(q) Apply exposed aggregate rendering in two coats as follows:-

i. First coat 10 mm thick, consisting of cement and sand 1:3.

ii. Finishing coat 10 mm thick, consisting of cement and stone chippings 1:1, with the chippings mixed in one of the proportions shown in Table 2.1.17.3. Before the finishing coat has set, scrub off the surface to expose the aggregate.

Table 2.1.17.3

Proportions of Chippings

Colour	Cement	Stone Chippings Dark Grey/Light Grey/White			Marble Chippings Black/White	
Dark	Ordinary	70	-	20	10	-

Medium	White	60	20	20	-	20
White	White	-	-	-	-	100

(r) Mix and apply acoustic plaster by special spray equipment in accordance with the manufacturer's recommendations to the thickness and number of coats specified.

2.1.17.4 Premixed Plaster

2.1.17.4.1 Materials

(a) Premixed plaster shall be factory-produced by weighted combination of plaster raw materials and chemicals and supplied to sites in bags. Mixing with clean water shall be required before application.

(b) There are two types of premixed plaster, cement based and gypsum based. Gypsum based is for internal use only.

(c) Cement based plaster contains mineral filler material as aggregate and portland cement as main binder, with additives for improved compressive strength and reduced shrinkage.

(d) Gypsum based plaster contains pre-mixed minerals; gypsum base rendering materials and additives which could be applied in one single thick application without cracking and separation from the substrate.

(e) The premixed plaster shall comply with **BS EN 13914-1:2005**, **PD CEN/TR 15123, BS 8481 & BS EN 13914-2** and **BS EN 13279-1 & 2**. The premixed plaster manufacturing company shall have acquired ISO certification in their manufacturing process of the premixed plaster product.

2.1.17.4.2 Workmanship

(a) Premixed plaster and clean water shall be mixed on site with portable electrical mixer or other equipment according to manufacturer's recommendations. Accurate amount of water shall be used to ensure effective mixing and consistent quality.

(b) Bagged premix mortar shall be stored separately by types, off the ground in dry, well-ventilated and covered space. Use in order of delivery and within manufacturer recommended time limit.

(c) Tolerance of evenness of substrate shall be 5 mm for internal concrete.Tolerance of wall, block wall and beams, and 3 mm for internal ceiling soffit.

(d) Substrate shall be clean; free from dust, contamination, paint, oil and loose scale. Dampen dry substrate before plastering.

(e) Premixed plaster may require the substrate to be treated with spatterdash or to be keyed before application depending on manufacturer's recommendations.

(f) Do not use mixes after initial set has taken place and do not re-temper or reconstitute mixes unless permitted by the manufacturer's instructions.

(g) Premixed plaster shall be carried out by experienced applicators. All the workers and supervisory staff employed for the work shall be fully instructed and trained on the

method of preparation and application in accordance with the manufacturer's recommendations.

(h) Cement based premixed plaster shall be applied with trowel or spraying machine in several coats. Application method, thickness, number of coats and drying time between coats shall be strictly in accordance with manufacturer's recommendations.

(i) Gypsum based premised plaster shall be applied with trowel or spraying machine in single coat of thickness in accordance with manufacturer's recommendations.

(j) Half-set plaster shall be leveled with featheredge, scraped off surplus material and worked from bottom to top of wall.

(k) Allow drying time of 30-60 minutes in accordance with manufacturer's recommendations; sprinkle surface with clean water and smooth with a hard sponge float to remove trowel and featheredge marks in circular motion.

2.1.17.5 Screeds

2.1.17.5.1 Materials

(a) Aggregate for lightweight screeds shall be as follows:-

i. 5 mm exfoliated vermiculite to **BS EN 13055-1**.

ii. Approved proprietary lightweight beads or granules.

(b) Air entraining agent for lightweight screed shall be an approved admixture which will produce screeds with a dry density not more than 1,200 kg/m^2.

(c) Vapour barrier shall be 0.08 mm polythene sheet.

2.1.17.5.2 Workmanship

(a) Floor screeds generally shall be in accordance with **BS 8204: Part 1-5** and **BS 8000: Part 9** and wall screeds to **BS 5385**:Part 1 and **BS 8000**:Part 10 respectively.

(b) Screeds generally shall consist of cement and sand 1:3. Use the minimum water consistent with workability.

(c) For floor screeds over 40 mm thick, mix shall be 1 part cement, 1.5 parts sand or granite fines and 3 parts coarse aggregate graded 10 mm down with at least 75% being retained on a 5 mm B.S. sieve.

(d) Use granite fines instead of sand, when required to avoid efflorescence on the surface of the finish.

(e) Thickness of wall render shall be 10 mm (minimum) with surface scratched to form key.

(f) Thickness of floor screeds shall be as follows:-

i. Laid monolithically with the base : 15 mm (minimum) thick. (for preparation of base, see Clause 2.1.17.2.3 .

ii. Bonded to a hardened concrete base : 20 mm (minimum) thick. (For preparation of base, see Clause 2.1.17.2.2).

iii. Not bonded to the base : 50 mm (minimum) thick including tile finish.

iv. Floating : 65 mm (minimum) thick including tile finish.

(g) Lay monolithic and bonded screeds in one coat.

Lay and compact screeds level or to falls, as required.

(h) Lay screeds in bays of 15 sq. m (maximum) with length not more than 1.5 times the width in chequerboard pattern. Allow 24 hours (minimum) between laying adjoining bays.

(i) Lightweight aggregate screeds shall consist of cement and lightweight aggregate 1:8 for roofs and 1:6 for floors unless contrary to the manufacturers' recommendations.
Air entrained screeds shall have a dry density of not more than 1,200 kg/m^3.

Lightweight screeds shall be 50 mm (minimum) thick, excluding topping.

Finish lightweight screeds with cement and sand or granite fines 1:4 topping 15 mm (minimum) thick laid monolithically with the screed.

When specified lay vapour barrier under lightweight roof screeds. Lap 150 mm at joints.

(j) The surface of screeds shall be finished with one of the following surface finishes, level, to falls as specified:-

i. Steel trowel or power float to give a smooth untextured surface.

ii. Wood float to give an even textured surface.

iii. Stiff brush to give a slightly roughened texture.

The finish shall be in accordance with manufacturer's recommendations for the finish to be applied or laid.

(k) Where pipes of less than 50 mm diameter pass through flat roofs:-

i. Form cement and sand or granite fines 1:3 surround 150 x 150 mm around pipe sleeve, to project 150 mm above finished roof level.

ii. Finish top to slope.

iii. For groups of pipes, form combined surrounds.

2.1.17.6 In-Situ floor and wall finishes

2.1.17.6.1 Materials

(a) Stone aggregate shall be crushed grey granite or white stone to **BS EN 12620**, graded from 10 to 3 mm and free from dust.

(b) Marble aggregate shall be angular crushed marble, free from dust, and of the colour required.

(c) Surface hardener shall be an approved proprietary liquid hardener and dust proofer.

(d) Hardening admixture shall be an approved proprietary make.

(e) Dividing strip shall be aluminium, brass, stainless steel or plastic strip 3 mm thick and to the full depth of the screed. Plastic strip shall be of the colour required.

Form key as one of the following:-

i. Generally sides of section shall be grooved.

ii. Metal strip : one edge shall be cut and bent at 150 mm centres, to form lugs.

iii. Plastic strip : to have 5 to 10 mm holes at 150 mm centres with plastic pins inserted to form dowels.

(f) Non-slip strip insert shall be 25 x 15 mm slightly curved on top and consisting of :-

i. A compound of cement and carborundum dust 1:1, or

ii. A proprietary insert strip.

2.1.17.6.2 Workmanship

(a) In-situ floor finishes generally shall be to **BS 8204: Part 1-5.**

(b) Unless otherwise specified, minimum thickness of in -situ floor and wall finishes shall be as Table 2.1.17.4.

Table 2.1.17.4: Thickness of finish

Granolithic				Terrazzo	
Location	**Plain**	**Coloured Finish**			
		First coat	**Finishing coat**	**First coat**	**Finishing coat**
Floors laid monolithically	15 mm	-	15 mm	-	-
Floors	20 mm	10 mm	10 mm	10 mm	15 mm
Walls and Dadoes	20 mm	10 mm	10 mm	10 mm	10 mm
Treads	20 mm	-	20 mm	-	25 mm
Risers	15 mm	-	15 mm	-	15 mm

(c) Lay floor finishes as Clause 2.1.17.5.2 (g) and (h)

(d) Finish shall be composed of cement and sand 1:3

(e) Granolithic finish shall be mixed in the following proportions as Table 17.5

Table 2.1.17.5

Granolithic Finishes

Type	Cement	Sand	Granite aggregate	White stone	Surface finish

A	2	1	4		Trowelled or rubbed
B	2	1		4	
C	1		2		Washed
D	1			2	

(f) Finish surface as Clause 2.1.17.5.2 (k) as soon as compaction is completed. Do not bring excessive laitance to the surface and remove any which appears. Do not wet the surface. Repeat trowelling process or power floating at least three times at intervals within 10 hours of laying.

(g) Form the following alternative finishes as on granolithic, as required:-

i. Trowelled : smooth or wood float finish as Clause 2.1.17.2.4 (a).

ii. Rubbed : after trowelled finish has set, rub down with fine carborundum stone to form a smooth finish and to expose the aggregate.

iii. Washed : before trowelled finish has set, brush off the surface to expose the aggregate.

(h) Where coloured cement and sand and coloured granolithic finish are to be coloured finish laid in two coats the coats shall be as follows:-

i. First coat with ordinary cement and sand as Clause 2.1.17.6.2 (d) and

ii. Finishing coat as Clause 2.1.17.6.2 (d) or Clause 2.1.17.6.2 (e) and 5 mm thick (minimum) for cement and sand finish and 10 mm thick (minimum) for granolithic finish using coloured cement. Apply the finishing coat before the first coat has set.

(i) Where terrazzo is to be laid in two coats, the coats shall be as follows:-

i. First coat of cement and sand 1:3

ii. Finishing coat mixed in one of the proportions shown in Table 2.1.17.6. Apply the finishing coat before the first coat has set.

Table 2.1.17.6
Terrazzo

Type	Coloured cement	Marble aggregate	Grade of aggregate (mm)
A	1	2	5 to 3
B	1	2.5	10 to 5
C	1	3	10

Minimum thickness of first and finishing coat shall be as Table 2.1.17.4.

Divide terrazzo work into panels of 1 m^2 (maximum).

Grind surface to expose the aggregate and produce a smooth finish.

Fill any voids with matching cement.

Apply one coat of wax polis h to wall finishes. Floor finishes shall not be highly polished, or wax polished.

(j) Bed dividing strip through the total thickness of the base and finishing coat. Strips shall not be haunched prior to laying the base.

(k) Fill non-slip compound or bed non-slip into groove, and finish to project 3 mm above finished surface.

(l) Form granolithic or terrazzo aprons strings and skirtings to edge of stairs as drawings.

2.1.17.7 Rigid Tile or Slab Finishes

2.1.17.7.1 Materials

(a) Submit samples of tiles, and obtain approval.

(b) Plain concrete or granolithic concrete floor tiles shall be to **BS 1197:Part 2**, of the required colour and surface finish.

(c) Ceramic floor tiles including corresponding accessories shall be to **BS EN 14411**.

Ceramic floor tiles shall be Group A I or B I: water absorption not exceeding 3%.

Floor quarries shall be to Group A IIb of **BS EN 14411**: water absorption of 6% < E =< 10%.

Where ceramic floor tiles or clay floor quarries are described as "including specials" the full range of BS fittings shall be required. Elsewhere mitred angles of coved skirtings and the like shall be permitted.

All tiles and fittings shall be from the same manufacturer and shall match in colour and texture.

Where tiles are described as anti-slip, they shall be suitably embossed or treated with carborundum or similar grit to comply with relevant standards, e.g. Germany DIN standard or other recognised international standards to provide an anti-slip surface.

(d) Terrazzo floor tiles shall be to **BS EN 13748-1** and **BS EN 13748-2** and of the required colour and surface finish.

(e) Porcelain stoneware tiles shall be to **BS EN 14411**, Group B1a. Tiles are to be non-lip with floor sizes 300 x 300 x 10.5mm or 600 x 600 x 10.50.

(f) Concrete roofing tiles and fitting shall be to **BS EN 490** and **BS EN 491**.

(g) The tiles shall be flat tiles 30 mm thick and 300 mm square or 35 mm thick and 400 mm square.

(h) Insulating roofing tiles shall be 40 mm thick and 300 mm square or 400 mm square with a density of 1,250 kg/m^3. m ±10%. The upper surface shall be hard and suitable for pedestrian traffic. Five legged tiles shall not be permitted.

(i) Glazed ceramic wall tiles shall be to **BS EN 14411** and in Group A IIa or B IIa with a water absorption not exceeding 6%.

Tiles shall be glazed, white or coloured as required and with cushion edge and with inclusive spacer lugs as required by Engineer.

(j) External facing tiles shall be of the specified type from an approved manufacturer.

(k) Unless otherwise specified mosaic tiles shall be from an approved manufacturer and as follows:-

i. Glass mosaic tiles shall be fully vitrified glass tile size 20 x 20 mm and 4 mm thick, regular in shape, free from cracks or sharp edges and uniform in colour and texture.

ii. Glazed ceramic mosaic tiles shall be similar to glazed wall tiles but size 18 x 18 mm or 25 x 25 mm and 5 mm thick and with square edges.

iii. Unglazed vitreous mosaic tiles shall be size 18 x 18 mm or 18 x 38 mm or 38 x 38 mm and or 5 mm thick with matching coved tiles and from the colour range specified.

(l) Stone slabs for paving or wall facings or fittings shall be of the quality and colours specified on drawings or as selected by the Engineer and free from flaws and defects throughout. Unless otherwise specified, slabs for wall facings shall not be less than 20 mm thick and slabs for paving surfaces shall not be less than 32 mm thick.

Stones shall be jointed so as to be dressed to match stone by stone.

No stone shall be offered by quarries where variety is expected to develop or which deviates from the selected stone.

Marble shall be true metamorphic limestone.

(m) Precast concrete paving blocks shall be to **BS EN 1338 and BS 7533-3:Part 3** and of the size, colour and surface textured specified.

(n) Adhesive for tiles or mosaics shall be compatible with background and finish and shall be an approved proprietary brand.

The approved proprietary adhesive shall be used in strict accordance with the manufacturer's technical specifications and recommendations, including and not limited to the valid shelf life and the setting time of the product.

The expiry date and the setting time shall be clearly indicated with label and stamp for necessary inspection by the Engineer.

(o) Slurry shall be plain or coloured cement and water mixed to creamy consistency.

(p) Grouts mixed with plain or coloured cement shall be :-

i. For floor tiling generally : cement and sand 1:3, mixed to a paste with the minimum of water.

ii. For mosaic tiling or glazed wall tiling : cement and powdered limestone 1:3.

iii. For external facing tiles : cement and sand 1:3.

If agreed by the Engineer, approved proprietary brands of grout may be used in strict accordance with the manufacturer's technical specifications and recommendations.

2.1.17.7.2 Workmanship

(a) Floor and wall tiling generally shall be :-

i. Floor tiling shall be to **BS 5385:Parts. 3 and 5**.

ii. Internal wall tiling shall be to **BS 5385:Part 1**, external wall tiling shall be to **BS 5385:Part 2.**

(b) Fix floor tiles as follows:-

1. Semi -dry method direct to concrete base (for preparation of base, see Clause 2.1.17.2.2 :-

i. Soak tiles in clean water and allow to drain.

ii. Lay semi -dry mix cement and sand 1:4 bed thoroughly compacted to the required thickness (20 mm minimum) finished to the required levels, falls and currents.

iii. Pour cement and sand slurry over bedding and spread and trowel to 3 mm (minimum) thick.

iv. Lay tiles, mixed from six boxes, and tamp firmly into bed with straight and even joints and 3 mm (minimum) wide.

v. Allow bedding to set.

vi. Grout up joints and clean surplus grout face of tiles as work proceeds.

2. Thick bed method to screed:-

i. Soak tiles in clean water and allow to drain.

ii. Damp the screed with clean water to reduce suction if required.

iii. Lay cement and sand 1:3 bed generally 15 mm thick but never thicker than the tiles.

iv. Coat back of tiles with slurry immediately before fixing.

v. Lay tiles mixed from six boxes and tamp firmly into bed with straight and even joints and 3 mm (minimum) wide.

vi. Allow bedding to set.

vii. Grout up joints and clean surplus grout from face of tiles as work proceeds.

3. Thin bed method:-

i. If approved fix floor tiles using a bed of adhesive in accordance with manufacturer's recommendations.

(c) Lay on roof, concrete or lightweight tiles as follows:-

ii. Bed and joint tiles in cement mortar (1:4).

iii. Lay tiles loose and fill with cold bitumen between joints and point.

(d) Allow for expansion with a 75 mm space around perimeter and 25 mm joints per 9 m^2 cut through joints and fill with cold bitumen or approved sealant.

(e) Do not allow traffic on floors or roofs until 4 days after completion of tiling and subsequently permit only light traffic for a further 10 days.

(f) Fix tiles to wall render as follows:-

1. Thick bed method:-

i. Sort and remove tiles with uneven colour or dimensions. Soak tiles in clean water for 30 minutes (minimum). Stack to drain and fix as soon as the surface water has drained off.

ii. Damp the wall render with clean water sufficiently to prevent it absorbing water from the bedding mortar.

iii. Butter the back of each tile with cement slurry and tap firmly into position so that the bed is solid throughout. Thickness of finished bed shall be 5 to 15 mm.

iv. Joints shall be 2 mm (minimum) wide, and maximum 3.5 mm wide unless specified otherwise.

v. Make any adjustment to tiles within 10 minutes of fixing.

vi. Clean tiles and joints before bedding hardens.

vii. Grout up joints 24 hours (minimum) after fixing tiles. Clean off surplus grout as work proceeds.

viii. Clean tiles at completion.

Thick bed method shall not be used for fixing wall tiles with water absorption value lower than 0.5%.

2. Thin bed method:-

i. Apply wall render of cement : sand (1:3) to the concrete or substrate surface. Build up the render to the required thickness of 15 mm in layers. Thickness of each layer shall not exceed 10 mm. Allow the wall render to dry off thoroughly.

ii. Fix wall tiles, mixed from six boxes, to the wall render using an approved proprietary adhesive in accordance with the manufacturer's recommendations.

iii. Grout up joints using an approved grout or a proprietary grout as specified.

(g) Fixing of external wall tiles shall be thin bed method as follows:-

i. Apply wall render of cement : sand (1:3) to the substrate surface. Build up the render to the required thickness of 15 mm in layers. Thickness of each layer shall not exceed 10 mm. Allow the wall render to dry off thoroughly.

ii. Fix wall tiles to the wall render using an approved proprietary adhesive in accordance with the manufacturer's recommendations.

iii. Grout up joints using an approved grout or a proprietary grout as specified.

(h) Carry out infra-red thermographic scanning by an approved specialist and submit report within 4 months upon completion of external tiling. Should the report indicate that any part of the wall tiling has not been affixed properly, the Contractor shall carry out approved remedial measures at his own expense and carry out further infra-red thermographic scanning to the satisfaction of the Engineer.

(i) Fix mosaic tiles as follows:-

1. Thick bed method direct to concrete slab as follows:-

i. Lay semi -dry mix cement and sand 1:4 bed thoroughly compacted to the required thickness (20 mm minimum) finished to the required levels and falls.

ii. Pour cement and sand slurry over the bedding and spread and trowel 3 mm thick.

iii. Coat back of sheets of mosaic tiles with cement slurry immediately before fixing. Slurry shall be of the same colour as the final grout.

iv. Fix sheets of mosaic tiles and tamp firmly into bed, maintaining straight and regular joints, and ensuring that joints between sheets are equal to tile joints.

v. Remove backing paper, complete final straightening and rub surface with grout, coloured as required, to fill joints, cleaning surplus grout from face of tiles as work proceeds.

2. Thick bed method to wall render as follows:-

i. Damp the wall render with clean water sufficiently to prevent it absorbing water from the bedding mortar.

ii. Apply bedding coat of mortar 10 mm (maximum) thick consisting of cement and sand (1:3).

iii. Coat surface of wall render and back of sheets of mosaic tiles with slurry immediately before fixing. Slurry shall be of the same colour as the final grout.

iv. Fix sheets of mosaic tiles and tamp firmly into position maintaining straight and regular joint, ensuring that joints between sheets are equal to joints between tiles.

v. Remove backing paper, complete final straightening and rub surface with grout from face of tiles as work proceeds.

3. Thin bed method:-

i. If approved, fix mosaic tiles using a bed of proprietary adhesive in accordance with the manufacturer's recommendations.

ii. Grout up joints using a proprietary grout as specified, which may be coloured in accordance with Engineer's requirements.

(j) Bed stone paving slabs with one coat of approved sealer at back of stone slab on screeds. Bedding shall be not less than 12 mm thick comprising cement, and finely screened sand 1:3. Finish with a perfectly level and even surface and with joints between slabs 2.5 mm thick, or as directed by the Engineer.

(k) Lay slabs minimum 50 mm thick on 25 mm minimum bed of lime and sand or sand/cement mortar 1:3. Lay slabs to an even surface, well pressed into bed, with no level differences between adjacent slabs.

(l) Joints shall be even and about 5 mm wide. Stagger joints to form bond as specified. Grout up with cement lime and sand or granite fines 1:3:6. Work well into joints. Clean off surplus grout from surface of slabs.

2.1.17.8 Flexible tile or sheet finishes

2.1.17.8.1 Generally

(a) Flexible tile and sheet finishes shall be of the best quality of approved type and colour, and in accordance with the following specification. Sizes and thicknesses shall be as specified hereafter unless specifically ordered otherwise. The work shall be executed by an approved specialist contractor.

2.1.17.8.2 Materials

(a) Submit samples and obtain approval.

(b) Semi -flexible PVC tiles shall be to **BS EN 654**, size 225 x 225 or 300 x 300 and 2.5 mm thick.

(c) Unbacked flexible PVC (vinyl) tiles shall be to **BS EN 649**, size 225 x 225 or 300 x 300 and 2 mm thick.

(d) Unbacked flexible PVC (vinyl) sheet shall be to **BS EN 649**, 2.0 mm thick to floors and 1.2 mm thick to walls.

(e) Foam backed PVC (vinyl) sheet shall be to **BS EN 651:2011** and 3 mm thick overall. The wearing layershall be PVC (vinyl) sheet to **BS EN 649** 1.5 mm thick.

(f) Linoleum tiles and sheet shall be to **BS EN 12104:2000** and shall be 3.2 mm or 4.5 mm thick.

(g) Solid rubber tiles and sheet shall be to **BS 1711** and 4 mm thick.

(h) Adhesive shall be that recommended by the tile or sheeting manufacturer. Adhesive

(i) Polish shall be emulsion polish of approved type recommended by the tile or sheeting manufacturer.

(j) Store rolls after delivery, but before laying, in accordance with the manufacturer's instructions. Rolls which have deformed because of improper storage shall be rejected.

2.1.17.8.3 Workmanship

(a) Do not use tiles or sheets which have deteriorated in stock or which have a tendency to curl at the edges and corners.

(b) Thoroughly clean the screed or backing from grease, oil, wax, paint, dirt or dust and fill all cracks, minor holes and services with suitable filler recommended by the tile or sheeting manufacturer.

(c) Lay all tiles, floor and wall sheeting strictly in accordance with the manufacturer's instructions. If these instructions call for heating the tiles prior to laying, then apply such preheating to a temperature just sufficient to cause pliability. Preheat tiles in batches. Preheating single tiles shall not be permitted.

(d) Apply adhesive in a thin film and spread evenly with a notched or plain trowel, then even out with a roller as recommended by the manufacturer. If a notched trowel is used the notches shall be of the size recommended and shall be renewed periodically to ensure the correct spread of adhesive. Tiles or sheets shall be laid immediately after the adhesive is applied.

(e) Closely butt joints and cut accurately at right angles to the tiles or sheet surface to an agreed design and with only the minimum necessary jointing.

(f) Weld joints of PVC sheet to form a continuous surface with approved PVC welding rods coloured to match the sheeting.

(g) Relay any areas insufficiently bonded or showing an uneven surface.

(h) After laying, thoroughly clean the tiling or sheeting with water and a detergent recommended by the manufacturer. Apply two coats of non-slip, matt emulsion polish. Protect the floors with approved covering.

2.1.17.9 Carpet or textile floor coverings

2.1.17.9.1 Generally

(a) All carpet shall be of approved type and colour and in accordance with the following specification, of an approved brand, laid on screed treated with an approved sealant to reduce dust and pollution.

(b) Carpet shall be either of the following qualities as specified:-

- "General contract quality carpet" for use in single occupant offices, committee and

conference rooms, small libraries, staff quarters, light wear corridors and other areas as required.

- "Heavy contract quality carpet" for use in public rooms, general offices, reception areas, busy corridors and other areas as required.

(c) Carpet shall be manufactured by one of the following methods:

i. Single or face-to-face traditional loom.

ii. Needle insertion loom.

iii. Needle punch, fibre bonded, flocked or knitted.

iv. Other weaving machinery producing the quality of carpet to meet the performance requirements detailed in this specification.

2.1.17.9.2 Materials

(a) Submit samples of carpet and underlays together with relevant manufacturer's literature and submit test certificates for carpet to demonstrate that it complies with the requirements of Clauses 2.1.17.9.2 (f) and (g) and obtain approval.

(b) The composition of the pile yarn shall be fibres of one of the followings:-

Wool or wool blended with up to 20% nylon.

Nylon with antistatic properties for general use.

Polypropylene

Blend of fibres with antistatic properties for general use.

Blend of fibres formulated shall provide full antistatic properties to meet the requirements specified by International Business Machine (I.B.M.) or International Computer Company (I.C.L.) for computer floor coverings.

(c) The warp and weft, where applicable, shall be cotton, jute or polypropylene.

(d) The back coating where required shall be evenly spread with no build-up at the selvedges of the carpet and which gives fray-resistant finish to cut edges.

i. The quality and application of the back coating shall be such that:-

i. Its penetration shall assist tuft anchorage without wicking into the surface pile.

ii. The finish carpet may be seamed without gumming the needle and sewing thread, due to softening of the compound.

iii. Folding the carpet shall not cause permanent creasing.

ii. The backing coating shall:-

i. Not deteriorate substantially with age or low temperature.

ii. Not become sticky with temperatures and humidities experienced when laid or in transit thereto.

iii. Be capable of spot cleaning using dry cleaning solvents without serious deterioration.

iii. The backing compound may be loaded with 100 parts of filler to 100 parts of dry rubber.

(e) Carpets shall be dyed by a process employed strictly in accordance with the dyestuffs manufacturer's instructions that produces full and even penetration of the fibres with minimum degradation of the yarn.

(f) Colour fastness of carpet shall meet the requirements of Table 2.1.17.7:-

Table 2.1.17.7

Colour Fastness Related to	**Minimum Acceptable Grade**	**Method of Test**
Light	5	**BS 1006**
Wet and dry rubbing	4	Pile yarn assembled rubbing and tested in accordance with **BS2677**
Shampooing	4	Test on finished carpet in accordance with the recommendations of the Society of Dyers and Colourists
Organic solvents	4	**BS 3661**/20

(g) Physical properties of the finished carpet shall be in accordance with Table 2.1.17.8:-

Properties	**Requirements**	**Method of Test**
Total mass	Requirement as to mass shall depend upon construction of finished carpet and the amount of back coating applied to achieve the required tuft anchorage	**BS 4223** (method 12)
Number of tufts per 100 cm^2.	Minimum 1,000	**BS 4223** **(**method 8)
Thickness loss under dynamic loading	Thickness loss after 1,000 impacts not more than 25%	**BS ISO 2094** Using dynamic loading machine on original pile thickness
Thickness loss	Thickness loss after	**BS ISO 2094**

Properties	Requirements	Method of Test
Thickness; compression and recovery	Percentage compression recovery not less than 60%	**BS 4098** on original pile thickness
Dimensional stability; extension due to mechanical action	Mean non-recoverable not exceed Warp 1%, Weft 1%	**BS 4682:Part 2**
Dimensional change when immersed in cold water; to determine behaviour of the carpet when subjected to total saturation in cleaning or shampooing when excessive water is applied	Dimensional change not to exceed Warp 2%, Weft 2%	**BS 4682:Part 3**
Flammability	Shall not propagate flame after removal of nut and the charred area shall not exceed 35 mm radius	**BS 4790**
Moth proofing	The carpet shall be permanently moth proofed	**BS 4797**

(h) Although there is no standard laboratory test for resistance to wear, tenderers to must satisfy the Employer that their products will sustain the wear anticipated. For example, they may quote tests or reports illustrating the suitability of their products, or list locations, where their products have been laid for a period of at least 2 years, or produce satisfactory evidence from overseas to endorse their suitability.

(i) Foam backed carpets shall not be permitted unless the foam is expanded PVC.

(j) Carpet tiles shall be of the same size so that they could be easily interchanged, relocated or replaced.

Special tiles, with proper edging around, cut out to receive floor socket or outlet are required.

All carpet surfaces shall be "Scotch-guarded", or other approved protective treatment to be provided. No unraveling of yarn at edge of module is permitted.

All carpet tiles shall be dimensionally stable (resist shrinkage) in any circumstance.

(k) Carpet manufacturing company shall have acquired "ISO 14001:1996 – Environmental Management Systems" or "Eco-Management and Audit Scheme (EMAS) of Denmark" or similarly approved by the Engineer.

Carpets shall be completely free of Polyvinyl Chloride (PVC).

Carpet backings shall be PVC free; materials to be cotton, jute, resin or polyurethane.

Adhesives shall be free of synthetic latex, giving no volatile organic compound emission. Water-based adhesives or adhesive-free installation shall be used.

Metal complex dyes and acid dyes shall not be used for dyeing.

Carpets shall be long lasting, having a lifecycle not less than 10 years.

Carpets shall not contain harmful substances and odour. They shall pass the testing and labeling program run by "Carpet and Rug Institute's Indoor Air Quality Carpet Testing Programme" (U.S.A.) or "Danish Indoor Climate Labeling"(Denmark) or "GUT" (European association for environmentally friendly carpets) or similarly approved by the Engineer.

Carpets shall be capable of being reused, recycled or acceptable by landfill for disposal. When reused, the above requirements shall be followed. In case of recycle or landfill, the carpets shall not cause contamination to the surrounding environment.

(l) Provide underlay, where required, one of the following types to **BS 5808**:-

i. Felt
ii. Cellular
iii. Rubber crumb
iv. Composite underlay

(m) Carpet grippers shall have two rows of small angled pins at not less than 50mm centres projecting 4 mm from a preformed strip. Submit samples of carpet grippers and obtain approval.

(n) Adhesive for fixing carpet shall be as recommended by the carpet manufacturers and be compatible with the sub-base. Storage and use should be in accordance with the appropriate recommendations, e.g. the British Adhesive Manufacturers Association booklet "Safe Handling of Adhesives in Industry".

(o) Release bond agent shall be a proprietary release coating or other approved system and be used strictly in accordance with the manufacturer's instructions.

2.1.17.9.3 Workmanship

(a) Install carpets and underlays in accordance with **BS 5325**.

i. Install carpets so that they are flat and of even tension. Carpet shall not be displaced by movement of people or objects on the surface to the point where permanent slackness, rucking or rippling is caused.

ii. Closely fit edges to skirting, cover fillets or other perimeters. Joint carpet at doorway within the thickness of the closed door.

iii. Secure doorway terminations of carpet by sealing, whipping or binding before seaming or covering with cover strips where they abut dissimilar materials.

iv. No carpet jointing shall be permitted at right angles to a door location within 2 m of any door centre line unless accepted by the Engineer.

v. No fitting-out of areas with small pieces or offcuts shall be permitted.

vi. Carpet tiles on raised floor panels shall either be stuck down with double-sided tape or alternatively with some form of bonding agent integral with the backing of the tile with the approval of the Engineer.

(b) Provide underlays in all cases except as follows:-

i. Where foam or felt backing is an integral part of the carpet proposed.

ii. Where the carpet shall be fully adhered in accordance with the manufacturer's Recommendations.

iii. Where the manufacturer recommends that no underlay is required.

Ensure the base is smooth, clean, and dry and compatible with the underlay and carpeting. Similarly ensure any adhesive to be used is compatible with the base, underlay and carpet.

Lightly smooth the underlay by hand to ensure that it lies flat with no bubbles or wrinkles visible on the surface. Secure the underlay sufficiently to prevent movement when the carpet is laid over it.

(c) Plan the layout of the carpet to keep seams to the minimum practicable.
Seams shall be unobstructive and positioned such that, where possible:-

i. They run the length of the area.

ii. Traffic runs along the length rather than across the seams.

iii. Seams shall not be placed in areas subjected to heavier or twisting wear or in doorways or narrow accesses.

Seam or joint carpet by one of the following methods:-

iv. Machine or hand sewing; sew seams to the full length and properly lock off. Stitch to an even tension and ensure the seam lies flat after laying. Protect the raw edge of the pile where necessary, to prevent loss of pile along the seam.

v. Reinforced tape and adhesive (cold applied) ; ensure that the adhesive is dry before stretching.

vi. Heat bonded tapes; ensure that adequate penetration of adhesive is achieved by applying sufficient heat and pressure simultaneously.

vii. Seaming cement; Joint foam backed or unitary-backed carpets with a continuous bead of seaming cement to the full length of the primary backing and joint under compression.

(d) Secure carpets by using one of the following methods:-

1. Carpet gripper method (suitable for woven, tufted, and secondary backed bonded carpet) -

   i. Plug and screw or nail carpet gripper strip around the perimeter 6-8 mm from the skirting. Use recommended adhesives between screws and nail centres. Stretch carpet over the gripper using knee kickers, trim the edge of the carpet and ensure that it is securely trapped in the gap between the gripper and the skirting. Use power stretchers for installations over 7 m long or wide and use a double row of carpet grippers.

2. Fully adhering method (suitable for all types of carpet) -

i. Ensure that the floor is properly dry, free from dust, and contaminants which will affect the adhesion. Ensure that the adhesive is spread evenly and that only a sufficient area that can be properly bonded is laid at one time. Ensure that maximum adhesive contact is obtained by brushing or rolling in accordance with the manufacturer's instructions.

ii. Cut edges shall be seamed straight and square before adhesion in accordance with the manufacturer's instructions. Trim the carpet to the perimeter before the adhesive dries.

iii. Do not permit traffic or installation of furniture on adhered areas for at least 24 hours.

3. Release bonded method (suitable for all types of carpet) -

i. Apply the release agent before adhering generally in accordance with the Clause 2.1.17.9.3 (d)(2) above.

(e) Clear all carpet areas of tools and waste. Remove all pieces of partly loose warp or face yarn with napping scissors. Rectify any lumps, surface irregularities and areas of inadequate or uneven tension that are apparent.

i. Clean in an approved manner the installed carpet throughout the building once after completion prior to acceptance by the Engineer.

2.1.17.10 Raised accessed flooring

2.1.17.10.1 Materials

(a) The raised floor deck shall be fitted with fully removable load bearing panels, interchangeable, and supported on adjustable pedestals.

(b) The f loor system shall not contain materials which by direct contact could be detrimental to the safety and comfort of the users or which may emit abnormally toxic combustion materials and gases when burned.

(c) The floor system shall be sturdy, rigid and firm. The design of the system shall prevent vibration, rattles, rocking squeaks and other noises. Floor panels that are cut shall be supported by additional pedestals and shall have framing modified accordingly.

(d) All necessary accessories such as ramp s, stairs, railings, air grilles, skirting trims, vertical edging panels, shall be of a similar standard or quality to the main floor system.

(e) All panels shall be of the following dimensional requirements:-

i. They shall be removable and fully transferable in position and direction.

ii. A close fit to all perimeters is required and the maximum gap shall be 15 mm and the edge panels shall be located to prevent movement.

iii. Before application of load, the platform floor surface shall be level to ±1.5 mm over any 5 metre square or ± 6 mm over the entire floor.

iv. Height difference between adjacent panels without finish, shall not exceed 0.75 mm, before load application. Height difference between loaded and not loaded shall not exceed 3.25 mm.

v. Under no load condition, the concavity or convexity of the panel shall not exceed 0.75 mm when measured horizontally parallel to any edge or along the diagonal, and the deviation due to twist shall not exceed 1 mm.

vi. Panel deviation from square or work size shall not exceed ±0.5 mm.

vii. Panel edge strips if utilised, shall be firmly fixed and shall not peel or become detached or break. The edging shall resist a pull off strength of 5 N for 5 minutes. Edge stripping shall be dimensionally stable during the stated service life.

Edges of panels shall be chamferred at an angle of 5 degrees for easy removal of panels. Site-cut edges of panels shall be treated to resist fire, moisture, and attack by vermin etc.

viii. The dead load of the raised access floor system shall not exceed 1KN/ m^2.

(f) The platform floor system, including the pedestals, panels, floor covering and fixings shall withstand the following conditions, without any delamination or other forms of deterioration.

(g) The system shall comply with the following fire and safety requirements:-

i. It shall be non-inflammable and shall not sustain any combustion.

ii. It shall meet the fire requirements of **BS 6266** Section 4.4

iii. It shall achieve, within the cavity, Class 1 classifications when tested in accordance with **BS 476:Part 7** and an index of Performance (1) not exceeding 12 and a sub index (i) not exceeding 6 when tested in accordance with **BS 476:Part 6**.

iv. Panels which are constructed using combustible material shall be completely and securely clad on the underside in non-combustible material with a melting point of not less than 600°C. This cladding shall be securely fixed to ensure that flame or radiant heat do not come into contact with the combustible material.

v. All supporting structure shall be incombustible and shall have a melting point of not less than 600°C.

vi. It shall have a thermal property such that the mean temperature of the upper panel surface shall not increase by more than 140°C, when subject to the 1 Kg crib fire test.

(h) The system shall have the electrostatic properties such that the resistance between the surface of the floor covering and the main building earth continuity conductor shall be between 5 x100000 and 2 x $10^{10}\Omega$(ohms) at RH 50%.

All substantial metallic components of the floor system shall be capable of being electrically bonded.

(i) All materials shall be resistant to the growth of fungi and micro-organisms, and to the attack by insects.

The materials shall meet **BS 1982** method of test for fungal resistance and manufactured building materials made of or containing materials of organic origin.

(j) The system shall not contain any toxic materials which by physical contact or by inhalation of gases from such materials, could prove harmful to the occupants of the building.

(k) The materials used in the system shall not give off any odours which could be unpleasant to the occupants of the building.

(l) Materials used in the system shall not be vulnerable to attack by vermin. The design of the system should resist infestation by vermin.

(m) The system and the floor panels shall not create dust or contaminations which are likely to be harmful to personnel or equipment.

(n) The system supporting components and the floor panels shall have a minimum life of 25 years.

(o) All parts of the system shall be installed free of rust, corrosion, rot or any form of deterioration.

All parts shall be suitably finished to prevent deterioration under normal use in the environments. All finishes shall be clearly stated at the time of tender.

(p) Materials shall be non-combustible. They shall be compatible with all other materials used in the raised floor system.

For insulation, the conductivity shall not be more than 0.036 w/m deg. C at 24^{o}C.

2.1.17.10.2 Workmanship

(a) All areas shall be examined before the beginning of the work to determine that the structure is in a condition to receive the system. The area shall be broom-cleaned and uninterrupted for free movement of work flow.

(b) The surface of the floor and the void below shall be left clean and dust free.

(c) The raised floor system shall be adequately protected from damage and dirt before handover to others for the installation of floor coverings and/or other works.

2.1.17.11 Painting

2.1.17.11.1 Generally

(a) Unless otherwise approved by the Engineer, paint and associated materials in a coating system shall be obtained from the same manufacturer and shall be supplied in sealed containers marked to identify the contents, the manufacturer's brand label and recommendations for use. Paint and associated materials for general use shall be a proprietary type approved by the Engineer and shall be obtained from manufacturers approved by the Engineer.

(b) Paint and associated materials which will be applied to surfaces which may come into contact with potable or fresh water shall be a proprietary type approved by the Engineer.

(c) Undercoats and finishing coats shall be compatible with the primer and with each other and shall be obtained from the same manufacturer.

(d) Undercoats and primary finishing coats shall be of slightly different tints to each other and to the finishing coat.

(e) Flat finish undercoats shall be used for hard gloss finishes.

(f) Supply all proprietary brand materials in sealed containers each containing the manufacturer's brand label and printed instructions. Destroy the tins immediately after use of the contents.

(g) Where possible, all the materials in any coating system shall be obtained from the same manufacturer. Furnish the Engineer with two copies of the manufacturer's data sheets for the paints proposed to be used.

(h) Store materials on Site or in the Contractors' workshops, etc. in cool, well ventilated, covered storage space. Label tins of paint for "External use" and for "Internal Use", "Undercoating" and "Finishing" respectively.

(i) Where flammable paints or solvents are used, no smoking shall be permitted. Appropriate signs as required by the Engineer shall be displayed.

2.1.17.11.2 Materials

(a) Aluminium primer shall comply with **BS 4756**, Type 1.

(b) Zinc chromate primer and metallic zinc-rich primer Type 2 shall comply with **BS 4652**.

(c) Lead primer shall comply with **BS 2523**.

(d) Calcium plumbate primer shall comply with **BS 3698**.

(e) Bitumastic paint shall be quick drying Type B complying with **BS 1070**.

(f) Bituminous paint shall comply with **BS 6949**.

(g) Knotting shall comply with **BS 1336**.

(h) Stopping shall comply with **BS 544**.

(i) Rust inhibitor shall be a chemical agent which is capable of converting rust into iron phosphate.

(j) Sealers for plaster, masonry and similar materials shall be a stabilizing solution or oil based plaster sealer.

(k) Wood preservative shall be as stated in Clause 2.1.11.2.22 and 2.1.11.2.23.

(l) Polyurethane paint shall be a two-pack type.

(m) Cold cure epoxy paint shall be a two-pack type.

(n) Textured paint for external use shall be a heavy duty masonry paint incorporating a fine aggregate filler.

(o) Plastic emulsion paint shall be a vinyl or acrylic based emulsion incorporating a fungicide.

(p) Cement paint shall be a waterproof cement based paint supplied in drums and shall not be mixed with lime or similar materials.

(q) Synthetic gloss paint for internal and external use shall have an alkyd resin base combined with drying oils and pigments.

(r) White spirit shall be to **BS 245**.

(s) Linseed oil shall be to **BS EN ISO 2007**

(t) Fluorescent paint shall be water based or oil based, as specified. Use fluorescent paint in conjunction with white flat water or oil base undercoat, priming coat to suit the surface being painted.

(u) Selection of colours for paintwork

i. The colours of paintwork shall be provisionally selected by the Engineer from a catalogue showing the range of colours offered by the manufacturers; the catalogue shall be submitted to the Engineer at least 14 days before painting starts.

ii. Trial panels shall be painted in each of the colours provisionally selected by the Engineer. Each trial panel shall be 1 m x 1 m and shall be painted with the complete paintwork system.

iii. The Engineer shall select the final colour of paintwork from the trial panel.

iv. Trial panels shall be used as a means of comparison for the colour of the finished paintwork. Trial panels shall be protected from damage and shall be left in position until the Engineer instructs their removal.

2.1.17.11.3 Storage of paint and associated materials

(a) Paint and associated materials shall be stored in a dry weatherproof store; the store shall be maintained in a cool, well ventilated condition.

(b) Tins of paint shall be labelled as being for external use, internal use, undercoating and finishing, as appropriate, and shall be protected from exposure to conditions which may adversely affect the material.

(c) Paint and associated materials shall be stored in accordance with the manufacturers' recommendations and shall not be used after the recommended shelf life has been exceeded.

2.1.17.11.4 Preparation of surfaces for painting

(a) Surfaces which are to be painted shall be dry and clean, and deleterious and loose material shall be removed.

(b) Absorbent surfaces which are to be painted with cement paint shall be thoroughly dampened to provide even suction.

(c) Knotting shall be applied to knots in timber.

(d) Screws and nails in timber and building board surfaces shall be recessed or punched below the finished surface and the whole surface shall be stopped.

(e) Plaster, cement render, masonry, concrete and similar surfaces shall be stopped and sealed. Scale and rust shall be removed from non-galvanized steel and ironwork; the surface shall be painted with rust inhibitor at least 12 hours before priming or shall be blast-cleaned in accordance with the paint manufacturer's recommendations.

(f) Surfaces adjacent to paintwork shall be temporarily masked to prevent contamination during painting.

2.1.17.11.5 Type and number of coats for painting system

(a) The type and number of coats applied to different surfaces for each painting system shall be as stated in Table 2.1.17.9 below:

(b) Paint and associated materials shall be applied in accordance with **BS 6150** and shall be mixed and applied in accordance with the manufacturers' recommendations.

(c) Painting shall not be carried out in wet or misty weather, in direct strong sunlight, or if in the opinion of the Engineer there is excessive dust in the atmosphere.

(d) Paint and associated materials shall be applied with bristle brushes or rollers. If mechanical spraying is permitted by the Engineer the primer coat, or the first undercoat if a primer coat is not required, shall be applied by brush.

(e) Primer coats shall be thoroughly brushed into all surfaces including joints, angles and sawn ends. Primer coats shall be applied to surfaces which will be inaccessible before fittings are fixed in position.

(f) Paint and associated materials shall not be applied until the underlying surface has been rubbed down with fine glass paper and is clean and dry.

(g) Undercoats and finishing coats shall be applied in an even film free from brush marks, sags and runs. If two hard gloss finishing coats are to be applied, the second coat shall be applied within 48 hours after the first coat.

(h) Cement paint shall be applied within 1 hour after mixing; a minimum of 12 hours drying time shall be allowed between coats.

(i) "Wet Paint" signs in English shall be prominently displayed adjacent to newly painted surfaces.

Table 2.1.17.9 :Type and number of coats for painting systems

Type and number of coats for painting systems

Painting system	Surface type	Primer		No. of undercoats	Finishing coat	
		Type	No. of coats		Type	No. of coats
A	Internal woodwork	Aluminium primer	1	1	Hard gloss	1

Type and number of coats for painting systems

Painting system	Surface type	Primer		No. of undercoats	Finishing coat	
		Type	No. of coats		Type	No. of coats
B	Internal woodwork natural finish	Polyurethanne primer	1	1	Polyurethane paint	1
				1		
C	External woodwork	Aluminium primer	1	2	Hard gloss	1
D	Hidden surfaces of woodwork and rough sawn timbering				Wood preservative	2
E	Non-structural internal bright steel	Zinc chromate metallic zinc-rich or lead primer	1	1	Hard gloss	1
F	Non-structural external bright steel	Zinc chromate metallic zinc-rich or lead primer	1	1	Hard gloss	1
G	Internal galvanized steel	Calcium plumbate primer	1	1	Hard gloss	1
H	External galvanized steel	Calcium plumbate primer	1	1	Hard gloss	1
I	Galvanized steel adjacent to the coast or sewerage treatment works	Epoxy red oxide chromate primer	1	1	Cold cure epoxy paint	1
J	Ironwork			1 before fixing	Bitumastic paint	2
K	Internal walls and ceilings	Alkali resistant primer	1		Semi-gloss plastic emulsion paint	2
L	External walls without tile or similar finishes				Cement paint	2

Type and number of coats for painting systems

Painting system	Surface type	Primer		No. of undercoats	Finishing coat	
		Type	No. of coats		Type	No. of coats
M	Structural steelwork	as stated in Structural Steelwork Section				

2.1.17.11.6 Workmanship

(a) Painting generally shall be in accordance with **BS 6150** and **BS 8000:Part. 12** and as described in the following clauses:-

i. Do not carry out work in wet humid or foggy weather, direct sunlight, or on surfaces which are not thoroughly dry, or if there is excess dust in the air.

ii. Ensure that all holes, cracks and other defects in surfaces have been made good prior to painting.

iii. Brush each coat well into the surface so that every part, including joints, junctions, angles, etc., is adequately covered, but take care to avoid excessive or uneven thickness of paint film, particularly at edges, angles and junction.

iv. Before applying coatings check that the moisture content of the substrate shall not adversely affect the completed work.

v. Apply coatings only to clean, dry surfaces after any previous coatings have hardened, and rub down smooth with fine glass paper before the subsequent coat is applied.

vi. Successive coats of paint shall be of slightly differing tints, and the intercoating time shall not exceed the limits recommended by the paint manufacturers.

vii. Apply coatings with approved bristle brushes of suitable size. Flat wall brushes shall be not less than 150 mm wide.

viii. Do not use rollers, cloths or gloves unless ordered or approved by the Engineer.

ix. Do not use mechanical spraying machines unless ordered or approved by the Engineer. When mechanical spray painting is ordered or permitted, the priming coat (or first undercoat, if no priming coat) shall be applied by brush.

x. Where required, prime and paint prior to fixing surfaces which become inaccessible.

xi. Remove all articles of ironmongery, hardware, etc. before painting and replace with matching screws (and plugs, if required,) of suitable size, after completion.

xii. Leave everything clean and completely free from all paint stains, splashes, etc.

xiii. Do not paint weatherstripping on metal windows or doors.

xiv. Touch up coated surfaces on completion, where ordered.

xv. Carry out decoration in colours to **BS 4800** as selected by the Engineer.

xvi. Paint sample panels as ordered and obtain approval before carrying out work.

(b) General protection and cleaning

i. Protect surfaces, fittings, furniture, and the like by suitable and approved means.

ii. Protect freshly applied surface coatings from damage.

iii. Exhibit "Wet Paint, in English signs and provide protective barriers where necessary.

iv. Protect surfaces adjacent to those being coated.

v. Remove and clean off all splashes whilst work is in progress, make good any damage, and leave work, and all areas in which work is executed, clean and perfect on completion.

2.1.17.11.7 Preparatory work

Unless specifically stated to the contrary, the descriptions of "Painting" work shall be understood to include all preparatory work required and necessary to produce a first class finish, free from all blemishes, brush marks, blisters and weeping and the following definitions are to apply where preparation is to be carried out:-

(a) "Wash down" shall mean either:-

i. the removal with clean water of all dirt, etc. not absorbed into the surface of a material not previously decorated, or

ii. the removal with clean water of existing limewash, non-washable distemper or similar material not absorbed into the decorated surfaces, or

iii. the removal of dirt, etc. from and cleaning down of, existing washable distempered, cement painted, synthetic painted and similarly decorated surfaces with sugar soap powder mixed with water, followed by further applications of clean water.

(b) “Broom down” shall mean the thorough dry brushing of any surface with a stiff broom or brush so as to remove all cobwebs, dust or loose particles.

(c) "Scrape" shall mean the removal of all existing coats of paint, limewash, colourwash, distemper, etc. by scraping tools without the use of chemical solvents or heat and without damage to the underlying material. Any damage so caused shall be made good. The surface shall be washed down on completion.

(d) "Wire brush" shall mean the thorough brushing of the surface with a stiff wire brush.

(e) "Strip" shall mean the complete removal, without damage to the underlying surface, of all existing coats of limewash, distemper, paint or other decorative material by means of washing and scraping together with the use of chemical solvents or heat, if necessary. After the use of chemical solvents the surfaces shall be washed down and neutralised in accordance with the manufacturer's recommendation.

(f) "Stop" to plaster shall mean carefully trimming the edges of all holes, cracks or crevices of any description and filling with an approved proprietary brand of filler or with Plaster of Paris to produce an even, flat surface, and touching up all patches with a coat of sealer prior to
repainting.

(g) "Stop" to woodwork shall mean the cleaning out and filling of all holes, cracks and crevices, etc.

(h) "Knot" to metal pipes shall mean the application of one coat of patent knotting to surface of any bitumen coated pipe.

(i) "Knot" to woodwork shall mean the application of a sufficient number of coats of "knotting" over all knots in the timber to prevent the bleeding of resin, etc. through the subsequent decoration.

(j) "Rub down" shall mean the rubbing of newly prepared surfaces, or surfaces of existing paint remaining after preparation for redecoration, with approved waterproof glass paper, pumice stone or similar, to give a true and keyed surface for new paint.

(k) "Fill" shall mean filling of grain with approved surface filler.

2.1.17.12 Ceiling finishes

2.1.17.12.1 Demountable suspended ceilings

(a) Generally

i. All suspended ceilings shall be polyester painted steel tiles supported in a concealed clip-in grid system, to **BS EN 13964:2004 + A1:2006**.

ii. Suspended ceiling tiles shall be 600 x 600mm with a sheet thickness of minimum 0.6mm.

iii. Finish to tiles shall be electrostatically applied polyester paint. Colour to be RAL 9010 20% gloss.

iv. Acoustic Ceilings shall be provided to areas with sound reduction performance requirement between a noise source and a sensitive area.

(b) Design requirements

i. Design ceiling suspension systems in accordance with **ASTM C636** and manufacturer's printed directions.

ii. Design tile ceiling system for adequate support of electrical fixtures as required by the current bulletin of the Electrical Safety Authority. Acoustic panel system is not designed to carry the weight of electrical equipment.

iii. Design hanger anchor and entire suspension system static loading not to exceed 25% of their ultimate capacity including lighting fixture dead loads.

iv. Design tile suspension system to support weight of mechanical and electrical items such as air handling boots and lighting fixtures, and with adequate support to

allow rotation/relocation of light fixtures. Acoustic panel system is not designed to carry the weight of mechanical and electrical equipment.

v. Design subframing as necessary to accommodate, to avoid conflicts and interferences where ducts or equipment prevent regular spacing of hangers.

(c) Submittals

1. Shop drawings: Submit shop drawings indicating:
   i. Suspension system layout including hangers and supports for acoustic tile system.
   ii. Acoustic panel system including suspension system, hangers, supports and panel sizes and locations.
   iii. Conditions at abutting, intersecting, and penetrating construction.
   iv. Dimensioned locations of lighting fixtures, diffusers, sprinkler heads and other items that pierce the ceiling plane.

2. Samples: Submit the following samples:
   i. One full-size sample of each type of tile panels to be used.
   ii. One of each type of suspension system members.

3. Certificates: Submit written certification stating that suspended ceiling system is designed for adequate support of electrical fixtures .

(d) Site conditions

1. Do not install the Work of this Section until:
   i. Mechanical and electrical Work above the ceiling is complete.
   ii. Relative humidity is below 80 %.
   iii. Ventilation is adequate to remove excess moisture.
   iv. Areas are closed an protected against weather, and maintained at no less than 50°F.
2. Install temporary protection and facilities to maintain product manufacturer's, and above specification, environmental requirements 24 h before, during, and after installation.

(e) Maintenance

i. Submit extra acoustic ceilings amounting to 2% of gross ceiling area, allowing proportionately for each pattern and type specified to nearest full carton.
ii. Submit Products which are part of same production run as installed Products.
iii. Store maintenance Products as directed by Engineer.

(f) Delivery, storage and handling

i. Transport, handle and store material in manner to prevent warp, twist, damage to panel edges and surfaces in accordance with Manufacturer's recommendations.
ii. Any warped and/or damaged panels and trim shall be rejected and be replaced by new, straight, undamaged and acceptable material at no cost to Employer.
iii. Bent, twisted or otherwise damaged Tee grid suspension components shall not be used under any circumstances. Replace such damaged items with new undamaged material at no additional cost to Employer.
iv. Store material in warm, dry place away from water and the elements. Protect against undue loading stresses and shock.

v. All packaged material shall be delivered in original manufacturers wrappers and containers with labels and seals intact.

(g) Materials

i. Galvanized steel sheet: **ASTM A653/A653-M**, Z275; cold rolled, galvanized steel sheet.

ii. Main carrying channels: **ASTM C645**; Channels formed from galvanized steel sheet, 38 x 19 mm cold rolled.

iii. Subframing: **ASTM C645**; Channels formed from galvanized steel sheet, dimensions

iv. and spans as required.

v. Hangers: 2.6 mm minimum diameter, galvanized steel wire.

vi. Tie wire: 1.6 mm minimum diameter, soft annealed galvanized steel wire.

vii. Wall mouldings and accessories, including but not limited to, corner caps, edge mouldings, panel hold over clip, metal closures, and trim. Finish and colour: same as main tees.

viii. Exposed main, cross tees, and relocatable cross tees: **ASTM C635/C635M-07**, 38 mm high steel, bulb tee design double steel web, rectangular single spans without exceeding a deflection of 1/360 of the span. Splices to be integral and reversible; cross tee interlocking into main tee.

ix. Acoustic tile: **ASTM E1264**, type 3, Form 2, Pattern CE. Wet-formed mineral fiber with factory applied vinyl latex paint. 600 x 600 x 16 mm thick square edge as indicated on Finish Schedule.

x. Metal acoustic tile: Perforated aluminum panel with satin silver metallic finish and nonwoven acoustical backing adhered to panels. 600 x 600 x 0.8 mm thick with round perforations in diagonal pattern providing 21% open area.

xi. Wall mouldings: To match acoustical ceiling suspension system.

xii. Eggcrate light cove louvres: Aluminum 12 mm deep, 12 mm x12 mm grid, colour to match wall moulding. Use wall moulding on all 4 sides for eggcrate louvre support.

(h) Workmanship

1. Suspension system

i. Coordinate locations and openings of mechanical and electrical services support, and penetration through the acoustical ceilings. Coordinate field conditions, clearances, measurements, and mechanical and electrical services testing and commissioning, above the acoustical ceilings.

ii. Install hanger wires plumb and securely anchored to the building structural framing, independent of walls, pipes, ducts, and metal deck; install additional framing and hangers to bridge interference items.

iii. Install acoustical ceiling systems in accordance with manufacturer's written instructions, reviewed shop drawings, and **ASTM C636**, listed in order of precedence.

iv. Install hanger wires at 1200 mm maximum centres along carrying channels, not less than 25 mm, and not more than 150 mm from channel ends.

v. Install additional hangers at lighting fixture and air distribution ductwork locations. Do not attach hanger wires to mechanical or electrical equipment. Do not support mechanical and electrical fixtures and fitting on ceiling without the ceiling manufacturer's written acceptance.

vi. Install acoustical ceiling suspension system to a tolerance of 1:1200 of span and 0.25 mm maximum between adjacent metal members. Tolerances are not cumulative. Refer to Electrical Contract Drawings for fixture layout.

vii. Do not bend or twist hangers as a means of levelling. Form double loops tightly and lock to prevent vertical movement or rotation within the loop.

viii. Install edge moulding at intersection of ceiling and vertical surfaces.

ix. Centre acoustical ceiling suspension systems on room axis; install equal border pieces.

x. Install hangers onto the ends of main tee runners at not more than 150 mm from ends of runners, adjacent and perpendicular to walls.

xi. Support the suspension system independently of walls, columns, ducts, pipes and conduits.

xii. Install main runners in maximum available lengths. Layout joints in suspension members to avoid the perimeters of recessed fixtures. Lock grid members to form a rigid assembly.

xiii. Install additional tee, suspension system framing around recessed fixtures, diffusers, grilles and other items for a complete assembly.

2. Acoustic lay-in tiles

i. Install acoustic tile in grid system openings supported by bottom flanges of members.

ii. Provide special shapes and sizes to provide a complete installation by cutting tile to fit into openings. Fit tile moderately tight between upright legs of members.

iii. Carefully cut and trim acoustic tiles to accommodate items piercing the finished ceiling plane.

iv. Secure metal panels into grid opening with concealed hold down clips.

v. Install moulding continuous around perimeter and level.

vi. Install eggcrate light cove louvres with inconspicuous butt and mitred corner joints and seat evenly.

vii. Remove and replace acoustic tiles with broken edges, or damaged, marked, discoloured, soiled, or stained faces.

(i) Adjustments and cleaning

Clean soiled or discoloured surfaces of exposed work on completion of work.

Replace components which are visibly damaged, marred or uncleanable.

2.1.17.12.2 Plasterboard ceiling

(a) Plasterboard ceilings to non-fire rated areas shall be as British Gypsum's CasoLine MF Concealed grid MF suspended ceiling system with 1No layer 12.5mm Gyproc wallboard, taped and jointed to receive paint finish.Insulation as required to achieve acoustic requirements of Building Regulations Part E.

(b) Plasterboard ceilings to non-fire rated areas and requiring moisture resistance shall be as British Gypsum's CasoLine MF Concealed grid MF suspended ceiling system with 1No layer 12.5mm Gyproc moisture resistant board, taped and jointed to receive paint finish. Insulation as required to achieve acoustic requirements of Building Regulations Part E.

(c) Plasterboard ceilings to fire rated areas shall be as British Gypsum's CasoLine MF Concealed grid MF suspended ceiling system, with 30mm stone mineral wool slab (45 kg/m^3) laid over grid and 2No layers 15mm Fireline wallboard, taped and jointed to receive paint finish.

(d) Contractor shall allow for the incorporation and support of luminaries, grilles, speakers, etc and co-ordinate the installation of the ceilings and lighting system.

2.1.17.13 References and Standards

BS EN 197-1(2011):Cement.Composition, specifications and conformity criteria for common cements.

BS EN 13964 (2004+A1:2006): Suspended ceilings. Requirements and test methods

BS EN 490 (2011): Concrete roofing tiles and fittings for roof covering and wall cladding. Product specifications

BS EN 491(2011): Concrete roof tiles and fittings for roof covering and wall cladding. Test methods

BS 8204-1 (2003+A1:2009): Screeds, bases and in situ floorings. Concrete bases and cementitious levelling screeds to receive floorings. Code of practice

BS 8204-2 (2003+A2:2011): Screeds, bases and in situ floorings. Concrete wearing surfaces. Code of practice
.
BS 8204-3 (2004+A2:2011): Screeds, bases and in situ floorings. Polymer modified cementitious levelling screeds and wearing screeds. Code of practice
.

BS 8204-4 (2004+A1:2011): Screeds, bases and in situ floorings. Cementitious terrazzo wearing surfaces. Code of practice

BS 8204-5 (2004+A1:2011): Screeds, bases and in situ floorings. Mastic asphalt underlays and wearing surfaces. Code of practice

ASTM C636/ C636M -13: Standard Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-In Panels

ASTM A653/653M-11 (2011): Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process

ASTM C645-13: Standard Specification for Nonstructural Steel Framing Members

ASTM A635/A635M-09b (2009): Standard Specification for Steel, Sheet and Strip, Heavy-Thickness Coils, Hot-Rolled, Alloy, Carbon, Structural, High-Strength Low-Alloy, and High-Strength Low-Alloy with Improved Formability.

ASTM E1264-08e1 (2008): Standard Classification for Acoustical Ceiling Products

BS EN 459-1 (2010): Building lime. Definitions, specifications and conformity criteria

BS EN 13914-2 (2005): Design, preparation and application of external rendering and internal plastering. Design considerations and essential principles for internal plastering

BS 8481(2006): Design, preparation and application of internal gypsum, cement, cement and lime plastering systems. Specification

BS EN 12878 (2005): Pigments for the colouring of building materials based on cement and/or lime. Specifications and methods of test.

BS EN 480-4 (2005): Admixtures for concrete, mortar and grout. Test methods. Determination of bleeding of concrete

BS EN 13658-1(2005): Metal lath and beads. Definitions, requirements and test methods. Internal plastering

BS EN 10223-2 (2012): Steel wire and wire products for fencing and netting. Hexagonal steel wire netting for agricultural insulation and fencing purposes.

BS EN 10244-2 (2009): Steel wire and wire products. Non-ferrous metallic coatings on steel wire. Zinc or zinc alloy coatings

BS EN 13279-1 (2008): Gypsum binders and gypsum plasters. Definitions and requirements

BS EN 13279-2 (2004):Gypsum binders and gypsum plasters. Test methods

BS EN 649 (2011): Resilient floor coverings. Homegeneous and heterogeneous polyvinyl chloride floor coverings. Specification

BS EN 12104 (2000): Resilient floor coverings. Cork floor tiles. Specification

BS EN ISO 105-C06 (2010):Textiles. Tests for colour fastness. Colour fastness to domestic and commercial laundering

BS 2677

BS 3661

BS 1202-1 (2002): Specification for nails. Steel nails

PD CEN/TR 15123 (2005): Design, preparation and application of internal polymer plastering systems

BS EN 13914-1 (2005): Design, preparation and application of external rendering and internal plastering. External rendering

BS 8212 (1995): Code of practice for dry lining and partitioning using gypsum plasterboard.

BS 5270-1 (1989): Bonding agents for use with gypsum plasters and cement. Specification for polyvinyl acetate (PVAC) emulsion bonding agents for indoor use with gypsum plasters.

BS EN 13055-1(2002): Lightweight aggregates. Lightweight aggregates for concrete, mortar and grout

BS 8000-9 (2003): Workmanship on building sites.Cementitious levelling screeds and wearing screeds. Code of practice.

BS 8000-10 (1995): Workmanship on building sites. Code of practice for plastering and rendering.

BS 8000-12 (1989): Workmanship on building sites.Code of practice for decorative wallcoverings and painting.

BS 5385-1 (2009): Wall and floor tilingDesign and installation of ceramic, natural stone and mosaic wall tiling in normal internal conditions. Code of practice

BS 4223 (1989): Methods for determination of constructional details of textile floor coverings with yarn pile.

BS ISO 2094 (1999): Textile floor coverings. Determination of thickness loss under dynamic loading.

BS 4098 (1975): Method of determination of thickness, compression and recovery characteristics of textile floor coverings.

BS 4682-2(1988): Methods of test for dimensional stability of textile floor coverings. Determination of dimensional changes due to changes in ambient humidity

BS 4682-3 (1981): Methods of test for dimensional stability of textile floor coverings Determination of dimensional changes after exposure to heat.

BS 4790 (1987): Method of determination of the effects of a small source of ignition on textile floor coverings (hot metal nut method).

BS 4797 (1978, ISO 3998-1977): Method of test for textiles-determination of resistance to certain insect pests.

BS EN 12620 (2013): Aggregates for concrete

BS 1197-2 (1973): Specification for concrete flooring tiles and fittings.Metric Units.

BS EN 14411(2012): Ceramic tiles. Definitions, classification, characteristics, evaluation of conformity and marking

BS EN 13748-1 (2004): Terrazzo tiles. Terrazzo tiles for internal use

BS EN 13748-2 (2004): Terrazzo tiles. Terrazzo tiles for external use

BS EN 1338 (2003): Concrete paving blocks. Requirements and test methods

BS 7533-3 (2005+A1:2009): Pavements constructed with clay, natural stone or concrete pavers. Code of practice for laying precast concrete paving blocks and clay pavers for flexible pavements

BS EN 654 (2011): Resilient floor coverings. Semi-flexible polyvinyl chloride tiles.Specification

BS 5808 (1991): Specification for underlays for textile floor coverings.

BS 5325 (2001): Installation of textile floor coverings. Code of practice

BS 6266 (2011):Fire protection for electronic equipment installations. Code of practice

BS 476-6 (1989+A1:2009): Fire tests on building materials and structures. Methods of test for fire propagation for products.

BS 476-7 (1997): Fire tests on building materials and structures.Method of test to determine the classification of the surface spread of flame of products.

BS 1982 (1990): Fungal resistance of panel products made of or containing materials of organic origin.

BS 4756 (1998): Specification for ready-mixed aluminium priming paints of woodwork.

BS 4652 (1995): Specification for zinc-rich priming paint (organic media).

BS 2523 (1996): Specification for lead based priming paints.

BS 3698 (1964): Specification for calcium plumbate priming paints.

BS 1070 (1993): Specification for black paint (tar based).

BS 6949 (1991): Specification for bitumen-based coatings for cold application excluding use in contact with potable water.

BS 1336 (1971): Specification for knotting.

BS 544 (1969): Specification for linseed oil putty for use in wooden frames.

BS 245 (1976: 2000): Specification for mineral solvents (white spirit and related hydrocarbon solvents) for paints and other purposes.

BS EN ISO 150 (2007): Raw, refined and boiled linseed oil for paints and varnishes. Specifications and methods of test

BS 6150 (2006): Painting of buildings. Code of practice

BS 4800 (2011): Schedule of paint colours for building purposes.

BS 5385-1 (2009): Wall and floor tiling. Design and installation of ceramic, natural stone and mosaic wall tiling in normal internal conditions. Code of practice.

BS 5385-2 (2006): Wall and floor tiling. Design and installation of external ceramic and mosaic wall tiling in normal conditions. Code of practice.

BS 5385-3 (2007): Wall and floor tiling. Design and installation of internal and external ceramic and mosaics floor tiling in normal conditions. Code of practice.

BS 5385-5 (2009): Wall and floor tiling. Design and installation of terazzo, natural stone and agglomerated stone tile and slab flooring. Code of practice.

BS EN 520 (2004+A1:2009): Gypsum plasterboards. Definitions, requirements and test methods

BS EN 651 (2011): Resilient floor coverings. Polyvinyl chloride floor coverings with foam layer. Specification

BS 1711 (1975): Specification for solid rubber flooring

BS EN ISO 10595 (2012): Resilient floor coverings. Semi-flexible/vinylcomposition (VCT) poly(vinyl chloride) floor tiles. Specification

2.1.18 HANDRAILING, LADDERS, STAIRS AND FLOORING

2.1.18.1 Materials

2.1.18.1.1 Steel

(a) Steel for handrailing, ladders, stairs and flooring shall comply with the following:

Steel tubes and tubulars suitable for screwing to **BS 21** pipe threads :	**BS EN 10255:2004**
Hot rolled sections :	**BS 4: Part 1**
Hot rolled structural steel sections	
- equal and unequal angles :	**BS EN 10056-1**
- hollow sections :	**BS EN 10210-2**
Weldable structural steels :	**BS EN1027-2, BS 6131, BS EN 10029.**

2.1.18.1.2 Stainless steel

(a) Stainless steel for handrailing, ladders, stairs and flooring shall be grade 304 S 15 complying with **BS EN 10095** and **BS EN 10250-4**. Stainless steel tubes shall be longitudinally welded tubes complying with **BS EN 10296**, designation LW 21 GZF(S). Tubes for handrails shall be polished.

2.1.18.1.3 Aluminium

(a) Aluminium for handrailing, ladders, stairs and flooring shall be type H 30 TF and shall comply with the following:

Wrought aluminium and aluminium alloys for general engineering purposes	
- plate, sheet and strip :	**BS EN 485**
- drawn tube :	**BS EN 515**
- bars, extruded round tubes and sections :	**BS EN 573-3(2005 & 2007)**

(b) Aluminium shall be anodised to Grade AA 25 in accordance with **BS EN ISO 7599:2010.**

2.1.18.1.4 Bolts, nuts, screw, washers and rivets

(a) Bolts, nuts, screws, washers and rivets shall comply with the following:

ISO metric black hexagon bolts, screws and nuts :	**BS 4190**
ISO metric black cup and countersunk headbolts and screws with hexagon nuts :	**BS 4933**
Metal washers for general engineering purposes :	**BS 4320**
Rivets for general engineering purposes :	**BS 4620**
Wrought aluminium and aluminium alloys for general engineering purposes	
- rivet, bolt and screw stock :	**BS 1473**
Stainless steel fasteners :	**BS EN ISO 3506**

(b) The length of bolts shall be such that the threaded portion of each bolt projects through the nut by at least one thread and by not more than four threads.

(c) Rag, indented bolts, expansion bolts and resin bonded bolts shall be a proprietary type approved by the Engineer and shall be capable of withstanding the design working load.

(d) Galvanized bolts, nuts, screws, washers and rivets shall be used with galvanized handrailing, ladders, stairs and flooring and aluminium bolts, nuts, screws, washers and rivets shall be used with aluminium handrailing, ladders, stairs and flooring; stainless steel bolts, nuts, screws, washers and rivets shall be used with other types of handrailing, ladders, stairs and flooring. Bolts, nuts, screws and washers shall be insulated from aluminium by non-metallic washers and sleeves.

2.1.18.1.5 Cement mortar

(a) Mortar for grouting fixing bolts shall consist of 1 part of cement to 3 parts of sand together with the minimum amount of water necessary to achieve a consistency suitable for completely filling the bolt holes. The mix shall contain a non-shrink admixture.

(b) Resin grout shall be proprietary type approved by the Engineer and shall contain a non-shrink admixture.

(c) Mortar for building in curbs for metal flooring shall consist of 1 part of cement to 3 parts of sand together with the minimum amount of water necessary to achieve a consistency suitable for the work. The mix shall contain a non-shrink admixture.

2.1.18.2 Design by contractor

2.1.18.2.1 Design by Contractor

(a) Handrailing, ladders, stairs and flooring which are to be designed by the Contractor shall comply with the following requirements:

i. Handrailing shall be capable of withstanding a horizontal loading of 740 N/m. The deflection of handrailing shall not exceed 1 in 200 at mid-span.

ii. Stairs shall be designed for a live loading of 5 kPa.

iii. Flooring shall be designed for a live loading of 5 kPa. The deflection of flooring shall not exceed 1/200 of the span.

2.1.18.3 Fabrication of handrailing, ladders, stairs and flooring

2.1.18.3.1 Fabrication of steelwork

(a) Steelwork for handrailing, ladders, stairs and flooring shall be fabricated in accordance with BS **EN 1090-2:2008+A1:2011**

2.1.18.3.2 Galvanizing to steel

(a) Steel which is to be galvanized shall be hot-dip galvanized in accordance with **BS EN ISO 1461** to a coating thickness of at least 500 g/m^2.

(b) Galvanizing to steel shall be applied after welding, drilling and cutting are complete.

2.1.18.3.3 Welding steel

(a) Welds to steel for handrailing, ladders, stairs and flooring shall be full depth fillet welds. The welded surface shall be clean and flush before application of the protective coating.

(b) Steel shall not be welded after galvanizing unless permitted by the Engineer; if permitted, the welded areas shall be free from scale and slag and shall be treated with appropriate coating system approved by the Engineer which is compatible with the protective system of the parent material.

2.1.18.3.4 Fabrication of handrailing

(a) Handrailing shall be discontinued at movement joints in structures. The spacing between standards shall be regular and shall not exceed 1.6 m. Curved handrailing shall not be made up of a series of straights.

2.1.18.3.5 Fabrication of ladders

(a) Ladders shall comply with **BS 4211**

i. Steel ladders shall be hot-dip galvanized.
ii. Aluminium ladders shall be Grade 6082 aluminium.
iii. Rungs, extended stringers, safety cages and brackets shall be welded to the stringers of ladders.
iv. Rungs on aluminium ladders shall have longitudinal grooves and pressed aluminium alloy caps shall be fixed to open ends.

2.1.18.3.6 Fabrication of stairs

(a) Stairs shall comply with **BS 5395: Part 1**.

2.1.18.3.7 Fabrication of flooring

(a) The shape of each panel of flooring shall be such that the panel can be easily removed. The mass of each panel shall not exceed 40 kg. Where intermediate supports are provided to support flooring they shall be capable of being removed to provide the specified clear opening.

(b) Curbs shall be provided in concrete surfaces for flooring.

(c) Cut-outs in flooring shall be neatly shaped and shall be provided with toe plates. Cut-outs in open mesh flooring shall be trimmed with edge bars welded to the bearing bars. The clearance between the edge of cutouts and the component passing through the cut-out shall not exceed 30mm.

(d) The bearing bars in open mesh flooring shall be welded to the nosing bars. The transverse bars shall be rivetted or welded to the bearing bars. Panels of open mesh flooring shall be secured with adjustable fixing clips.

(e) Chequer plate flooring shall have a non-slip pattern of a type approved by the Engineer and shall be provided with lifting holes. The flooring shall be secured to curbs by countersunk screws.

2.1.18.3.8 Fabrication of toe plates

(a) Toe plates shall be fixed to handrail standards by brackets and shall be bolted or welded to stairs and flooring.

2.1.18.3.9 Fabrication of safety chains

(a) Safety chains shall comply with **BS EN 818** and shall be capable of withstanding a breaking force of 30 kN and a proof force of 15 kN.

(b) Steel safety chains shall be 8 mm nominal size, Grade M4 noncalibrated chain Type 1 and shall be hot-dip galvanized.

(c) The links of stainless steel safety chains shall be welded and shall have an internal length exceeding 45 mm and an internal width of between 12 mm and 18 mm. Fins caused by welding shall be removed.

(d) Hooks on chains shall be fitted with a sprung securing device.

2.1.18.4 Submissions

2.1.18.4.1 Particulars of handraining, stairs, ladders and flooring

(a) The following particulars of the proposed handrailing, ladders, stairs and flooring shall be submitted to the Engineer:

i. details of manufacturer's name and place of manufacture,

ii. a certificate showing that the materials comply with the requirements stated in the Contract,

iii. drawings showing layout and details of handrailing, including

iv. positions of the different type of standards,

v. drawings showing details of ladders, stairs, toe plates and safety chains,

vi. drawing showing layout and details of flooring, including positions and sizes of panels and supports,

vii. details of methods of fixing and of rag, indented, expansion and resin bonded bolts, including manufacturer's literature, and design details.

(b) The particulars shall be submitted to the Engineer at least 14 days before fabrication starts.

2.1.18.4.2 Samples of materials

(a) The following samples of the proposed handrailing, ladders, stairs and flooring shall be submitted to the Engineer at least 14 days before the relevant work starts:

i. handrails,

ii. standards,

iii. ladders, including rungs,

iv. toe plates,

v. flooring and curbs,

vi. safety chains, and

vii. rag, indented, expansion and resin bonded bolts.

(b) The details of samples shall be as instructed by the Engineer.

2.1.18.5 Storage of materials

2.1.18.5.1 Storage of handrailing, ladders, stairs and flooring

(a) Handrailing and flooring shall be stored on level supports in a dry weatherproof store and in a manner which will not result in damage or deformation to the materials or in contamination of the materials.

(b) Handrailing, ladders, stairs and flooring shall be protected from damage and damaged handrailing, ladders, stairs and flooring shall not be used in the permanent work unless permitted by the Engineer.

2.1.18.6 Installation of handrailing, ladders, stairs, and flooring

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2.1.18.6.1 Installion of handrailing, ladders and flooring

(a) Handrailing shall be installed to a smooth alignment.

(b) Handrail standards, flanges, ladders and stairs shall be bolted to metalwork and shall be fixed to concrete using rag, indented, expansion or resin bonded bolts. The bolts shall be fitted into pockets left in the concrete and the pockets shall be filled with cement mortar or resin grout.

2.1.18.6.2 Installation of flooring

(a) Flooring and curbs shall be flush with the adjoining surfaces.

(b) Curbs shall be fitted into rebates left in the concrete and the rebates shall be filled with cement mortar.

(c) Flooring shall be closely butted and the gap between panels and curbs, adjacent panels and other surfaces shall not exceed 10 mm.

2.1.18.7 Tolerances

2.1.18.7.1 Tolerances: handrailing, ladders, stairs and flooring

(a) Handrailing, ladders, stairs and flooring shall comply with the following requirements:

i. The position and height of handrailing shall be within 10 mm of the specified position and height.

ii. The level of the top rung of ladders and the top tread of stairs shall be within 75 mm of the specified level.

iii. The level of flooring and curbs shall be within 3 mm of the specified level.

2.1.18.8 References and Standards

BS END 10255 (2004):Non-alloy steel tubes suitable for welding and threading. Technical delivery conditions

BS 4-1 (2005): Structural steel sections. Specification for hot-rolled sections

BS END 10210-2 (2006): Hot finished structural hollow sections of non-alloy and fine grain steels. Tolerances, dimensions and sectional properties.

BS END 10056-1 (1999): Specification for structural steel equal and unequal angles. Dimensions.

BS END 10025-6 (2004+A1:2009): Hot rolled products of structural steels. Technical delivery conditions for flat products of high yield strength structural steels in the quenched and tempered condition

BS 7668 (2004): Weldable structural steels. Hot finished structural hollow sections in weather resistant steels. Specification

BS END 10029 (2010): Hot-rolled steel plates 3 mm thick or above. Tolerances on dimensions and shape

BS END 10226-1 (2004): Pipe threads where pressure tight joints are made on the threads. Taper external threads and parallel internal threads. Dimensions, tolerances and designation

BS END 10095: (1999) Heat resisting steels and nickel alloys

BS END 10296-1 (2003): Welded circular steel tubes for mechanical and general engineering purposes. Technical delivery conditions. Non-alloy and alloy steel tubes

BS END 485-1 (2008+A1:2009): Aluminium and aluminium alloys. Sheet, strip and plate. Technical conditions for inspection and delivery

BS END 515 (1993): Aluminium and aluminium alloys. Wrought products. Temper designations

BS END 573-3 (2003): Aluminium and aluminium alloys. Chemical composition and form of wrought products. Chemical composition

BS END 573-3 (2009): Aluminium and aluminium alloys. Chemical composition and form of wrought products. Chemical composition and form of products

BS END 12373-1 (2001): Aluminium and aluminium alloys. Anodizing. Method for specifying decorative and protective anodic oxidation coatings on aluminium

BS 4190 (2001) ISO metric black hexagon bolts, screws and nuts. Specification

BS 4320 (1968): Specification for metal washers for general engineering purposes.

BS 4620 (1970): Specification for rivets for general engineering purposes.

BS 1473 (1972): Specification for wrought aluminium and aluminium alloys for general engineering purposes - rivet, bolt and screw stock.

BS END ISO 3506-1 (2009): Mechanical properties of corrosion resistant stainless steel fasteners. Bolts, screws and studs.

BS END ISO 3506-2 (2009): Mechanical properties of corrosion resistant stainless steel fasteners. Nuts.

BS END ISO 1461 (2009): Hot dipped galvanised coatings on fabricated iron and steel articles. Specifications and test methods.

BS 4211(2005+A1:2008): Specification for permanently fixed ladders.

BS 5395-1 (2010): Stairs. Code of practice for the design,of stairs with straight flight and winders.

BS END 818-1(1996+A1:2008): Short link chain for lifting purposes. Safety. General conditions of acceptance

BS END 1090-2 (2008+A1:2011):Execution of steel structures and aluminium structures. Technical requirements for steel structures

BS END 1027 (2000): Windows and doors. Watertightness. Test method

BS 6131 (1982): Glossary of terms relating to household sewing machines

BS END 10250-4 (2000): Open steel die forgings for general engineering purposes. Stainless steels

BS END ISO 7599 (2010): Anodizing of aluminium and its alloys. General specifications for anodic oxidation coatings on aluminium

BS 4933 (2010): Specification for ISO metric black cup and countersunk head bolts and screws with hexagon nuts

2.1.19 METAL COMPOSITE PANEL CLADDING/COVERING

2.1.19.1 Wall cladding

2.1.19.1.1 General performance

(a) Wall cladding to be constructed to achieve a U value of 0.35 w/m²/K and shall comprise a colour coated outer sheet bonded to polyurethane insulation bonded to a metal inner sheet finished in white. Substrate to be ZA255 Galvalloy hot dip zinc-aluminium alloy coated steel to **BS END 10346:2009** Grade Fe E220G with a Z275 coating. Flashings, trims, drips and closers shall provide a completely watertight construction.

(b) Insulated cladding panels with a nominal 200 micron white plastisol coating internally and all joints sealed with a butyl rubber sealant.

(c) External corners shall be constructed from 0.7mm matching HP200 colour coated pressed metal flashings.

(d) Colour and finish of outer face to be leather grain plastisol to standard **BS 4800: 2011** colours.

2.1.19.2 Materials

2.1.19.2.1 Steel sheet

(a) Galvanized-Steel Sheet: ZA255 Galvalloy hot dip zinc-aluminium alloy coated steel to **BS END 10346: 2009** Grade Fe E220G with a Z275 coating.

(b) Corrugated Metal Wall Panels: Provide corrugated metal wall panel cladding system fabricated primarily from a manufacturers standard galvanized steel sheet.panels formed to sizes, shapes and profiles shown and as required to suit performance criteria but not less than 18 gauge. thick. Design system to be complete with all framing members, fasteners, shims, clips, perimeter extrusions, panel extrusions, stiffeners, anchors, gaskets, and wet sealant components.

The corrugated metal cladding system shall be custom fabricated so that the panels are secure yet accommodate expansion and contraction; and that individual panels may be installed using concealed fasteners. All steel cladding members shall be factory finished in corrugated manufacturers standard baked enamel finish in custom colour to match the aluminum window colour.

2.1.19.2.2 Aluminium sheet

(a) Flat Metal Wall Panels: Provide flat metal wall panel cladding system fabricated primarily from aluminum composite panels formed to sizes, shapes and profiles shown and as required to suit performance criteria but not less than 6 mm thick. Design system to be complete with all aluminum framing members, fasteners, shims, clips, perimeter extrusions, panel extrusions, stiffeners, anchors, gaskets, and wet sealant components. The flat metal cladding system shall be custom fabricated so that the composite panels are secure yet accommodate expansion and contraction; and that individual panels may be installed or removed with a minimum amount of disturbance to adjacent components using concealed fasteners. Design support system to avoid penetrating waterproofing systems indicated. All aluminum members shall be finished to match the aluminum windows.

2.1.19.3 Submittals

2.1.19.3.1 Product data

(a) Submit product data for each type of cold-formed metal framing, accessory, and product specified. Include manufacturer's product specifications, standard details, and general recommendations, as applicable to materials and finishes for each component and for total panel assemblies.

2.1.19.3.2 Shop drawings

(a) Submit shop drawings showing layout, spacings, sizes, thicknesses, and types of cold-formed metal framing, fabrication, fastening and anchorage details. Show reinforcing channels, opening framing, supplemental framing, strapping, bracing, accessories, connection details, and attachments to other units of Work. Plans and elevations shall be submitted at not less than 1:50 scale, details of sections and connections shall be shown at not less than 1:5 scale. Show layouts of panels, thickness and dimensions of parts, details of corner conditions, joints, panel profiles, supports, anchorages, trim, flashings, closures, and special details.

2.1.19.3.3 Mill certificate

(a) Submit mill certificates signed by manufacturers of cold-formed metal framing certifying that their products comply with requirements, including uncoated steel thickness, yield strength, elongation, and galvanized-coating thickness.

2.1.19.3.4 Welding

(a) Submit current welder certificates signed by Contractor certifying that welders (both field and shop) comply with requirements specified under **BS END 1011-1 and BS END 1011-2.**

2.1.19.3.5 Samples

(a) Samples: Provide two sample panels 305 mm long by actual panel width, in each profile, style, colour, and texture indicated. Include clips, caps, fasteners, closures, and other exposed panel accessories.

i. **Panel Mock-Up: Provide a 600 mm by 600 mm square mock-up of the flat metal wall panels with a typical joint in the middle to demonstrate the joint appearance and the concealed anchorage system for the panels to the substrate.**

(b) Submit manufacturer's colour charts and chips approximately 100mm x 100mm, showing full range of colours, textures and patterns available for wall panels with factory applied finishes.

2.1.19.4 Fabrication

2.1.19.4.1 Panels

(a) Fabrication and finish metal wall panels and accessories at the factory to greatest extent possible, by manufacturer's standard procedures and processes and as necessary to fulfil indicated performance requirements. Comply with indicated profiles and with dimensional and structural requirements.

(b) Provide panel profile, including major ribs and intermediate stiffening ribs, if any, for full length of panel. Fabricate metal wall panel side laps with factory-installed captive gaskets or separator strips that provide a tight seal and prevent metal-to-metal contact, in a manner that will seal weather tight and minimize noise from movements within panel assembly.

2.1.19.4.2 Sheet metal accessories

(a) Fabricate flashing and trim to comply with recommendations in SMCNA 1793 that apply to the design, dimensions,metal, and other characteristics of item indicated:

i. Form exposed sheet metal accessories that are without excessive oil canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.
ii. End seams: fabricate non-moving and seams with flat-lock systems. Form seals and seal with epoxy seam sealer. Rivet joints for additional strength.
iii. Sealed joints: form non-expansion but movable joints in metal to accommodate elastometric sealant to comply with SMCNA 1793
iv. Concealed fasteners and expansion provisions where possible.Exposed fasteners are not allowed on faces of accessories exposed to view.
v. Fabricate cleats and attachment devices of size and metal thickness recommended by SMCNA 1793 or by the metal wall panel manufacturer for application, but not less than thickness of metal being secured.

2.1.19.4.3 Fasteners

(a) Exposed fasteners

i. Provide corrosion resistant fasteners for wall panels, made of coated steel, aluminum, [300 - series corrosion resisting stainless steel][305 -series corrosion resisting stainless steel], or nylon capped steel compatible with the sheet panel or flashing and of a type and size recommended by the manufacturer to meet the performance requirements and design loads.

ii. Fasteners for accessories must be the manufacturer's standard. Provide an integral metal washer matching the colour of attached material with compressible sealing EPDM gasket.

(b) Hidden fasteners:

i. Provide corrosion resistant fasteners recommended by the manufacturer to meet the performance requirements and design loads.

(c) Screws:

i. Screws to be corrosion resistant coated steel, aluminum and/or [300 - series][305 - series] stainless steel being the type and size recommended by the manufacturer to meet the performance requirements.

(d) Rivets:

i. Rivets to be closed-end type, corrosion resistant coated steel, aluminum or stainless steel where watertight connections are required.

(e) Attachment clips:

i. Fabricate clips from steel hot-dipped galvanized in accordance with BS END ISO 1461 (1999). Size, shape, thickness and capacity as required meeting the insulation thickness and design load criteria specified.

2.1.19.4.4 Accessories

(a) General

i. All accessories must be compatible with the metal wall panels. Sheet metal flashing, trim, metal closure strips, caps and similar metal accessories must not be less than the minimum thickness specified for the wall panels.

ii. Exposed metal accessories/finishes to match the panels furnished, except as otherwise indicated. Molded foam rib, ridge and other closure strips must be non-absorbent closed-cell or solid-cell synthetic rubber or pre-molded neoprene to match configuration of the panels.

(b) Rubber Closure Strips

i. Provide closed-cell, expanded cellular rubber conforming to ASTM D 1056 and ASTM D 1667; extruded or molded to the configuration of the specified wall panel and in lengths supplied by the wall panel manufacturer.

(c) Metal Closure Strips

i. Provide factory fabricated [aluminum][steel] closure strips to be the same[gauge][thickness], colour, finish and profile of the specified wall panel.

(d) Joint Sealants

i. Sealants and Caulking
Provide approved gun type sealants for use in hand- or air-pressure calking guns at temperatures above 4 degrees C (or frost-free application at temperatures above minus 12 degrees C) with minimum solid content of 85 percent of the total volume. Sealants must dry with a tough, durable surface skin which permit remaining soft and pliable underneath, providing a weather-tight joint. No migratory staining is permitted on painted or unpainted metal, stone, glass, vinyl, or wood.
Prime all joints receiving sealants with a compatible one-component or two-component primer as recommended by the wall panel manufacturer.

ii. Shop-Applied
Sealant for shop-applied caulking must be an approved gun grade, non-sag one component polysulfide or silicone conforming to ASTM C 920, Type II, and with a curing time to ensure the sealant's plasticity at the time of field erection.

iii. Field-Applied
Sealant for field-applied caulking must be an approved gun grade, non-sag one component polysulfide or two-component polyurethane with an initial maximum Shore A durometer hardness of 25, and conforming to ASTM C 920,Type II. Colour to match panel colours.

iv. Pressure Sensitive Tape
Provide pressure sensitive tape sealant, 100% solid with a release paper backing; permanently elastic, non-sagging, non-toxic and non-staining as approved by the wall panel manufacturer.

2.1.19.4.5 Sheet metal flashing and trim

(a) Fabrication

i. Shop fabricate sheet metal flashing and trim where practicable to comply with recommendations in SMACNA 1793 that apply to design, dimensions, metal, and other characteristics of item indicated. Obtain field measurements for accurate fit before shop fabrication.

ii. Fabricate sheet metal flashing and trim without excessive oil canning, buckling, and tool marks and true to line and levels indicated, with exposed edges folded back to form hems.

2.1.19.5 Execution

2.1.19.5.1 Examination

(a) Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, metal wall panel supports, and other conditions affecting performance of the Work. Examine primary and secondary wall framing to verify that rafters, purlins, angles, channels, and other structural panel support members and anchorages have been installed within alignment tolerances required by metal wall panel manufacturer and as required for the geographical area where construction will take place.

(b) Examine solid wall sheathing to verify that sheathing joints are supported by framing or blocking and that installation is within flatness tolerances required by metal wall panel manufacturer.

(c) Examine roughing-in for components and systems penetrating metal wall panels to verify actual locations of penetrations relative to seam locations of metal wall panels before metal wall panel installation.

(d) Submit to the Engineer a written report, endorsed by Installer, listing conditions detrimental to performance of the Work. Proceed with installation only after unsatisfactory conditions have been corrected.

2.1.19.5.2 Preparation

(a) Clean substrates of substances harmful to insulation, including removing projections capable of interfering with insulation attachment.

(b) Miscellaneous framing installation, including sub-purlins, girts, angles, furring, and other miscellaneous wall panel support members and anchorage must be according to metal wall panel manufacturer's written instructions.

2.1.19.5.3 Wall panel installation

(a) Provide full length metal wall panels, from sill to eave as indicated, unless otherwise indicated or restricted by shipping limitations. Anchor metal wall panels and other components of the Work securely in place, with provisions for thermal and structural movement.

(b) Erect wall panel system in accordance with the approved erection drawings, the printed instructions and safety precautions of the manufacturer.

(c) Sheets are not to be subjected to overloading, abuse, or undue impact. Bent, chipped, or defective sheets shall not be applied.

(d) Sheets must be erected true and plumb and in exact alignment with the horizontal and vertical edges of the building, securely anchored, and with the indicated eave, and sill.

(e) Work is to allow for thermal movement of the wall panel, movement of the building structure, and to provide permanent freedom from noise due to wind pressure.

(f) Field cutting metal wall panels by torch is not permitted.

(g) Use stainless-steel fasteners for exterior surfaces and galvanized steel fasteners for interior surfaces.

(h) Use aluminum or stainless-steel fasteners for exterior surfaces and aluminum or galvanized steel fasteners for interior surfaces.

(i) Anchor metal wall panels and other components of the Work securely in place, using manufacturer's approved fasteners according to manufacturers' written instructions.

(j) Where dissimilar metals will contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with bituminous coating, by applying rubberized-asphalt underlayment to each contact surface, or by other permanent separation as recommended by metal wall panel manufacturer.

(k) Install gaskets, joint fillers, and sealants where indicated and where required for weatherproof performance of metal wall panel assemblies. Provide types of gaskets, fillers, and sealants indicated or, if not indicated, types recommended by metal wall panel manufacturer.

2.1.19.5.4 Fastener installation

(a) Anchor metal wall panels and other components of the Work securely in place, using manufacturer's approved fasteners according to manufacturers' written instructions.

2.1.19.5.5 Flashing, trim and closure installation

(a) Comply with performance requirements, manufacturer's written installation instructions, and SMACNA 1793. Provide concealed fasteners where possible, and set units true to line and level as indicated.

(b) Install work with laps, joints, and seams to form permanently watertight and weather resistant.

(c) Install sheet metal work is to form weather-tight construction without waves, warps, buckles, fastening stresses or distortion, and allow for expansion and contraction. Cutting, fitting, drilling, and other operations in connection with sheet metal required to accommodate the work of other trades is to be performed by sheet metal mechanics.

(d) Install exposed metal flashing at building corners, sills and eaves, junctions between metal siding and walling. Exposed metal flashing must be the same material, colour, and finish as the specified metal wall panel.

(e) Exposed flashing and flashing subject to rain penetration to be bedded in the specified joint sealant.

(f) Isolate flashing which is in contact with dissimilar metals by means of the specified asphalt mastic material to prevent electrolytic deterioration. Form drips to the profile indicated, with the edge folded back 12mm to form a reinforced drip edge.

(g) Install metal closure strips at open ends of corrugated or ribbed pattern walls, and at intersection of wall and wall unless open ends are concealed with formed eave flashing; and in other required areas.

(h) Install mastic closure strips at intersection of the wall with metal walling; top and bottom of metal siding; heads of wall openings; and in other required locations.

2.1.19.6 Workmanship

(a) Make lines, arises, and angles sharp and true. Free exposed surfaces from visible wave, warp, buckle, and tool marks. Fold back exposed edges neatly to form a 1/2 inch hem on the concealed side. Make sheet metal exposed to the weather watertight with provisions for expansion and contraction.

(b) Make surfaces to receive sheet metal plumb and true, clean, even, smooth, dry, and free of defects and projections which might affect the application. For installation of items not shown in detail or not covered by specifications conform to the applicable requirements of SMACNA 1793.

(c) Provide sheet metal flashing in the angles formed where roof decks abut walls, curbs, ventilators, pipes, or other vertical surfaces and wherever indicated and necessary to make the work watertight.

2.1.19.7 Acceptance provisions

2.1.19.7.1 Erection Tolerances

(a) Erect metal wall panels straight and true with plumb vertical lines correctly lapped and secured in accordance with the manufacturer's written instructions.

2.1.19.7.2 Leakage Tests

(a) Finished application of metal wall panels are to be subject to inspection and test for leakage by request of the Engineer. Conduct inspection and tests at no cost to the Employer.

(b) Inspection and testing is to be made promptly after erection to permit correction of defects and the removal and replacement of defective materials.

2.1.19.7.3 Repais to finish

(a) Scratches, abrasions, and minor surface defects of finish may be repaired with the specified repair materials. Finished repaired surfaces must be uniform and free from variations of colour and surface texture.

(b) Repaired metal surfaces that are not acceptable to the project requirements and/or Enginer are to be immediately removed and replaced with new material.

2.1.19.7.4 Paint-Finish Metal Siding

(a) Paint-finish metal siding will be tested for colour stability by the Engineer during the manufacturer's specified guarantee period.

(b) Panels that indicate colour changes, fading, or surface degradation, determined by visual examination, must be removed and replaced with new panels at no expense to the Employer.

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(c) New panels will be subject to the specified tests for an additional year from the date of their installation.

2.1.19.8 Field quality control

2.1.19.8.1 Construction Monitoring

(a) Make visual inspections as necessary to ensure compliance with specified requirements. Additionally, verify the following:

i. Materials comply with the specified requirements.

ii. All materials are properly stored, handled and protected from damage. Damaged materials are removed from the site.

iii. Framing and substrates are in acceptable condition, in compliance with specification, prior to application of wall panels.
iv. Panels are installed without buckles, ripples, or waves and in uniform alignment and modulus.

v. Side laps are formed, sealed, fastened or seam locked as required.

vi. The proper number, type, and spacing of attachment clips and fasteners are installed.

vii. Installer adheres to specified and detailed application parameters.

viii. Associated flashing and sheet metal are installed in a timely manner in accord with the specified requirements.

(b) Provide five (5) bound copies of Manufacturer's Field Reports to the Engineer two (2) weeks prior to project close-out.

2.1.19.9 Cleanup and disposal

(a) Clean all exposed sheet metal work at completion of installation. Remove metal shavings, filings, nails, bolts, and wires from work area. Remove grease and oil films, excess sealants, handling marks, contamination from steel wool, fittings and drilling debris and scrub the work clean. Exposed metal surfaces must be free of dents, creases, waves, scratch marks, solder or weld marks, and damage to the finish coating.

(b) Collect and place scrap/waste materials in containers. Promptly dispose of demolished materials. Do not allow demolished materials to accumulate on-site; transport demolished materials from government property and legally dispose of them.

2.1.19.10 Roof cladding

Roof cladding system shall be Rigidal Ziplok advanced 'zipup' standing seam system that creates a continuous weathertight roof.

The side laps shall be zipped up in conjunction with a unique halter system that is fixed directly
to the supporting structure without penetrating the external weather sheet.

2.1.19.11 References and Standards

BS END 1011-4 (2000): Welding. Recommendations for welding of metallic materials. Arc welding of aluminium and aluminium alloys.

BS END ISO 1461(2009): Hot dip galvanized coatings on fabricated iron and steel articles. Specifications and test methods

ASTM D1056 (2007): Standard Specification for Flexible Cellular Materials -;Sponge or Expanded Rubber

ASTM D1667 (2011): Standard Specification for Flexible Cellular Materials-Vinyl Chloride Polymers and Copolymers (Closed-Cell Foam)

ASTM C920 (2011): Standard Specification for Elastomeric Joint Sealants.

SMACNA (Sheet Metal And Air Conditioning Contractors' National Association) 1793 - Architectural Sheet Metal Manual, 6th Edition

BS END 10346 (2009): Continuously hot-dip coated steel flat products. Technical delivery conditions

BS END 1011-1 (2009): Welding. Recommendations for welding of metallic materials. General guidance for arc welding

BS END 1011-2 (2001): Welding. Recommendations for welding of metallic materials. Arc welding of ferritic steels

BS 4800 (2011): Schedule of paint colours for building purposes

2.1.20 STRUCTURAL STEEL WORKS

2.1.20.1 Generally

2.1.20.1.1 Generally

(a) The use of structural steelwork shall be to **BS 5950.**

2.1.20.2 Materials

2.1.20.2.1 Transportation and storage

(a) Bundle, pack, handle and transport steelwork in a manner that shall prevent damage to the steelwork and any protective coating.

(b) Take precautions to minimize exposure of steelwork to atmospheric or chemical pollution before and after fabrication.

(c) Store steelwork awaiting erection clear of the ground and keep different members separate. Lay or stack to avoid accumulation of water or dirt on or against any of the surfaces. Provide suitable packings between layers of stacked steelwork. Ventilate covered steelwork sufficiently to preclude condensation.

(d) Store and stack steel members in such a manner that markings are clearly visible.

2.1.20.2.2 Mechanical properties and chemical composition

Structural steelwork shall comprise weldable structural steel to **BS END 10029 (2010)**: grade 43A, grade 43C or 43D(for hollow section only) or grade 50 B.

(a) The use of weldable cold - formed structural hollow sections shall comply with **BS 5950:Part 5**, **BS 5950:Part 7** and **BS END 10219-2:2006**.

2.1.20.2.3 Hot-rolled sections

(a) Dimensions, mass, tolerances and rolling margins shall be :

i. Universal beams, columns, joists, tees and channels to **BS 4: Part. 1**.

ii. Hollow sections to **BS END 10210-2**.

iii. Angles to **BS END 10056-1**

(b) Tolerances and rolling margins for plates, flat bars, wide flats, universal wide flats, round and square bars shall be to **BS 7668**.

2.1.20.2.4 Cold-rolled sections

(a) Dimensions, mass and tolerances of cold rolled sections shall be to **BS END 10162**. Do not use cold rolled sections without approval.

2.1.20.2.5 Rivets

(a) Rivets shall be mild steel rivets for general engineering purposes to **BS 4620**

2.1.20.2.6 Black bolts, screws, nuts and washers

(a) Black hexagon bolts, screws and nuts shall be to **BS END 13602**. Bolts and screws to be strength grade 4.6 and nuts shall be strength grade 4 unless otherwise specified.

(b) Washers for black hexagon bolts, screws and nutsshall shall be single coil square or rectangular section steel spring washers to **BS 4464**, unless otherwise specified. Provide tapered washers to give the bolt heads and nuts a satisfactory bearing where so required.

(c) Length of bolts shall be such that the threaded portion of each bolt projects through the nut by at least one thread after tightening

2.1.20.2.7 Precision hexagonal bolts, screws, nuts and washers

(a) Precision hexagonal bolts, screws and nuts shall be to **BS 3692**. These bolts and screws shall be of strength grade 8.8 and nuts to be of strength grade 8 unless otherwise specified.

(b) Washers and length of bolts shall be as specified in Clause 2.1.20.2.6

2.1.20.2.8 High strength friction grip bolts nuts and washers

(a) High strength friction grip bolts and associated nuts and washersshall be of general grade to **BS 4395** :**Part. 1** unless otherwise specified.

2.1.20.2.9 Turnbuckles and other elements

(a) Obtain approval for specially made elements and components such as turnbuckles

2.1.20.2.10 Non-availability of specified materials

(a) Obtain approval for any variation required when the specified material is not available and bear any additional cost arising therefrom.

2.1.20.2.11 Manufacturer's certificates

(a) Provide the manufacturer's certificates for all steel sections, rivets, bolts, screws, nuts and washers delivered to Site

2.1.20.2.12 Markings

(a) Clearly mark all steelwork in an approved manner.

(b) Bolts, screws, nuts and washers to have either embossed or indented markings identifying the relevant BS.

2.1.20.3 Testing of materials

2.1.20.3.1 Generally

(a) Allow sufficient time for the testing of specimens. Do not incorporate materials until relevant tests have been carried out and approval obtained.

2.1.20.3.2 Testing of sections

(a) Provide one test specimen for every 40 tonnes or part thereof of each section of same thickness from the same cast. For the purpose of this clause "same thickness" means similar sections with a variation in thickness not exceeding + 5 mm. Test specimens shall be taken from sections selected at random on Site by the Engineer.

(b) Prepare the test specimens shall be to **BS END ISO 6892-1:2009** as directed and appropriately mark and deliver them to a laboratory, as directed by the Engineer.

(c) Manufacturer's certificates may be accepted as proof of quality in lieu of sampling on site when all steel sections are prefabricated prior to shipment.

2.1.20.3.3 Security - sampling

(a) Cut test sections under the direction and supervision of the Engineer who shall put his signature on the specimen in indelible ink.

2.1.20.3.4 Security – before delivery for grinding preparation

(a) Keep the specimen with Engineer's signature securely under lock and key in a sample room or in the Engineer's office before delivery to workshop for preparation to the required shape where necessary

2.1.20.3.5 Security – before delivery to laboratory

(a) Take test specimen returned from workshop to the Engineer for verification of signature. Keep section securely under lock and key in a sample room or in the Engineer's office before delivery to the laboratory

2.1.20.3.6 Security – delivery

(a) Deliver samples to the testing laboratory under the escort of the Engineer.

2.1.20.3.7 Security – stock management

(a) Submit for approval by the Engineer at the commencement of the Contract a stock management system to preclude unauthorized use of structural steel sections prior to receipt of test results as well as swapping of sections of different testing s tatus. The followings shall be included:

i. Provide identification marks to different specimens arriving on Site which are uniquely traceable to the record of each batch.

ii. The record of a batch of steel sections shall include date of arrival to Site, quantities delivered of different sections, delivery note, mill certificate and the supplier's certificate.

iii. Establish and maintain a record system, such as colour coding or other approved systems, for identifying and showing clearly specimens that are under different testing status (awaiting test results, approved for use, non-compliant, re-test, omitted for testing etc.).

iv. Keep separately specimens of different testing status at different locations.

2.1.20.3.8 Security – removal of non-compliant steel sections

(a) Remove non-compliant steel sections from Site as soon as possible under the supervision of the Engineer.

2.1.20.3.9 Testing of bolts, nuts and washers

(a) Provide test specimens and carry out testing of bolts and associated nuts and washers in accordance with the relevant BS in an approved testing laboratory when so directed by the Engineer. Rate of sampling shall be as Table 2.1.19.1 unless otherwise specified. Submit test results as soon as they are available.

Table 2.1.19.1

Sampling of bolts

Diameter of bolts	Rate of sample
not exceeding 16 mm	1 in 15000 or part thereof
not exceeding 16 mm but not exceeding 24 mm	1 in 5000 or part thereof
exceeding 24 mm	1 in 2500 or part thereof

2.1.20.3.10 Failure of tests

(a) If any test specimens do not comply with the relevant BS, the Engineer may require further tests. Remove unsatisfactory material off Site when instructed by the Engineer.

2.1.20.4 Workmanship

2.1.20.4.1 Erection

(a) Prepare and submit details of the proposed method of erection for approval. Details submitted shall include type of plant and equipment to be used and, if necessary, drawings and calculations of any temporary work. Approval shall not in any way relieve the Contractor of his responsibility for safe erection of permanent work, or the safe erection and subsequent dismantling of Temporary Works.

(b) Design, construct and dismantle falsework to **BS 5531** when specified.

(c) Do not erect fabricated steelwork until all welded joints and specified protective coatings have been inspected, tested where required, and approved.

(d) Align structural members accurately to the specified tolerances and obtain approval before any permanent welding or tightening of bolts is carried out.

(e) Do not bed stanchion bases or grout anchor bolts until the steelwork has been plumbed, levelled, aligned and approved, and until the method of erection has been approved.

(f) Do not load any part of the structure without prior approval.

2.1.20.4.2 Cutting, sawing and drilling

(a) Cut members to size. Flame cutting shall be by machine. Finish cut edges as follows :

i. Remove burrs, sharp arrises and slag from edges of all cut members.

ii. Dress machine sheared or cropped edges to a neat finish, free from distortion.

(b) Grind stiffeners, plates and the like to fit the profile of the parent member with diagonal cuts to clear the root radius.

(c) Machine stanchion splices and butt joints of compression members true and square.

(d) Form holes for rivets or bolts by drilling, except holes in plate less than 15 mm thick where they may be formed by punching. Punch holes to a size 2 mm less than the required diameter and finish the holes by reaming.

(e) Finished holes shall be 2 mm larger than the nominal size of rivets and bolts up to 24 mm diameter and 3 mm larger where these are over 24 mm diameter. Holes for precision bolts shall be similarly formed except specified as close tolerance holes. Close tolerance holes shall be formed by drilling and to a size of bolt diameter + 0.15 mm - 0 mm.

2.1.20.4.3 High friction grip bolts

(a) Clean the interface of members shall be jointed with high strength friction grip bolts to the specified surface preparation and leave unpainted.

(b) Use high strength friction grip bolts in accordance with **BS END 1993-1-8:2005**
Tighten the bolts and nuts by one of the following methods

i. The torque-control method using a calibrated power-operated or a hand-operated torque wrench to the following proof loads :

TABLE 2.1.19.2

Proof loads

Nominal size and thread diameter	Proof load (minimum shank tension) KN
M12	49.4
M16	92.1
M20	144
M22	177
M24	207
M27	234
M30	286
M36	418

Calibrate the wrench regularly as follows:

- At the commencement of each new working day or shift.
- With each change of bolts diameter.
- With each change of bolts grip length in excess of $^1/_5$th of the length used in the calibration of the wrench in accordance with **BS END 1993-1-8:2005**.

Reapply the wrench to bolts previously tightened in a multi-bolt connection to ensure all bolts have the correct torque.

ii. The direct tension indicator method using approved proprietary load indicators, in the form of specially hardened washers with protrusion on one face, strictly in accordance with the manufacturer's instructions.

Adopt wrenches of adequate capacity. Maintain the wrenches in a proper working condition in accordance with the manufacturer's recommendations

2.1.20.4.4 Joints

(a) Prepare and prime the contact surfaces at riveted, bolted and screwed joints. If the contact surfaces are specified to be coated or otherwise treated, e.g.machined surface finish, the joint shall be approved before assembly.

2.1.20.4.5 Welding

(a) Welding shall be a metal arc process in accordance with **BS END 1011-1** and **BS END 1011-2** together with other clauses contained in the GS, unless otherwise specified.

(b) Welding consumables used shall be chosen to ensure that the mechanical properties of the weld metal are not less than those required for the parent metal.

(c) Execute welding in a flat or horizontal position wherever possible. Do not weld overhead without approval.

2.1.20.4.6 Welders and testing of welders

(a) Provide an experienced and competent operator to supervise welding.

(b) Welders shall be tested to meet the requirements of **BS END 287**:**Part 1** but, in the case of welders engaged on fillet welding only, **BS 4872**:Part 1 is an acceptable alternative.

(c) Test on welders shall be witnessed by a qualified welding inspector and certificates endorsed by an independent inspection authority. The certification shall remain valid providing it complies with the conditions for re-approval of certification specified in **BS END 287**:Part 1 or **BS 4872**:Part 1
where appropriate.

2.1.20.4.7 Welding record

(a) Keep a record on Site when specified to identify welders responsible for major welds.

2.1.20.4.8 Welding procedures

(a) Submit welding procedures which shall be prepared and certified by a qualified welding inspector. Obtain approval of the proposed welding procedures prior to commencing welding including:

i. Welding process or processes when more than one is used in making a complete joint,

ii. Parent metal specification, thickness and other relevant dimensions,

iii. Classification, type and size of electrodes and other consumables,

iv. Welding current, arc voltage and welding speed,

v. Sketch showing edge preparation, fit-up and approximate number and arrangement of runs in multi-run welds,

vi. Whether shop or site welding,

vii. Welding positions,

viii. Welding sequence,

ix. Minimum preheating temperature and interpass temperature range,

x. Post-weld heat treatment if required.

(b) Do not depart from the agreed welding procedure without prior agreement of the Engineer.

2.1.20.4.9 Approval testing of welding

(a) Carry out approval testing of welding procedures to **BS END 15614** when specified, strictly in accordance with the proposed welding procedure using representative samples of the materials.

(b) Strictly follow the procedures of welding established in the successful approval test for the works. Carry out further approval tests if either the material or procedure changes.

2.1.20.4.10 Electrodes

(a) Covered electrodes shall be to **BS END 2560**. If electrodes used in conjunction with fluxes are employed, they shall give a weld deposit having mechanical properties at least equal to the minimum specified for the parent metal. Use electrodes and fluxes strictly in accordance with the manufacturer's recommendations

2.1.20.4.11 Preparation for welding

(a) Prepare fusion surfaces to **BS END 1011-1** and **BS END 1011-2**. Surfaces must be dry. Warm the surfaces if required to remove condensation.

2.1.20.4.12 Slag, tack welds, fillet and butt welds

(b) Remove welding slag by chipping before depositing subsequent runs.

(a) Tack welding may only be used with express approval. Tack welds shall be minimum 50 mm long.

(b) Butt welds shall be full penetration welds between prepared fusion faces, unless otherwise specified. Carry out back chipping, grinding or gouging of the deposited weld as required to obviate imperfections in the root run.

(c) Grind butt welds flush without loss of parent metal.

(d) Deposit fillet welds to the required length, throat thickness and with partial or full penetration as specified.

2.1.20.4.13 Temporary attachments

(a) Do not weld temporary attachments to principle joints. Obtain approval of the position of welds for temporary attachments.

2.1.20.4.14 Stud shear connectors

(a) Weld stud shear connectors by automatic stud welding gun strictly in accordance with the manufacturer's recommendations unless specified otherwise

2.1.20.4.15 Acceptance of welds

(a) Employ an approved independent testing firm to carry out and interpret the inspection and testing of welds, and provide any necessary labour and attendance.

(b) Submit evidence proving that operators carrying out the inspection and testing have been trained and assessed for competence in the inspection and testing of welds. In addition, submit certificates of competence from a recognised authority for operators carrying out ultrasonic examination

(c) Arrange for the independent testing firm to submit a testing programme for the approval of the Engineer. Any welds that shall be rendered inaccessible by subsequent work shall be exa mined prior to the loss of access.

(d) All welds shall be visually inspected in accordance with **BS END ISO 17637:2011** Non-destructive testing shall be carried out after visual inspection in accordance with the table below

Weld Type	**Frequency of Non-destructive Testing**
All types of butt welds	100% ultrasonic examination and magnetic

	particle flaw detection
Fillet welds with leg length exceeding and including 10 mm	20% ultrasonic examination and magnetic particle flaw detection
Fillet welds with leg length not exceeding 10 mm	20% magnetic particle flaw detection
Secondary attachment welds, e.g. for fixing purlins, side rails	5% of attachments by magnetic particle flaw detection and ultrasonic examination if leg length exceeds and includes 10 mm

(e) The standard of acceptance for butt welds shall be in accordance with **BS END 1011-1** and **BS END 1011-2**. The standard of acceptance for fillet welds and secondary attachment welds shall be in accordance with Table 2 in the Appendix of the Practice Note for Authorized Persons and Registered Structural Engineers **PNAP 160**.

(f) Ultrasonic examination shall be carried out in accordance with **BS END ISO 12402-5:2006+A1:2010** Level 2B. Print out results shall be made available during ultrasonic examination on site at 3 specified locations per weld (such as at both ends and in the middle of the weld) and at positions in question. Magnetic particle flaw detection shall be carried out in accordance with **BS END ISO 9934-1:2001**

(g) Examination shall be carried out not less than 16 hours from the time of completion of the weld to be inspected, or not less than 40 hours in the case of butt welds thicker than 40 mm or any welds to Grade 55 steels (except for piling/foundation contracts, where only 2 weld joints are needed to be examined after 40 hours for each contract).

(h) Should test results indicate that welds are below the standard of acceptance, carry out at the Contractor's own expense approved remedial measures and further acceptance tests.

2.1.20.4.16 Painting in general

(a) Painting shall be as Clause 2.1.17.11 in general.

2.1.20.4.17 Preparation and painting of new surfaces

(a) Prepare new surface to receive protective coatings in accordance with one of the followings :-

i. Manually clean metal surface thoroughly to remove all dirt, weld spatter, grease and the like. Chip, scrape and wire-brush to remove mill scale and rust. The surface so prepared shall not be inferior to Swedish Standard SIS 055900 St2. Painting shall be as Table 15.3, Type A.

ii. Degrease metal surface, mechanically re move all millscale, rust and weld spatter with powerdriven tools such as carborundum grinding discs, chipping hammers and needle guns. Cleanoff all loosened particles by wire brushing or vacuum cleaning. The surface so prepared shall not be inferior to Swedish Standard SIS 055900 St3. Apply the protective coating within 2 hours to the cleaned surface. Painting shall be as Table 15.3 Type B.

iii. Blast-clean steel so that the prepared surface is not inferior to Swedish Standard SIS 055900 Sa 2.5. Clean the blasted surface by vacuum and do not touch the surface by hand or contaminate it in any other way. Apply the protective coating within 2 hours to the cleaned surface. Submit a sample of blast cleaned steel not less than 150 x 150 x 6 mm adequately protected in sealed clean polythene wrapping for approval before any work is carried out.

This approved sample shall be retained for comparison with the subsequent prepared steelwork.

2.1.20.4.18 Redecoration of existing painted surfaces

(a) For redecoration of existing painted surfaces of structural steelwork, clean the existing paint coat with an approved detergent, remove loose and flaking portions with wire brush and grind rusted areas back to bare metal as instructed by the Engineer, care being taken to avoid producing a smooth surface by excessive grinding.

(b) Where the existing coating is intact after cleaning, apply the proposed paint coating over a trial panel and examine for adherence after the curing period as recommended by the paint manufacturer. Do not use the paint until the trial is passed.

(c) Where bare metal is exposed, apply primer, undercoat and finishing coat as directed by the Engineer.

2.1.20.4.19 Hot dip galvanizing

(a) Prior to galvanizing, the following requirements have to be satisfied :

i. All welding slags and paints on the steel surface shall be removed.

ii. All cut surfaces shall be ground smooth.

iii. Adequate number of vent holes shall be provided for closed end hollow sections, and

iv. Drainage holes shall be provided at joints where free flow of molten zinc would otherwise be impossible, e.g. joints between stiffeners and I sections.

(b) Apply hot dip galvanized coatings to **BS END ISO 1461**. The thickness of zinc coating shall be minimum 85 µm unless otherwise specified.

(c) Small areas of galvanized coating damaged by welding, cutting or by rough treatment during transit or erection shall be made good by the use of at least two coats of zinc rich paint to **BS 4652**. Thoroughly clean all areas affected by welding with abrasives or mechanical driven tools before applying the zinc rich paint.

2.1.20.4.20 Painting to joints

(a) As soon as possible after joints have been completed and approved, the parent and the joint material, exposed parts of bolts, nuts and washers and weld affected areas shall be brought up to the same standard of preparation and painting as the adjoining surfaces.

2.1.20.5 References and Standards

BS 5950: Structural use of steelwork in buildings.

BS END 1993-1-3 (2006): Eurocode 3. Design of steel structures. General rules. Supplementary rules for cold-formed members and sheeting

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BS 5950-7 (1992): Structural use of steelwork in building. Specification for materials and workmanship: cold formed sections.

BS END 101037-1 (1996): Plate and wide flats of made of high yield strength structural steels in the quenched and tempererd or precipitation hardened conditions.

BS 7668 (2004): Weldable structural steels. Hot finished structural hollow sections in weather resistant steels. Specification

BS END 10029 (2010): Hot-rolled steel plates 3 mm thick or above. Tolerances on dimensions and shape

BS 4-1 (2005): Structural steel sections. Specification for hot-rolled sections
.
BS END 10210-2 (2006): Hot finished structural hollow sections of non-alloy and fine grain steels. Tolerances, dimensions and sectional properties.

BS 4395-1 (1969): Specification for high strength friction grip bolts and associated nuts and washers for structural engineering. General grade.

BS END 1993-1-8 (2005):Eurocode 3. Design of steel structures. Design of joints

BS END 287-1 (2011): Qualification test of welders. Fusion welding. Steels.

BS END ISO 15614-1(2004+A2:2012): Specification and qualification of welding procedures for metallic materials. Welding procedure test. Arc and gas welding of steels and arc welding of nickel and nickel alloys

BS END 10162 (2003): Cold rolled steel sections. Technical delivery conditions. Dimensional and cross-sectional tolerances.

BS 4464 (1969): Specification for spring washers for general engineering and automobile purposes. Metric series

BS END 10002-1 (1990): Tensile testing of metallic materials. Method of test at ambient temperatures.

BS 5531(1988): Code of practice for safety in erecting structural frames.

BS END 1011-1(2009): Welding. Recommendations for welding of metallic materials. General guidance for arc welding

BS END 1011-2 (2001): Welding. Recommendations for welding of metallic materials. Arc welding of ferritic steels

BS 4872-1 (1982): Specification for approval testing of welders when welding procedure approval is not required. Fusion welding of steel.

BS END ISO 17637 (2011):Non-destructive testing of welds. Visual testing of fusion-welded joints

BS END ISO 2560 (2009): Welding consumables. Covered electrodes for manual metal arc welding of non-alloy and fine grain steels. Classification

BS END ISO 12402-5 (2006+A1:2010):Personal flotation devices. Buoyancy aids (level 50). Safety requirements

BS END ISO 9934-1 (2001):Non-destructive testing. Magnetic particle testing. General principles
.

BS END 10219-2 (2006):Cold formed welded structural hollow sections of non-alloy and fine grain steels. Tolerances, dimensions and sectional properties

BS END 10056-1 (1999): Specification for structural steel equal and unequal angles. Dimensions

BS 4620 (1970): Specification for rivets for general engineering purposes

BS 3692 (2001): ISO metric precision hexagon bolts, screws and nuts. Specification

BS END ISO 6892-1 (2009): Metallic materials. Tensile testing. Method of test at ambient temperature

BS END ISO 2560 (2009): Welding consumables. Covered electrodes for manual metal arc welding of non-alloy and fine grain steels. Classification

BS END ISO 1461 (2009): Hot dip galvanized coatings on fabricated iron and steel articles. Specifications and test methods

BS END 10025-1 (2004): Hot rolled products of structural steelsGeneral technical delivery conditions

BS END ISO 6892-1 (2009): Metallic materials. Tensile testingMethod of test at ambient temperature

2.1.21 BS END 10025-6 (2004+A1:2009): Hot rolled products of structural steelsTechnical delivery conditions for flat products of high yield strength structural steels in the quenched and tempered conditionSPECIALITIES

2.1.21.1 Signage and Graphics

2.1.21.1.1 Materials

1. Material: melamine laminate, non-glare surface, two-colour.
2. Size of Plate: 37mm high x length required for text; 3mm thick.
3. Colours: White letters and numerals on black background.
4. Letters: Helvetica Medium, 14mm high with standard stroke width.

2.1.21.1.2 Workmanship

1. Install all signage, and other Work of this Section level and plumb; secure to substrate in manner as recommended by the Manufacturer for the specific surface where required.
2. Clean all surfaces of Work of this Section.
3. Remove all debris resulting from the Work of this Section from Work area.

2.1.21.1.3 Sign locations

1. Locate interior signs at the locations shown on a schedule to be -furnished by the Contractor for approval of the Engineer.

2. Provide either room name plate or number plate for all rooms in this project. Use the room names and/or numbers shown on the Drawings unless otherwise approved by the Engineer.

2.1.21.1.4 Handicapped signs

1. Fabricate signs to comply with the requirements of **ANSI A 177.1.**

2. Provide handicapped signs of type and with approved text at locations as scheduled or the Drawings interior and exterior.

3. Provide signs at parking areas exterior to the structure.

2.1.21.1.5 Schedule of signage types

The Contractor shall submit a schedule indicating sign type, material, location, text, text letter style, colour, and other pertinent information.

The Contractor is to submit complete details for each of the following sign types.

i. Area Use Sign
ii. Floor Designation with Names and/or numbers
iii. Passenger Information Signs and Graphics
iv. Public Information Signs and Graphics
v. Room Name Plates and Number Plates
vi. Handicapped Use Only
vii. Signs and/or graphics required for building code compliance
viii. Do Not Enter
ix. Restricted Area
x. No Smoking
xi. Up/Down
xii. No Parking

The Contractor is to submit a sample of each type, indicating colours, letter style, size, and other pertinent information.

2.1.21.1.6 Schedule of signage

Contractor shall submit a detailed schedule of all signage required for each space, door, public and passenger area, interior and/or exterior in full compliance with code requirements.

Signage schedule shall include the following information:

a. Sign construction showing materials, size and colours
b. Quantity of each type and/or size
c. Location
d. Unit message
e. Method of attachment

2.1.21.2 Entrance mats and grids

2.1.21.2.1 Materials

(a) Aluminum - **ASTM B 221**, alloys 6063-T5, 6063-T6 for extrusions.

(b) Architectural Bronze **- ASTM B 455**, copper/zinc alloy C38500 for extrusions.

(c) Vinyl/Acrylic - High-impact PVC alloy.

(d) Flexible and prime PVC extrusions.

(e) Tread insert options - refer to Section 2.1.21.2.4.

2.1.21.2.2 Floor mats

(a) Exposed hinge rail connectors shall be extruded 6063-T6 aluminum. (Optional C380 architectural bronze available) complete with perforations for drainage.

(b) Tread rails shall be manufactured from high-impact vinyl/acrylic, complete with coextruded soft-durometer cushions. Supplied in mill (standard) or one of the colours as offered by manufacturer. (Call factory for custom colours.) Choose from anodized of heavyduty powder coat finish.

2.1.21.2.3 Mat frames

(a) SM - Tapered Vinyl Frame shall be 1 1/2"(38.1mm) wide, with tapered lead-in edge for surface mounted applications. Frame colour shall be one of the colours as offered by manufacturer.

(b) AL - Aluminum Block-out Frame shall be a 3/4"(19.1mm) deep recessed frame in 6063-T5 aluminum alloy (optional architectural bronze) with 1/4"(6.4mm) wide exposed surface. Black or brown vinyl fillers shall be furnished as required when standard 2" (50.8mm) tread spacing cannot be maintained. Frame colour shall be supplied in mill (standard) or one of the
optional colours as offered by manufacturer. (Custom colours are available.) Choose from anodized or heavy-duty powder coat finish. Note: Mill finish frames in contact with concrete
to be primer coated. Installer shall use recommended latex screed to ensure level base.

(c) TNG - Tapered Angle Frame (note: the tapered angle frame is for use when additional screed for level base is not necessary.) shall be a 1/2"(12.7mm) deep recessed frame in 6063-T5 aluminum alloy. Frame colour shall be supplied in standard mill or one of the
optional colours as offered by manufacturer. (Custom colours are available.) Choose from anodized or heavy-duty powder coat finish. Note: Mill finish frames in contact with concrete

(d) ANG - Aluminum Angle Frame shall be a 1/2"(12.7mm) deep recessed frame in 6063-T5 aluminum alloy (optional architectural bronze) with 1/8" (3.2mm) wide exposed surface. Black or brown vinyl fillers shall be furnished as required when standard 2" (50.8mm) tread
spacing cannot be maintained. Frame colour shall be supplied in mill (standard) or one of the
optional colours as offered by manufacturer. (Custom colours are available.) Choose from anodized or heavy-duty powder coat finish. Note: Mill finish frames in contact with concrete
to be primer coated. Installer shall use recommended latex screed to ensure level base.

(e) THFR -Threshold Frame shall be supplied in 6063-T6 aluminum alloy. For surface/recess installations to provide a flush transition from the entryway door threshold to the mat surface.
The frame does require a leveling screed.

(f) TA - Tapered Aluminum Frame shall be a 1 1/2"(38.1mm) wide 6063-T5 aluminum alloy and permanently positions mat for surface mounted applications. Frame colour shall be supplied in mill (standard) or one of the optional colours as offered by manufacturer. (Custom
colours are available.) Choose from anodized or heavy-duty powder coat finish. Note: Mill finish frames in contact with concrete to be primer coated.

2.1.21.2.4 Tread insert options

(a) Carpet shall meet the Carpet and Rug Institute's standard for indoor
air quality. Fibers shall include a minimum of 100, 12 mil monofilament fibers per square inch
and colourfast, solution-dyed nylon. Each carpet fiber and monofilament shall be fusion-bonded to a rigid two-ply backing to prevent fraying and supplied in continuous splice-free lengths. Anti-static carpet fiber shall contain antimicrobial additive and be treated with Scotchgard® to reduce soiling.
Carpet weight shall be 33-oz./yd^2.

(b) Exterior Carpet shall be solution dyed polypropylene fibers with 50/50 blend of
600/12-denier multi filament and 595/D1 monofilament, available in one of 4 standard colours
as offered by manufacturer. The texturized fibers have ultraviolet blockers and colour as an
integral part of the filament. Each carpet fiber and monofilament shall be fusion-bonded to a
rigid two-ply backing to prevent fraying and supplied in continuous splice-free lengths.
(Waterproof fibers do not get soggy, rot, fade or stain.) Carpet weight shall be 32-oz./yd^2.

(c) Vinyl shall include a flexible dual durometer vinyl insert in any one of six standard colours as selected.

(d) Logo Option. Each entrance mat specifically detailed shall include a logo or trademark.

2.1.21.2.5 Execution

(a) Verification of conditions: Examine areas and conditions under which work is to be performed
and identify conditions detrimental to proper or timely completion. Do not proceed until unsatisfactory conditions have been corrected.

(b) Preparation: Manufacturer shall offer assistance and guidance to provide a template of irregular shaped mat assemblies to ensure a proper installation.

(c) Installation: Install the work of this section in strict accordance with the manufacturer's recommendations. Set mat at height recommended by manufacturer for most effective cleaning action. Coordinate top of mat surface with bottom of doors that swing across to provide ample clearance between door and mat.

(d) Cleaning:It is important to the life cycle of the entrance mat that a maintenance schedule be developed which includes regular vacuuming and extraction that correctly matches the amount of traffic the mat incurs.

(e) Protection: After completing required frame installation and concrete work, provide temporary filler of plywood or fiberboard in recess, and cover frames with plywood protective flooring. Maintain protection until construction traffic has ended and project is near time of substantial completion.
Defer installation of floor mats until time of substantial completion of project.

2.1.21.2.6 Submittals

(a) Product data for each type of floor mat and frame specified including manufacturer's specifications and installation instructions.

(b) Shop drawings in sufficient detail showing layout of mat and frame specified including details
indicating construction relative to materials, direction of traffic, spline locations, profiles, anchors and accessories.

(c) Samples for verification purposes: Submit an assembled section of floor mat and frame members with selected tread insert showing each type of colour for exposed floor mat, frame
and accessories required.

(d) Maintenance data in the form of manufacturer's printed instructions for cleaning and maintaining floor mats.

2.1.21.2.7 Quality assurance

(a) Flammability in accordance with **ASTM E648**, Class 1, Critical Radiant Flux, minimum 0.45 watts/m^2.

(b) Slip resistance in accordance with **ASTM D-2047-96**, Coefficient of Friction, minimum 0.60 for accessible routes. Approved systems must meet a minimum coefficient of friction of 0.60, when tested in wet conditions.

(c) Standard rolling load performance is 300 lb./wheel with larger loading requirements as specified (load applied to a solid 5" x 2" wide polyurethane wheel, 1000 passes without damage

(d) Single Source Responsibility: Obtain floor mats and frames from one source of a single manufacturer.

(e) Utilize superior structural aluminum alloy 6063-T6 for rail connectors.

2.1.21.2.8 Delivery, storage and handling

(a) Deliver materials to the project site ready for use and fabricated in as large sections and assemblies as practical, in unopened original factory packaging clearly labeled to identify manufacturer.

2.1.21.2.9 Project Conditions

(a) Field measurements: Check actual openings for mats by accurate field measurements before
fabrication. Record actual measurements on final shop drawings. Coordinate fabrication schedule with construction progress to avoid delay of work.

(b) For recess application coordinate frame installation with concrete construction to ensure recess and frame anchorage are accurate and that the base is level and flat. Defer frame

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2.1.21.3 References and Standards

ASTM B221 - 13: Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes

ASTM B455-10 (2010): Standard Specification for Copper-Zinc-Lead Alloy (Leaded-Brass) Extruded Shapes

ASTM E648-10e1 (2010): Standard Test Method for Critical Radiant Flux of Floor-Covering Systems Using a Radiant Heat Energy Source

2.1.22 ASTM D2047-11 (2011): Standard Test Method for Static Coefficient of Friction of Polish-Coated Flooring Surfaces as Measured by the James MachineGENERAL FIXTURES, FURNISHINGS AND EQUIPMENT

2.1.22.1 Metal Lockers

2.1.22.1.1 Materials

(a) Steel Sheet: Commercial quality, stretcher leveled, cold rolled carbon steel sheet, stretcher leveled, free of buckling, scale, and surface imperfections.

(b) Fasteners: Zinc or nickel plated steel; slotless type exposed bolt heads; self locking nuts or lock washers for nuts on moving parts.

(c) Equipment: Manufacturer's standard plated steel hooks or coat rods.

2.1.22.1.2 Wardrobe lockers

(a) Body: Form backs, tops, bottoms, sides, and intermediate partitions of flanged 0.61 mm minimum steel sheet.

(b) Frames: Form channel frames of 1.5 mm minimum steel sheet. Form continuous integral strike on vertical frame members or weld 2.3 mm minimum latch hooks to latch strike frame.

(c) Cross Frames: Form intermediate channel cross frames to double tier lockers of 1.5 mm minimum steel sheet.

(d) Door: One piece steel sheet, flanged at all edges, constructed to prevent springing when opening or closing. Fabricate to swing 180 degrees.

- Thickness: 1.5 mm minimum.

(e) Reinforcing: Brace or reinforce inner face of doors over 381 mm wide.

(f) Reinforcing and Sound Dampening Panels: Brace or reinforce inner face of doors with manufacturer's standard reinforcing angles, channels, or stiffener panels.

(g) Louvered Vents: Stamped, louvered vents in door face, as follows:

(h) Double Tier Lockers: No fewer than 6 louver openings top and bottom.

(i) Hinges: Steel, full loop, 5 knuckle tight pin, 51 mm high minimum. Weld to inside of frame and secure to door with not fewer than 2 factory installed fasteners that are completely concealed and tamperproof when door is closed.

- Provide at least 2 hinges for each door 1067 mm high or less.

(j) Recessed Handle and Latch: Manufacturers' standard housing to form recess for latch lifter and locking devices; nonprotruding latch lifter containing strike and eye for padlock; and automatic, prelocking, pry resistant latch mechanism with latching action as follows:

- Double Tier Lockers: Not less than 2 point latching.

2.1.22.1.3 Locks

(a) Fabricate lockers to receive padlocks.

2.1.22.1.4 Locker accessories

(a) Equipment: Furnish each locker with the following items, unless otherwise shown:

- Double Tier Units: 1 double prong ceiling hook, and not fewer than 2 single prong wall hooks.

(b) Number Plates: Manufacturer's standard etched, embossed, or stamped, nonferrous metal number plates with numerals not less than 9 mm high. Number lockers in sequence indicated. Attach plates to each locker door, near top, centered, with at least 2 fasteners of same finish as number plate. Locker number sequence shall begin with 100, 101, 102, etc. for each separate locker room.

(c) Continuously Sloping Tops: Manufacturer's standard continuously sloped top, not less than 0.91 mm steel sheet. Provide closures at ends and sloped corner fillers.

(d) Recess Trim: Manufacturer's standard 1.2 mm minimum steel sheet trim with concealed fastening clips.

(e) Filler Panels: 1.2 mm minimum steel sheet, factory fabricated.

(f) Locker Benches:

i. Bench Tops: Provide manufacturers standard one piece units fabricated from laminated maple with one coat of clear sealer on all surfaces, and one coat of clear lacquer on top and sides. Provide benches in lengths indicated with a cross sectional size of 241 mm wide x 32 mm thick with rounded corners and edges; benches shall be provided with an overall height of 445 mm.

ii. Pedestals: Provide manufacturers standard 32 mm o.d. steel tube pedestal support assemblies complete with 3.4 mm thick steel flanges welded to each end of tube. Predrill flanges with fastener holes, and provide each pedestal complete with fasteners and anchors. Furnish a minimum of 2 pedestals for each bench, with pedestal spacing not more than 1829 mm o.c.

2.1.22.1.5 Fabrication

(a) Fabricate lockers square, rigid, and without warp, with metal faces flat and free of dents or distortion. Make exposed metal edges free of sharp edges and burrs, and safe to touch. Weld frame members together to form a rigid, 1 piece structure.

- Preassemble lockers by welding all joints, seams, and connections. Grind exposed welds flush.

(b) Locker Unit Size: 305 mm wide x 457 mm deep x 914 mm high, unless otherwise indicated.

2.1.22.1.6 General Finishes

(a) Comply with NAAMM "Metal Finishes Manual" for recommendations relative to applying and designating finishes.

(b) Finish all steel surfaces and accessories, except prefinished stainless steel and chrome plated surfaces.

(c) Protect mechanical finishes on exposed surfaces from damage by applying strippable, temporary protective covering prior to shipment.

(d) Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within 1/2 of the range of approved samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved samples and they are assembled or installed to minimize contrast.

2.1.22.1.7 Steel sheet finishes

(a) Surface Preparation: Solvent clean surfaces complying with SSPC SP 1 to remove dirt, oil, grease, and other contaminants that could impair paint bond. Remove mill scale and rust, if present, from uncoated steel complying with SSPC SP 5 (White Metal Blast Cleaning) or SSPC SP 8 (Pickling), and phosphatize surfaces.

(b) Baked Enamel Finish: Immediately after cleaning and pretreating, apply manufacturer's standard baked enamel finish consisting of a thermosetting topcoat. Comply with paint manufacturer's instructions for application and baking to achieve a minimum dry film thickness of 0.028 mm on doors, and frames, and 0.018 mm elsewhere.

- Colour and Gloss: As selected by Engineer from manufacturer's full range of choices for colour and gloss.

2.1.22.1.8 Workmanship

(a) Install metal lockers complete with accessories according to manufacturer's recommendations. Install plumb, level, rigid, and flush.

(b) Connect together welded locker groups with standard fasteners according to manufacturer's
recommendations, with no exposed fasteners on face frames.

(c) Anchor lockers to floors and walls at intervals recommended by manufacturer but no greater than 910mm. Install anchors through back-up reinforcing plates where necessary to avoid metal distortion, using concealed fasteners.

(d) Install recess trim to recessed lockers using concealed fasteners. Provide hairline joints and concealed splice plates.

(e) Install sloping top units to lockers using concealed fasteners. Provide hairline joints and concealed splice plates.

(f) Securely fasten pedestals, and integral brackets, to bench tops. Anchor pedestals to floor and integral brackets to locker dividers.

2.1.22.1.9 Adjusting, cleaning and protection

(a) Adjust doors and latches to operate easily without binding. Verify that integral locking devices are operating properly.

(b) Clean interior and exposed exterior surfaces and polish stainless-steel and nonferrous metal surfaces.

(c) Protect lockers from damage, abuse, dust, dirt, stain, or paint. Do not permit locker use during construction.

(d) Touch up marred finishes, or replace locker units that cannot be restored to factory-finished appearance. Use only materials and procedures recommended or furnished by locker manufacturer.

2.1.22.1.10 Submittals

(a) Product data: Submit duplicate copies of manufacturer's product data indicating:

i. Performance criteria, compliance with appropriate reference standard(s), characteristics, and limitations.

ii. Product transportation, storage, handling and installation requirements.

(b) Shop drawings: Submit shop drawings indicating type and class of lockers, elevations, sections, dimensions, gauges, tops, bases, hooks, shelves, trim, numbering, doors, handles, anchorage and hardware, and finishes.

(c) Samples: Submit the following samples:
i. Two 50 x 50 Samples of colour and finish on actual base metal.

(d) Closeout submittals: Submit maintenance and cleaning instruction for incorporation into Operations and Maintenance Manuals

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2.1.22.2 Blinds

2.1.22.2.1 Generally

(a) The materials used to manufacture slim-line venetian blinds shall comply with **BS 3415** and shall be free from visible defects e.g. dents, scratches, etc.

(b) Blinds shall be installed in accordance with manufacturer's instructions.

2.1.22.2.2 Materials

(a) Headrail shall be enamel coated galvanized steel section to **BS END 10162** of sufficient strength and thickness to support the completed blind without visible sagging or twisting.

(b) Blinds shall be supplied with galvanized steel fixing brackets able to support the blind and retain it securely.

(c) The blinds shall be constructed with enamel coated flexible aluminium slats of 25 mm wide and 0.18 mm thick (finished thickness) ±5% tolerance in thickness. The material and profile of any slat in the assembled blind shall be such as to provide the strength and flexibility in accordance with **BS 3415**.

(d) Slat widths within a blind shall be consistent to within + 0.2 mm or- 0.5 mm.

(e) Slats shall have radiused ends or corners and shall be free from burrs and sharp edges.
(f) The bottom rail shall be constructed from enamel coated galvanised steel section to **BS END 10162** rigid throughout its length in the mounted blind. The ends of the bottom rail shall be enclosed with ABS plastic end-caps.

(g) Ladder tapes or cords shall be constructed from polyester fibre.

(h) Technical pamphlets and a sample of the venetian blind shall be submitted for the approval of the Engineer.

2.1.22.2.3 Workmanship

(a) The headrail shall not deviate from the horizontal by more than + 5 mm when the blind is mounted beneath a plane surface, and no part of the operating mechanism, within the headrail, shall make contact with that surface.

(b) Unless specifically intended for installation within a recess or box, the ends of the headrail shall be closed off by ABS plastic end caps.

(c) Brackets shall be pre-bored to allow for end or top or face fixing. A minimum of 2 Nos. for blinds with widths not exceeding 1 200 mm and 1 additional bracket for every increment of 600 mm in width. It shall be possible to remove the headrail from the brackets when they are fixed.

(d) Holes and slots cut into each slat shall be positioned symmetrically across the width of the slat and their width shall not exceed the width of the cord passing through them by more than 3 mm to minimize light penetration of the finished blind, consistent with satisfactory operation. The holes and slots in slats of the same blind shall align to within 1 mm, to minimize abrasion of cords and tapes passing through them.

(e) In a finished, assembled blind, the slats shall be capable of tilting through an angle of not less than 70° to the horizontal in each direction and each slat shall overlap the adjoining slat by at least 10% of the slat width in each of the fully closed positions at any point of drop of the blind. The top slat shall be within 5 mm of the headrail in the fully closed position.

(f) Unless specifically designed to clear an obstruction at the point of installation, the length of any slat shall be within ±2 mm of the overall width of the blind, and the alignment of slat ends at any position of the blind, shall not deviate from vertical by more than ±2 mm.

(g) Unless specifically designed to clear an obstruction at the point of installation, the length of the bottom rail including end-caps shall be within ±3 mm of the overall width of the blind.

(h) Tape or cord securing points shall be in alignment to within 3 mm with the holes for these in the slats. Tape or cord anchorage shall withstand a force of 400 N applied directly to the tape or cord.

(i) The rise and fall control mechanism shall ensure quick release and a smooth raising and lowering action at any position, with no fluctuation greater than ±10% in the graduation of the force required to raised or lower the blind completely.

(j) A cord locking control mechanism shall be released by drawing the control cord across the face of the blind and shall be locked when the cord is in a vertical position. The cord locking system shall be so designed that it shall not be possible to drop a blind accidentally.

(k) Lift cords of 2 mm diameter shall have a breaking force of not less than 400 N when tested in accordance with the method given in section three of **BS EN ISO 2307:2010**

(l) Cords shall be secured together so as to prevent horizontal misalignment of the blind by pulling the individual rise and fall cords.

(m) The tilt control shall be able to hold the suspended slats securely in any tilted position.

(n) Control rods ("wand") shall have a breaking force of not less than 400 N when tested in accordance with the method given in section three of **BS EN ISO 2307:2010** and the "wand" shall be of solid core ABS transparent plastic rods.

(o) When tested in accordance with the method given in section three of **BS EN ISO 2307:2010**, vertical sections or supports of the tape or cord shall have a breaking tape/cord strength of not less than 250 N; and the horizontal sections or cross-web of the tape or cord shall have a breaking strength of not less than 50 N. The cross web shall be securely joined to the vertical supports and shall withstand a force of not less than 50 N without separation. The interval between tapes in a finished blind shall be such that the horizontal deflection of the slats between ladders does not exceed 3 mm.

(p) Tapes shall be distributed symmetrically across the blind width, and shall be provided at 225 mm from edge of blind and at 650 mm (maximum) centres.

(q) Vertical blind louvres shall be made of 100 mm wide glass fibre slats or impregnated fabric of a colour and quality approved by the Engineer and shall be installed complete with all necessary accessory materials in accordance with the manufacturer's instructions.

(r) The vertical blinds shall enable operation and rotation of slats in 180° upon a vertical axis to both sides by drawing of an endless cord or a chromium

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2.1.22.3 Cubicle systems

2.1.22.3.1 Generally

(a) Cubicle systems to consist of panels with light weight core material and high performance surface veneer which shall be impervious to water, easily cleaned and with a durable finish.

(b) Panels shall be designed to be bolted or screwed together and may be raised on posts or wall brackets above floor level, floor mounted, or suspended from above.

2.1.22.3.2 Construction

(a) Panels, doors and pilasters of cubicle system shall be either :-

i. Metal construction of baked enamel or vinyl finish constructed with hot-dipped galvanized steel sheets formed and bonded with a cellular honeycomb core, or polyurethane core, or other approved light weight core materials. Edges shall be tack welded around the perimeter and sealed with interlocking molding. Molding

corners shall be welded to each other and to face sheets and ground smooth to form a rigid frame around the component.

ii. Plastic construction fabricated of high pressure laminate on cores of particle board or plywood. Composition core shall be multi-ply to resist warping and assure surface smoothness. Face laminate shall overlap edge laminate to assure water run-off and enhance adhesive bonding.

iii. Solid Laminate for all components minimum. 12mm thick.

(b) Doors and panels supplied under sub paragraphs (i) and (ii) above shall be completely moisture resistant and 20mm thick (minimum) and pilasters shall be 32mm thick (minimum).

2.1.22.3.3 Door fittings

(a) Doors shall be fixed with stainless steel or chromium-plated self-closing hinges which shall be adjustable to allow the door to open to different degrees.

(b) Door latch shall be slide latch indicator bolt or concealed latch knob with indicator, or other proprietary product approved by the Engineer. Locking devices shall have emergency release mechanism.

(c) Buffer hook also serving as clothes hook shall be fixed to each door.

(d) Door stop and door keeper with full height rubber strip shall be fixed to the lock side of the pilaster.

2.1.22.3.4 Fixing of cubicle systems

(a) Cubicle system may be floor supported, wall mounted, overhead braced or ceiling hung. Overhead braced compartments shall be braced with anti-grip headrail.

(b) Panels and headrails shall be screw-fixed to wall and pilaster with stainless steel brackets or aluminium channels .

(c) Edges of pilaster shall be screw-fixed to wall with stainless steel brackets or aluminium channels.

(d) Ceiling mounted pilaster shall be fixed to the overhead structural members by means of stainless steel inverted stirrup brackets and adjustable threaded stud and shall be covered with stainless steel plinth or other approved coverings.

(e) Base of pilaster shall be screw-fixed to the floor by means of stainless steel inverted stirrup brackets with adjusting devices for levelling during installation and permanent height adjustment of the partitions. Connection between base of pilaster and floor shall be covered with stainless steel plinth or other approved coverings.

2.1.22.4 References and Standards

ASTM A366 (1997): Standard Specification for Commercial Steel (CS) Sheet, Carbon (0.15 Maximum Percent) Cold-Rolled

Surface Preparation Commentary for Steel and Concrete Substrates - SSPC SP 1

BS 3415 (1986): Specification for venetian blinds.

BS END 10162 (2003): Cold rolled steel sections. Technical delivery conditions. Dimensional and cross-sectional tolerances.

BS EN ISO 2307 (2010):Fibre ropes. Determination of certain physical and mechanical properties

2.1.23 ASTM A794/A794M – 12 : Standard Specification for Commercial Steel (CS), Sheet, Carbon (0.16 % Maximum to 0.25 % Maximum), Cold-Rolled WATER SUPPLY PIPEWORKS

2.1.23.1 Generally

(a) The works and materials specified in Clauses 2.1.23.1 (a) to 2.1.23.1 (e) shall comply with the sections stated, unless otherwise stated in this Section.

(b) Drainage works shall comply with Section 24.

(c) Earthworks shall comply with Section 2.1.5

(d) Formwork and finishes to concrete shall comply with Section 2.1.7.

(e) Concrete shall comply with Section 2.1.8.

2.1.23.2 Materials

2.1.23.2.1 Materials for water supply pipeworks

(a) Materials for water supply pipeworks for potable water shall be non-toxic, shall not promote microbial growth and shall not impart a taste, odour, cloudiness or discolouration to the water after disinfection and washing out of the pipelines as stated in Clause 2.1.23.12.1

2.1.23.2.2 Steel pipes and fittings

(b) Steel pipes and fittings shall comply with the following:

- Steel pipes, joints and specials for water and sewage : **BS END 10311:2005 and BS END 10224:2002 ,**Dimensions and masses per unit length of welded and seamless steel pipes and tubes for pressure purposes : **BS END 10220**
- Steel pipes and tubes for pressure purposes:carbon steel with specified room temperature properties : **BS END 10216-1** and **BS END 10217-1**.

(c) Steel pipes and fittings shall be manufactured by the electricresistance welded and induction-welded process or by the submerged- arc welded process; the tensile strength of the steel used shall be at least 410 N/mm².

(d) Steel pipes and fittings shall be coated or lined internally and externally as stated in Table 2.1.23.1.

(e) Gusseted steel bends and tees shall be fabricated in accordance with **BS 534, BS 2633** and **BS 4515**.

2.1.23.2.3 Ductile Iron (DI) pipes and fittings

(a) DI pipes and fittings shall comply with **BS EN 545**. Pipes and fittings other than collars, caps and blank flanges shall be lined internally with cement mortar in accordance with **BS EN 545**, Clause 3.2. Linings shall be made with sulphate-resisting Portland cement complying with **BS 4027**.

(b) Pipes shall be externally coated with metallic zinc in accordance with **BS EN 545**, Clause 3.1. Fittings shall be externally coated with zinc rich paint in accordance with **BS EN 545**, Clause 3.1.5(b). After zinc coating pipes and fittings shall be externally coated with a finishing coat of one of the following materials as stated in **BS EN 545**, Clause 3.3:

i. bitumen based hot applied coating material complying with Clause 2.1.23.2.10 and **BS EN 10300**, or
ii. bitumen based cold applied coating material complying with Clause 2.1.23.2.10 and **BS 3416** : Type II.

Table 2.1.23.1: Protection to steel pipes and fittings

Type of pipe or fitting	Internal coating	External coating
Pipes for fresh water	Bitumen lining complying with Clause 2.1.23.2.10 and **BS 534**: Clause 27.2	Reinforced bitumen sheathing complying with **BS 534**: Clause 26.3, or bitumen enamel wrapping (filled bitumen with glass tissue) to **BS 534**: Clause 26.4 or Clause 26.5, with bitumen-based coating materials complying with Clause 2.1.23.2.10 and **BS EN 10300**.
Fittings for fresh water other than slip-on type couplings and flange adapters	Bitumen lining complying with Clause 2.1.23.2.10 and **BS 534**: Clause 27.3	
Pipes exceeding DN 600 for salt water	Sulphate-resisting concrete lining complying with **BS 534**: Clause 29.1	
Fittings exceeding DN 600 for salt water other than slip-on type couplings and flange adapters	Sulphate-resisting concrete lining complying with **BS 534**: Clause 29.2	
Pipes not exceeding DN 600 for salt water	Sulphate-resisting concrete lining complying with **BS 534**: Clause 29.1 or sulphate-resisting cement mortar lining complying with **BS 534**: Clause 29.3	

Fittings not exceeding DN 600 for salt water other than slip-on type couplings and flange adapters	Sulphate-resisting concrete lining complying with **BS 534**: Clause 29.2 or sulphate-resisting cement mortar lining complying with **BS 534**: Clause 29.3	
Slip-on type couplings and flange adapters	Bitumen coating complying with Clause 2.1.23.2.10 and **BS 534** : Clause 25.1	

2.1.23.2.4 UPVC pipes and fittings

(a) UPVC pipes and fittings shall be Class D and shall comply with following:

i. UPVC pipe for cold water services : **BS 3505**

ii. Joints and fittings for use with UPVC pressure pipes
- injection moulded UPVC
- fittings for solvent welding for use with pressure pipes, including potable water supply : **BS 4346: Part 1**
- mechanical joints and fittings principally of UPVC : **BS 4346: Part 2**
- solvent cement : **BS END 14814:2007**

2.1.23.2.5 Galvanise iron (GI) pipes and fittings

(a) GI pipes and fittings shall comply with the following:

i. Steel tubes and tubulars suitable for screwing to **BS 21** pipe threads : **BS 1387**, medium grade

ii. Pipe threads for tubes and fittings where pressure-tight joints are made on the threads : **BS 21**

iii. Wrought steel pipe fittings (screwed BSP thread) : **BS EN 10241**

2.1.23.2.6 Flanges

(a) Steel flanges shall comply with **BS EN 1092-1** and shall be either steel plate for welding type or steel plate blank flange type. The dimensions and drilling of flanges shall comply with **BS EN 1092-1**as appropriate regardless of the nominal pressure rating.

(b) Steel ring flanges shall be machined in the bore to a diameter of 4mm ± 1 mm larger than the outside diameter of the pipe to which the flange is to be welded.

(c) Steel puddle flanges shall be separated into 180° segments.

(d) DI flanges shall be cast-on or welded-on standard flanges complying with **BS EN 545**.

2.1.23.2.7 Bolts and nuts

(a) Bolts and nuts for flanged joints shall comply with **BS EN 1092-1**

(b) Bolts and nuts shall be compatible with the type of joint and, unless otherwise approved by the Engineer, shall be obtained from the same manufacturer as the joint.

(c) Bolts shall be sufficiently long and shall be suitably threaded for jointing the relevant flanges.

2.1.23.2.8 Elastometric joint rings

(a) Elastomeric joint rings shall comply with **BS EN 681-1**.

(b) Elastomeric joint rings for DI pipes and fittings shall comply with **BS EN 545**, Clause 2.3.4.

(c) The dimensions of rings for use with flanged joints shall comply with **BS EN 1514**. The rings shall be compatible with the type of joint and, unless otherwise approved by the Engineer, shall be obtained from the same manufacturer as the joint.

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2.1.23.2.9 Anti-corrosion tape

(a) Anticorrosion tape shall be a proprietary type approved by the Engineer. The tape shall either be a petrolatum tape with fabric reinforcement or a bituminous tape with PVC backing. Petrolatum tape shall be used for valves, flanged joints, slip-on type couplings and flange adaptors of all sizes. Bituminous tape shall be used in buried or nonexposed condition for welded joints of steel pipe, repair of steel pipe sheathing and other applications as specified on the Drawings.

(b) Anticorrosion tapes shall have a high resistance to cathodic disbondment, acids and alkalis. Colour of bituminous tape shall be black.

(c) Primer and mastic filler for use with anticorrosion tape shall be compatible with the tape and shall be a type recommended by the manufacturer of the tape and approved by the Engineer.

(d) Bituminous tapes shall be stored in a cool dry place away from the sun's rays. No dirt or grits shall be allowed to stick on the edge of the tape before applying the tape for pipe protection.

(e) The following particulars of the proposed anticorrosion tape for water supply pipeworks shall be submitted to the Engineer:

i. manufacturer's literature for anticorrosion tape, and

ii. certificate for anticorrosion tape showing the manufacturer's name, the date and place of manufacture and showing that the material complies with the requirements stated in the Contract and including results of tests in accordance with the Contract.

(f) The particulars, including certificates, shall be submitted to the Engineer at least 14 days before the first delivery of the material to the Site. Certificates shall be submitted for each batch of the material delivered to the Site.

2.1.23.2.10 Bituminous coatings

(a) Bituminous coatings shall comply with the following:

i. Bitumen based hot applied coating material for protecting iron and steel including suitable primers where required : **BS EN 10300**

ii. Black bitumen coating solutions for cold application : **BS 3416**, Type II.

(b) Bituminous coatings used for repairing joints and coatings shall be compatible with the adjacent coating.

(c) Bituminous coatings shall be made from petroleum or asphaltic bitumen.

2.1.23.2.11 Whitewash

(a) Whitewash shall comply with **AWWA C 203**.

2.1.23.2.12 Zinc-based paint

(a) Zinc-based paint shall be a proprietary type approved by the Engineer.

(b) Primers for zinc-based paint shall comply with **BS 4652**.

(c) Rust inhibitor shall be a chemical agent which is capable of converting rust into iron phosphate.

2.1.23.2.13 Joint filler and compressible padding

(d) Joint filler for joints in concrete bed, haunch and surround shall be a proprietary type approved by the Engineer and shall be a firm, compressible, single thickness, non-rotting filler. The thickness of the filler shall be as stated in Table 2.1.23.2.

(e) Compressible padding between pipes and supports shall be bitumen damp-proof sheeting complying with BS 743.

Table 2.1.23.2: Joint filler for concrete bed, haunch and surround

Nominal diameter of pipe	Thickness of joint filler (mm)
less than 450 mm	18
450 mm - 1200 mm	36
exceeding 1200 mm	54

2.1.23.2.14 Polyethylene sheeting

(a) Polyethylene sheeting shall be impermeable and shall have a nominal thickness of 0.125 mm.

2.1.23.2.15 Extension keys

(a) Extension keys and clamps for valves shall be Grade 43A steel complying with BS **7668:2004** and shall be hot-dip galvanised in accordance with **BS EN ISO 1461** after fabrication.

2.1.23.3 Transport, handling and storage of materials

2.1.23.3.1 Transport, handling and storage of pipes, joints and fittings

(a) Pipes, joints and fittings for water supply pipeworks shall be transported, handled and stored in accordance with the manufacturers' recommendations and in a manner which will not result in damage or deformation to the pipes, joints and fittings or in contamination of the pipes, joints and fittings.

(b) Pipes, joints and fittings shall be protected from damage and damaged pipes, joints and fittings shall not be used in the permanent work unless permitted by the Engineer. Pipes, joints and fittings shall be securely packed and supported to prevent movement when being transported.

(c) UPVC pipes, joints and fittings shall be protected from exposure to conditions which may affect the material.

(d) Bolts and nuts shall be packed in sealed metal containers.

(e) Elastomeric joint rings shall be packed in bags and lubricant for joints shall be stored in sealed containers marked to identify the contents.

(f) The rings and lubricant shall be protected from exposure to conditions which may affect the material.

(g) Boxed or crated materials or those in sealed containers shall remain in their original boxes, crates or containers.

2.1.23.3.2 Handling of pipes and fittings

(a) Pipes and fittings other than thin walled pipes shall be handled by manual methods or by using lifting appliances or chains, wire rope or canvas slings of a type recommended by the pipe manufacturer and agreed by the Engineer; hooks shall not be used.

(b) Slings shall be placed around the pipes and fittings and padding shall be provided at points of contact between pipes and fittings and metal lifting appliances or slings. Pipes and fittings shall not be handled by means of metal slings passed through the pipes.

(c) Pipes and fittings shall not be subjected to rough handling, shock loading or dropping and shall not be rolled down ramps unless permitted by the Engineer; if permitted, the ramps shall be padded.

2.1.23.3.3 Storage of pipes

(a) Pipes other than thin walled pipes shall be stored horizontally at least 75 mm above the ground on wedged timber bearers. The bottom layers and the outer pipes in each layer shall be securely wedged to prevent sideways movement.

(b) Socket and spigot pipes shall be stored with the sockets alternating and in such a manner that loads are not applied to the sockets.

(c) The height of stacks of pipes other than thin walled pipes shall not exceed 2 m unless recommended by the manufacturer and permitted by the Engineer.

(d) Pipes shall not be strung out along the route of the pipeline unless permitted by the Engineer.

2.1.23.3.4 Transport and handling of thin walled pipes

(a) When being transported, thin walled pipes shall be supported on three rubber covered saddles shaped such that the pipes are supported over at least one-quarter of the circumference.

(b) The pipes shall be securely fixed in position at each saddle by straps tightened by turnbuckles. One saddle shall be placed at the mid-point of the length of the pipe and the other two saddles shall be placed at distances of one-fifth of the length of the pipe from each end of the pipe.

(c) When being handled and stored, thin walled pipes shall be protected from deformation by means of at least two screw jack cruciform struts with rubber padded ends shaped to fit the circumference of the pipes. The struts shall be fitted inside the pipes; any temporary struts fixed by the manufacturer shall be left in position until the cruciform struts have been fixed.

(d) Thin walled pipes shall be handled by using two reinforced canvas slings at least 300 mm wide. The slings shall be suspended from a lifting beam and shall be placed at a distance of onefifth of the length of the pipe from each end of the pipe.

(e) Thin walled pipes shall not be rolled.

(f) Thin walled pipes shall be stored on timber bearers padded with hessian or straw to provide continuous support over at least one-third of the circumference of the pipe. The pipes shall be securely fixed in position with wedges placed at a distance of one-fifth of the length of the pipe from each end of the pipe.

(g) Thin walled pipes shall not be stacked on top of each other.

2.1.23.3.5 Storage of valves

(a) Valves, including power operated valves and associated electrical and control equipment, shall be stored in accordance with the manufacturer's recommendations in a weatherproof store.

2.1.23.3.6 Access to pipelines

(a) Rubber wheeled trolleys shall be provided to obtain access inside pipelines exceeding DN 500 for water supply pipeworks in order to joint pipes, repair joints, coatings and linings and inspect the pipeline. Persons entering pipelines shall wear clean soft-soled footwear.

(b) Mechanical fans shall be provided to ensure that an adequate air supply is available to those entering pipelines for inspection. Engine driven fans shall be fitted with a flexible exhaust or other methods of keeping exhaust fumes clear of the fresh air intake.

2.1.23.4 Laying and bedding pipes

2.1.23.4.1 Laying pipes

(a) The Engineer shall be allowed to inspect trenches, bedding, pipes, joints, fittings and valves before pipelaying for water supply pipeworks starts. The Contractor shall inform the Engineer 24 hours, or such shorter period agreed by the Engineer, before pipelaying starts in any part of the permanent work.

(b) The permission of the Engineer shall be obtained before pipelaying starts in any part of the permanent work.

(c) The Contractor shall inspect pipes, joints, fittings and valves, including internal and external coatings, immediately before and after pipelaying; valves shall be inspected to ensure that they are in working order and are capable of being fully opened and closed. Deleterious material shall be removed and damage shall be repaired immediately before and after pipelaying; potable water shall be used for washing.

(d) The inside of pipelines shall be kept clean and free from water, dirt, stones, debris and deleterious material. Except when pipes are being jointed, the open ends of pipelines shall be sealed with a wooden plug or stopper or by other methods agreed by the Engineer.

(e) Measures shall be taken to prevent flotation of pipes.

(f) Pipelaying shall follow closely on excavation of the trench. Lengths of trench which in the opinion of the Engineer are excessive shall not be left open.

(g) Unless otherwise permitted by the Engineer, pipelines with a gradient steeper than 1 in 20 shall be laid in an uphill direction with sockets facing uphill.

(h) Pipes shall be laid in such a manner that water will not pond in locations with zero and shallow gradients and such that the line and level of pipes will comply with the specified tolerances.

2.1.23.4.2 Laying steel pipes

(a) Steel pipes with welded joints for water supply pipeworks shall be spot welded to the adjacent pipe to which they will be jointed immediately after laying. Steel pipes manufactured with longitudinal or spiral welds shall be aligned in such a manner that the welds are staggered from pipe to pipe by at least 15° of arc.

2.1.23.4.3 Laying pipes with flexible joints

(a) The degree of the curve of pipes for water supply pipeworks with flexible joints which are to be laid to a curve shall be equally distributed over all joints within the curved section. The deflection at a completed joint shall not exceed 3° or three-quarters of the maximum deflection recommended by the manufacturer whichever is less.

2.1.23.4.4 Installation of valves

(a) Operating gear and associated fittings shall be installed and fixed at the same time as valves for water supply pipeworks are installed. After installation, valves shall be cleaned inside and outside and left in a closed position.

(b) Extension keys and clamps shall be fixed to valves in valve chambers if the vertical distance between the top of the valve spindle and the finished ground level exceeds 600 mm. The length of extension keys shall be such that the top of the extension key is not more than 300 mm below the finished ground level.

2.1.23.4.5 Bedding pipes

(a) Surfaces on which pipes for water supply pipeworks will be laid shall be cleaned and objects which may damage the pipes shall be removed before pipes are laid.

(b) The bottom of trenches on which pipes will be laid directly shall be shaped to support the pipes uniformly along the length of the barrel; holes shall be dug to prevent pipes resting on the sockets and to allow the pipes to be jointed.

2.1.23.5 Cutting and drilling pipes

2.1.23.5.1 Cutting pipes

(a) Pipes for water supply pipeworks shall be cut and the ends shall be prepared in accordance with the manufacturer's recommendations; purpose made equipment recommended by the manufacturer and agreed by the Engineer shall be used for cutting the pipes.

(b) Cut ends of pipes shall be square and even, without damage to the pipe or coating. Cut ends, including cut ends of the piece not immediately required, shall be trimmed and chamfered to suit the type of joint and in such a manner that elastomeric joint rings will not be damaged by the cut end.

(c) Pipes requiring to be cut to form closing lengths shall not be cut until adjacent pipes have been laid and jointed and the length to be cut can be accurately measured.

(d) The permission of the Engineer shall be obtained before pipes provided by the Employer are cut. Only those pipes which in the opinion of the Engineer are suitable for cutting on Site shall be cut. All off-cuts shall be used for the permanent work unless in the opinion of the Engineer this is not practicable.

2.1.23.5.2 Drilling pipes

(a) Pipes for water supply pipeworks shall be drilled for small diameter connections using purpose made drilling and tapping equipment.

(b) The threads of screw joints shall be painted before assembly with two coats of bituminous paint and shall be wrapped with three turns of spun yarn or other material approved by the Engineer.

2.1.23.6 Jointing pipes

2.1.23.6.1 Jointing pipes

(a) Pipes for water supply pipeworks shall be jointed in accordance with the manufacturer's recommendations and using jointing equipment and jointing materials recommended by the manufacturer and agreed by the Engineer.

(b) The Contractor shall inspect pipes, joints, fittings and valves, including internal and external coatings, immediately before and after jointing. Deleterious material shall be removed and damage shall be repaired immediately before and after jointing; potable water shall be used for washing. Surfaces which are to be jointed and jointing materials shall be cleaned immediately before jointing.

(c) All joints in pipelines shall be watertight.

(d) The widths of gaps at joints shall be in accordance with the manufacturer's recommendations and shall be achieved by marking the outside of the pipe, by using metal feelers or by other methods agreed by the Engineer. The position of elastomeric joint rings shall be checked by using metal feelers after jointing.

(e) Gaps at joints in pipes shall be protected after jointing by methods agreed by the Engineer to prevent dirt, stones or other material entering the joint.

(f) Bolts holes in flanged joints and joints incorporating bolted components shall be correctly orientated before the bolts are tightened. The correct size of bolts and nuts shall be used. Bolt threads shall be lubricated and bolts shall be tightened using the correct size of spanner. Bolts shall be tightened in diametrically opposite pairs working around the bolt circle until all bolts are tightened to the torque recommended by the manufacturer.

(g) Bolt holes in flanged joints shall be orientated symmetrically about the vertical diameter with no bolt holes on the vertical diameter.

(h) Elastomeric joint rings shall be the correct size and shall not protrude into the bore of the pipe. The rings may be temporarily fixed to the face of the flange using a minimum amount of adhesive of a type recommended by the manufacturer; jointing compound or paste shall not be used.

2.1.23.6.2 DI pipes with push-in joints

(a) DI pipes with push-in joints for water supply pipeworks shall be jointed by smearing the spigot end of the pipe with lubricant and placing the elastomeric joint ring in position inside the groove of the socket end of the laid pipe. The spigot end of the pipe shall be placed in the socket end of the laid pipe and pushed home.

2.1.23.6.3 DI pipes with mechanical joints

(a) DI pipes with mechanical joints for water supply pipeworks shall be jointed as stated in Clauses 2.1.23.6.3 (b) to (d).

(b) The elastomeric joint ring and the ends of the pipe shall be smeared with lubricant over a distance recommended by the manufacturer.

(c) The gland and the elastomeric joint ring shall be placed in position on the spigot end of the pipe.

(d) The spigot end of the pipe shall be placed in the socket end of the laid pipe before the bolts are tightened.

2.1.23.6.4 Welding joints in steel pipes

(a) Welding of joints in steel pipes for water supply pipeworks shall be carried out by the metal-arc process in accordance with **BS 2633** and **BS 4515**.

(b) Butt welding shall not be used for jointing plain ended pipes other than for gusseted bends unless approved by the Engineer; if approved, the ends of the pipes shall be prepared in accordance with **BS 534** and **BS 2633** and welding shall be carried out in accordance with **BS 4515**.

(c) Records of welding operations shall be kept by the Contractor on the Site and shall be available for inspection by the Engineer at all times.

(d) Records shall contain the following details:
   i. date,
   ii. names of welders,
   iii. location of welding operation, and
   iv. electrodes used in making each weld.

2.1.23.6.5 Steel pipes with spigot and socket joints

(a) Steel pipes with spigot and socket joints for water supply pipeworks shall be jointed as stated in Clause 2.1.23.6.5(b) to (e).

(b) Pipes not exceeding DN 700 shall be welded externally. Pipes exceeding DN 700 shall be welded internally and shall then be welded externally with a sealing weld.

(c) Loose scale, slag, rust, paint and other deleterious material shall be removed from parts of pipes to be welded by wire brushing or by other methods agreed by the Engineer; the parts shall be kept clean and dry before welding.

(d) A double-run convex fillet weld shall be used for pipes not exceeding DN 900 and a triple-run convex fillet weld shall be used for pipes exceeding DN 900. The leg length of the fillet as deposited shall be at least the same as the full thickness of the pipe wall. The actual throat depth shall not be less than seven-tenths, and shall not exceed nine-tenths, of the minimum leg length as deposited.

(e) Deposition of the weld metal shall be carried out in such a manner that all welds have adequate root fusion and are of good, clean metal, free from cracks, gas holes, slag intrusion

and other impurities. The surface of the weld shall have an even contour with a regular finish and shall indicate proper fusion with the parent metal. Slag shall be removed from each weld by light hammering with a chipping hammer and by wire brushing.

(f) Welds which contain cracks or other cavities or defects or in which the weld metal overlaps on to the parent metal without proper fusion shall be cut out and the joints shall be rewelded

2.1.23.6.6 Steel pipes with welded steel collar joints

(a) Steel pipes with welded steel collar joints for water supply pipeworks shall be jointed by leaving a gap not exceeding 75 mm between the ends of the pipes to be jointed. A split steel collar shall be placed centrally around the ends of the pipes; the collar shall be at least the same thickness as the pipe wall and shall be approximately 300 mm long. The end of each pipe shall be fillet welded to the collar as stated in Clause 2.1.23.6.5.

2.1.23.6.7 Steel pipes with couplings and flange adapters

(a) Steel pipes with slip-on type couplings and flange adapters for water supply pipeworks shall be jointed as stated in Clause 2.1.23.6.7 (b) to (d).

(b) Protective wrappings shall be removed from the ends of plain ended pipes to be jointed and shall be replaced by:

i. bitumen coating complying with Clause 2.1.23.2.10 and BS 534 :Clause 25.1, or
ii. epoxy or plastics based coating of a proprietary type approved by the Engineer.

(c) The pipe shall be finished to an even, smooth surface free from distortion to allow the components of the coupling or flange adapter to be correctly positioned and jointed.

(d) The coupling or flange adapter shall be placed in position on the plain end before the bolts are tightened

2.1.23.6.8 UPVC pipes with pushin joints

(a) UPVC pipes with push-in joints for water supply pipeworks shall be jointed as stated in Clause 2.1.23.6.2.

2.1.23.6.9 UPVC pipes with solvent welded joints

- UPVC pipes with solvent welded joints for water supply pipeworks shall be jointed by applying solvent cement to the pipes to be jointed and pushing the pipes home. Excess solvent shall not be applied and surplus solvent shall be removed after jointing. Solvent welded pipes jointed outside the trench shall not be placed in the trench until the solvent setting period recommended by the manufacturer has elapsed.

2.1.23.6.10 GI pipe joints

(a) GI pipes for water supply pipeworks shall be screw jointed using a threaded coupler. The surface of the pipe and coupler shall be cleaned and the threads shall be painted with two coats of bituminous paint. The pipe thread shall be wrapped with three turns of spun yarn or other material approved by the Engineer and the joint tightened using purpose made tools. Coal tar compounds or lead-based paint shall not be used.

(b) Locking nuts to branch connections shall be tightened. Branch connections shall not protrude inside the pipe.

2.1.23.7 Protection to steel flanged joints, slip-on type couplings and flange adapters

2.1.23.7.1 Protection to steel flanged joints, slip-on type couplings and flange adapters

(a) Steel flanged joints, slip-on type couplings and flange adapters in steel pipes for water supply pipeworks shall be protected as stated in Clause 2.1.23.7.1 (a) to (d). Protection shall be carried out after jointing is complete.

(b) The joint, including bolts and nuts, shall be cleaned to remove all moisture, dirt, oil, grease and deleterious material. Bolts and nuts shall be painted with two coats of bituminous paint and the joint shall be coated with primer. Mastic filler shall be applied in such a manner that all depressions, corners and voids between the bolts and nuts are filled and a smooth surface is available on which to apply the anticorrosion tape.

(c) At least two layers of anticorrosion tape shall be applied to all parts of the joint and to the adjacent pipe for at least 200 mm beyond each end of the joint. The tape shall be applied in accordance with the manufacturer's recommendations and shall be wrapped spirally around the joint and pipe with at least 55% overlap per spiral.

(d) The tape shall be moulded manually after application to take up the contours of the parts being protected.

2.1.23.8 Repairs to joints, coatings and linings

2.1.23.8.1 Repairs to joints, coatings and linings

(a) Joints and damage to coatings and linings of pipes, joints and fittings for water supply pipeworks shall be repaired as stated in Clauses 2.1.23.8.1 to 2.1.23.8.7.

(b) Unless otherwise approved by the Engineer, repairs to joints, coatings and linings shall be carried out using materials of the same type and grade as in the pipe, joint or fitting.

(c) External repairs shall be completed before internal repairs are carried out.

(d) Internal repairs and adjacent areas shall be washed with potable water after the repair is complete.

2.1.23.8.2 Internal repairs to steel pipes with bitumen coatings

(a) Internal repairs to joints and coatings of steel pipes with bitumen coatings shall be carried out as stated in Clause 2.1.23.8.2 (a) to (e).

(b) Dirt, mill scale, rust and other deleterious material shall be removed from the areas to be repaired by wire brushing to leave dry, clean, bright metal. All damaged material shall be removed and the area shall be cleaned and dried.

(c) Primer shall be applied to the metal surface by brushing, avoiding bare spots, floods and sags.

(d) The area surrounding the area to be repaired shall be gently heated with a blow lamp or hot iron until the adjacent coating is molten.

(e) Bitumen shall be heated to 200°C and shall be stirred from time to time to prevent overheating. The bitumen shall be worked into the area to be repaired with a heated trowel to the same thickness as the adjacent coating; the bitumen shall be finished to a smooth, uniform surface.

2.1.23.8.3 External repairs to steel pipes with bitumen coatings

(a) External repairs to joints other than flanged joints, slip-on type couplings and flange adapters of steel pipes with bitumen coatings shall be carried out as stated in Clause 2.1.23.8.2 except as stated in Clause 2.1.23.8.3 (b) to (f).

(b) External repairs shall not start until any specified electrical continuity has been provided and any individual test to each joint has been carried out.

(c) A purpose made moulding box shall be cleaned and coated internally with whitewash. After the whitewash has dried, the box shall be fitted centrally around the joint and bolted together. Gaps between the pipe and the box shall be sealed with yarn or other material agreed by the Engineer to prevent leakage.

(d) The heated bitumen shall be poured into the box in one operation. After the bitumen has solidified, the box shall be removed, cleaned and stored for re-use.

(e) The affected area of bitumen coating shall be painted with whitewash after cooling.

(f) External repairs to coatings of steel pipes with bitumen coatings shall be carried out as stated in Clause 2.1.23.8.2 except that the heated bitumen together with woven glass cloth shall be worked into the area to be repaired. The affected area of bitumen coating shall be painted with whitewash after coating.

2.1.23.8.4 Internal repairs to steel pipes with concrete or cement mortar lining

(a) Internal repairs to joints and linings of steel pipes with concrete or cement mortar linings shall be carried out as stated in Clause 2.1.23.8.4 (b) to (e).

(b) The area to be repaired shall be cut back to leave clean, bright metal. The area surrounding the area to be repaired shall be wetted.

(c) The concrete or cement mortar shall be worked into the area to be repaired and compacted to the same thickness as the adjacent lining; the concrete or cement mortar shall be finished to a smooth uniform surface.

(d) The compressive strength and density of the compacted concrete or cement mortar shall be in accordance with **BS 534**, Clause 29.5. The repaired area shall be cured by using curing compound as stated in Clause 2.1.8.2.5.

(e) Samples of the concrete or cement mortar shall be provided and test cubes shall be made and tested.

2.1.23.8.5 Repairs to DI pipes with bitumen coatings

(a) Internal and external repairs to joints and coatings of DI pipes with bitumen coatings shall be carried out using bituminous paint. The area to be repaired shall be cleaned to bare metal and dried. The area to be repaired shall be painted with bituminous paint to the same thickness as the adjacent coating; the paint shall be finished to a smooth uniform surface.

2.1.23.8.6 Internal repairs to DI pipes with cement mortar lining

(a) Internal repairs to joints and linings of DI pipes with cement mortar linings shall be carried out as stated in Clause 2.1.23.8.6 (b) to (d).

(b) The area to be repaired shall be cut back to leave clean, bright metal. The area surrounding the area to be repaired shall be wetted.

(c) The cement mortar shall be worked into the area to be repaired and compacted to the same thickness as the adjacent lining; the cement mortar shall be finished to a smooth uniform surface. The repaired area shall be cured with curing compound as stated in Clause 2.1.8.2.5.

(d) The inside of pipe sockets and the faces of flanges shall be kept free from cement mortar.

2.1.23.8.7 Repairs to GI pipes

(a) Internal and external repairs to joints and coatings of GI pipes shall be carried out using zinc-based paint. The area to be repaired shall be cleaned to bare metal and dried. The area to be repaired shall be painted with a rust inhibitor, primer and two coats of zinc-based paint.

2.1.23.9 Thrust and anchor blocks

2.1.23.9.1 Thrust and anchor blocks

(a) The bearing face, and other faces stated in the Contract, of concrete thrust and anchor blocks for water supply pipeworks shall be cast directly against undisturbed ground; the faces of excavations shall be trimmed to remove loose material before concreting. Excess excavation and working space shall be filled with concrete of the same Grade as the block.

(b) Internal pressure shall not be applied to the pipeline until thrust and anchor blocks have developed the specified grade strength.

2.1.23.10 Bed, haunch and surround

2.1.23.10.1 Concrete bed, haunch and surround

(a) Concrete bed, haunch and surround to pipelines for water supply pipeworks shall be constructed as stated in Clause 2.1.23.10.1 (b) to (e).

(b) Pipes shall be supported at the required level by Grade 20 precast concrete wedges, blocks or cradles or by other methods agreed by the Engineer. One support shall be placed adjacent to each end of each pipe and the spacing between supports shall not exceed 3 m. Compressible sheeting shall be placed between the pipes and supports.

(c) Flexible joints shall be formed in concrete bed, haunch and surround at flexible joints in pipelines. Joint filler shall be placed next to the flexible joint in the pipeline and shall extend for the complete thickness of the bed, haunch and surround.

(d) Polyethylene sheeting shall be placed on the trench bottom before concreting.

(e) Concrete shall be placed evenly over the complete width of the bed and over the complete length of the pipe being concreted up to a level of 25 mm below the underside of the pipe.

Concrete shall then be placed on one side of the pipe only and worked under the pipe until the concrete spreads under the pipe. Concrete shall then be placed equally on both sides of the pipe to the specified level.

2.1.23.11 Tolerances

2.1.23.11.1 Tolerances : pipelines

(a) The line and level of pipelines for water supply pipeworks shall be within 25 mm of the specified line and level.

2.1.23.12 Cleaning and sterilisation of pipelines

2.1.23.12.1 Cleaning and sterilisation of pipelines

(a) Fresh water and potable water pipelines for water supply pipeworks shall be cleaned and flushed through with potable water. Cleaning and flushing shall be carried out after:

i. the complete pipeline, or parts of the pipelines permitted by the Engineer, has been tested,

ii. Temporary Works required for testing have been removed, and

iii. parts of the pipeline removed for testing have been reconnected.

(b) The pipeline shall be completely filled with water that has been dosed with a homogeneous solution of sterilising chemicals such that the final concentration of free chlorine in the water is at least 30 ppm. The water shall be left in the pipeline for at least 24 hours.

(c) After the 24 hour period, the pipeline shall be drained down and the sterilising water shall be flushed out using potable water until the concentration of the remaining chlorine is less than 1 ppm.

(d) Unless otherwise permitted by the Engineer, pipelines shall be cleaned and sterilised not more than 7 days before the pipeline is handed

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2.1.23.13 Testing: joints in steel pipes

2.1.23.13.1 Testing: joints in steel pipes

(a) Spigot and socket joints in steel pipes exceeding DN 700 for water supply pipeworks shall be tested after welding by the nitrogen gas test.

(b) A tapped hole of approximately 6 mm diameter shall be made in the socket end of each pipe to be tested and a non-return valve shall be fixed in the hole. The nitrogen gas test shall be carried out by pumping nitrogen to a pressure of 400 kPa into the annular space between the spigot and socket.

(c) The pump shall be disconnected and the pressure shall be recorded for 30 minutes.

2.1.23.13.2 Compliance criteria: joints in steel pipes

(a) There shall be no drop in pressure in the joint during the 30 minute period of the nitrogen gas test.

2.1.23.13.3 Non-compliance: joints in steel pipes

(a) If the result of any nitrogen gas test does not comply with the specified requirement for the test, the weld at the joint shall be cut out and the joint shall be rewelded and tested.

2.1.23.14 Testing: pressure pipelines for water supply pipeworks

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2.1.23.14.1 Testing: pressure pipelines for water supply pipeworks

(a) Pressure pipelines for water supply pipeworks shall be tested as stated in Clause 2.1.23.14.1 (b) to (g).

(b) The pipeline shall be tested in sections as stated in the Contract unless otherwise permitted by the Engineer; if testing in sections other than those stated in the Contract is permitted, the section to be tested shall be as long as practicable provided that the specified test pressure will not be exceeded. Final tests on complete pipelines which have been tested in sections shall not be carried out unless stated in the Contract.

(c) The test pressure shall be as stated in the Contract. If the test pressure is not stated in the Contract, the test pressure shall be:

i. times the maximum working pressure if the maximum working pressure does not exceed 1.5 MPa, or
ii. 1.3 times the maximum working pressure if the maximum working pressure exceeds 1.5 MPa.

(d) Unless otherwise permitted by the Engineer, pressure tests shall not be carried out until the fill material has been deposited and compacted over the complete length of the pipeline to be tested; if permitted, sufficient fill material shall be deposited to restrain the pipeline in position during the test.

(e) Tests shall not be carried out simultaneously on pipelines in the same trench.

(f) The method of testing shall be in accordance with Clause 2.1.23.16.

(g) Unless otherwise permitted by the Engineer, the pipeline shall be left charged with water at a head of at least 15 m after testing and until the pipeline has been sterilised or handed over to the Employer.

2.1.23.14.2 Compliance criteria: pressure pipelines for water supply pipeworks

(a) The results of tests on pressure pipelines for water supply pipeworks shall comply with the following requirements:

i. The leakage of water from the pipeline determined by the pressure test shall not exceed the permitted leakage calculated in accordance with Clause 2.1.23.16.4 in Clause 2.1.23.16.

ii. There shall be no discernable leakage of water from the pipeline or from any joint during the pressure test.

2.1.23.14.3 Non-compliance: pressure pipelines for water supply pipeworks

(a) If the result of any test on pressure pipelines for water supply pipeworks does not comply with the specified requirements for the test, the Contractor shall investigate the reason. Remedial or replacement work approved by the Engineer shall be carried out and the pipeline shall be retested.

2.1.23.15 Testing: water sterilisation

2.1.23.15.1 Testing: water sterilization

(a) After the pressure test on fresh water and potable water pipelines for water supply pipelines has been completed, samples of the water in the pipeline will be taken by the Engineer. The number of samples and locations of sampling shall be as instructed by the Engineer.

(b) Testing shall be carried out to determine the bacteriological content.

(c) The results of tests for bacteriological content of the water shall demonstrate that in the opinion of the Engineer the structure has been adequately sterilised .

2.1.23.16 Pressure tests on pipelines

2.1.23.16.1 Scope

(a) This method covers the determination of the leakage of water from pipelines for water supply pipeworks by means of a pressure test.

2.1.23.16.2 Equipment

(a) The following equipment is required:

i. Blank flanges or caps.
ii. Struts and wedges.
iii. Temporary concrete blocks or other anchors.
iv. Force pump and pump feed tank.
v. Pressure gauge, readable and accurate to 0.01 m head.
vi. Continuous pressure recorder and purpose made charts.

2.1.23.16.3 Procedure

The procedure shall be as follows:

(a) Pipes and valves shall be checked for cleanliness and the operation of valves shall be checked.

(b) Blank flanges or caps shall be fixed to the ends of the pipeline, or section of the pipeline, to be tested. Tests shall not be made against valve gates.

(c) The blank flanges and caps shall be secured with struts and wedges against temporary concrete blocks or other anchors. The blocks and anchors shall be completed and shall have hardened sufficiently before testing starts.

(d) Thrust and anchor blocks, pipe straps and other devices required to prevent movement of pipes and fittings shall be completed before testing starts.

(e) The pipeline shall be filled with water and all air shall be removed.

(f) Unless otherwise permitted by the Engineer, the pipeline shall remain filled for 3 days before testing starts to allow absorption to take place and to achieve conditions which are as stable as practicable.

(g) The pressure in the pipeline shall be increased slowly to the specified test pressure by pumping water into the pipeline using a force pump.

(h) The pressure in the pipeline shall be maintained within +0% and -5% of the specified test pressure for a test period of at least 2 hours.

(i) At the beginning and end of the test period and at 30 minute 170 intervals during the test period, readings shall be taken from the pressure gauge and the pressures (p) shall be recorded. The pressure shall be adjusted to the specified test pressure each time a reading is taken.

(j) The pressure shall be adjusted to within the specified tolerances for the test pressure at any time during the test period when the pressure falls outside the specified tolerances.

(k) The pressure shall be monitored during the test by means of a continuous pressure recorder with purpose made charts.

(l) The leakage of water from the pipeline shall be measured as the amount of water required to maintain the specified test pressure in the pipeline; the amount of water shall be determined from the fall in level of water in the pump feed tank.

2.1.23.16.4 Calculation

(a) The average test pressure (P) shall be calculated as the average of the pressures (p) recorded during the test.

(b) The permitted leakage of water from the pipeline during the pressure test shall be calculated from the equation:

Permitted leakage = $0.02 \times d \times l \times t/24 \times P/10$ litre where:
- d is the nominal diameter of the pipe (mm)
- l is the length of pipeline tested (km)
- t is the test period (hr)
- P is the average test pressure (m)

2.1.23.16.5 Reporting of results

(a) The following shall be reported:

i. The internal diameter of the pipe to the nearest 1 mm.
ii. The length of pipeline tested to the nearest 1 m.
iii. The test period to the nearest 0.01 hr.
iv. The pressures recorded during the test to the nearest 0.01 m.
v. The average test pressure to the nearest 0.01 m.
vi. The leakage and permitted leakage of water to the nearest 0.1 litre.

vii. Details of any discernable leakage of water from the pipeline during the test.
viii. Charts obtained from the continuous pressure recorder.
ix. That the test method used was in accordance with this Specification.

2.1.23.17 References and Standards

BS END 10311 (2005): Joints for the connection of steel tubes and fittings for the conveyance of water and other aqueous liquids

BS END 10224 (2002): Non-alloy steel tubes and fittings for the conveyance of water and other aqueous liquids. Technical delivery conditions

BS END 10220 (2002): Seamless and welded steel tubes. Dimensions and masses per unit length

BS END 10216-1 (2002): Seamless steel tubes for pressure purposes. Technical delivery conditions

BS END 10217-1 (2002): Welded steel tubes for pressure purposes.Technical delivery conditions. Non-alloy steel tubes with specified room temperature properties

BS 2633 (1987): Specification for Class I arc welding of ferritic steel pipework for carrying fluids.

BS 4515: Specification for welding of steel pipelines on land and offshore.

BS END 545 (2010): Ductile iron pipes, fittings, accessories and their joint for water pipelines. Requirements and test methods.

BS 4027 (1996): Specification for sulphate-resisting Portland cement.

BS END 10300 (2005): Steel tubes and fittings for onshore and offshore pipelines. Bitumen hot applied materials for external coating.

BS 3416 (1991): Specification for bitumen-based coatings for cold application suitable for use in contact with potable water.

BS 3505 (1986): Specification for unplasticized polyvinyl chloride PVC-U pressure pipes for cold potable water.

BS 4346-1 (1969): Joints and fittings for use with unplasticized PVC pressure pipes. Injection moulded unplasticized PVC fittings for solvent welding for use with pressure pipes, including potable water supply.

BS 1387 (1985): Specification for screwed and socketed steel tubes and tubulars and for plain end steel tubes suitable for welding or for screwing to BS 21 pipe threads.

BS END 1092-1(2007+A2:2013): Flanges and their joints. Circular flanges for pipes, valves, fittings and accessories, PN designated. Steel flanges

BS END 681-1(1996): Elastomeric seals. Material requirements for pipe joint seals used in water and drainage applications. Vulcanized rubber

BS END 1514: Flanges and their joints. Dimensions of gaskets for PN designed flanges.

AWWA C203 (2008): Standard for Coal-Tar Protective Coatings and Linings for Steel Water Pipelines—Enamel and Tape—Hot Applied

BS 4652 (1995:2000): Specification for zinc-rich priming paint (organic media).

BS 4346-2 (1970): Joints and fittings for use with unplasticized PVC pressure pipes. Mechanical joints and fittings, principally of unplasticized PVC

BS END 14814 (2007): Adhesives for thermoplastic piping systems for fluids under pressure. Specifications

BS END 10241 (2000): Steel threaded pipe fittings

BS END ISO 1461 (2009): Hot dip galvanized coatings on fabricated iron and steel articles. Specifications and test methods

BS 7668 (2004): Weldable structural steels. Hot finished structural hollow sections in weather resistant steels. Specification
BS END 10255 (2004): Non-alloy steel tubes suitable for welding and threading. Technical delivery conditions

BS END ISO 1452 (2009): Plastics piping systems for water supply and for buried and above-ground drainage and sewerage under pressure.

2.1.24 DRAINAGE WORKS

2.1.24.1 General

(a) The works and materials specified in Clauses 2.1.24.1 (b) to (g) shall comply with the sections stated, unless otherwise stated in this Section.

(b) Metalwork for handrailing, ladders, stairs, metal flooring, toe plates and safety chains shall comply with Section 2.1.18.

(c) Earthworks shall comply with Section 2.1.5.

(d) Formwork and finishes to concrete shall comply with Section 2.1.7.

(e) Concrete shall comply with Section 2.1.8.

(f) Water supply pipeworks shall comply with Section 2.1.23.

(g) Cable duct systems for electrical and mechanical installations shall comply with E&M specifications

2.1.24.2 Materials

2.1.24.2.1 Precast concrete pipes and fittings

(a) Precast concrete pipes and fittings shall comply with **BS 5911-1** and **BS EN 1916**.

(b) Precast concrete pipes and fittings shall have flexible spigot and socket joints.

2.1.24.2.2 Vitrified clay pipes and Fittings

(a) Vitrified clay pipes and fittings shall comply with **BS 65**; the pipes and fittings shall be glazed and shall be the normal chemical resistant type.

(b) Vitrified clay pipes and fittings shall have flexible mechanical joints.

2.1.24.2.3 DI pipes and fittings

(a) DI pipes and fittings shall comply with **BS EN 545**. Pipes and fittings shall be lined internally with cement mortar and shall be coated externally with bituminous coating.

(b) Flexible joints in DI pipes and fittings shall be the push-in type and shall be capable of withstanding a minimum angular deflection of 4°.

(c) Flexible joints shall also be capable of withstanding axial movements and shall allow a minimum withdrawal of 38 mm when there is no deflection of the joint.

(d) Flanged joints in DI pipes and fittings shall be PN 16 rating complying with **BS EN 1092-1**.

(e) Pipes which are to be built in to structures shall have puddle flanges welded on.

2.1.24.2.4 Grey iron pipes and Fittings

(a) Grey iron pipes and fittings shall comply with **BS 4622**.

2.1.24.2.5 UPVC pipes and Fittings

(a) UPVC pipes and fittings shall comply with the relevant British Standard stated in Table 2.1.24.1.

(b) UPVC pipes and fittings above ground shall have solvent welded spigot and socket joints. UPVC pipes and fittings below ground shall have either solvent welded spigot and socket joints or flexible spigot and socket joints with elastomeric joint rings as stated in the Contract.

(c) Joints and fittings for UPVC pressure pipes complying with **BS 3506** shall comply with the following:

i. Injection moulded UPVC fittings for solvent welding for use with pressure pipes, including water supply : **BS 4346: Part 1**

ii. Mechanical joints and fittings principally of UPVC : **BS 4346: Part 2**

(d) Solvent cement for UPVC pressure pipes shall comply with **BS 4346: Part 3**.

(e) The Class of UPVC pressure pipes complying with **BS 3506** shall depend on the pressure rating.

2.1.24.2.6 GI pipes and fittings

(a) GI pipes and fittings shall comply with the following:

i. Steel tubes and tubulars suitable for screwing to **BS 21** pipe threads : **BS EN 10255:2004** medium grade
ii. Pipe threads for tubes and fittings where pressure-tight joints are made on the threads : **BS 21**
iii. Wrought steel pipe fittings (screwed BSP thread) : **BS EN 10241.**

(b) GI pipes and fittings shall be medium class thickness and shall be galvanized in accordance with **BS EN ISO 1461**.

Table 2.1.24.1: UPVC pipes and fittings

Use	Nominal diameter (mm)	British Standard
Gravity sewage pipes and fittings above ground	32 - 50	**BS 5255**
	82 - 160	**BS 4514**
Gravity surface water pipes and fittings above ground	63 - 75	**BS EN 12200-1**
	82 - 160	**BS 4514**
Gravity sewage and storm water pipes and fittings below ground	110 - 160	**BS 4660**
	200 - 630	**BS EN 1401-1**
Pressure pipes and fittings above and below ground	10 - 600	**BS 3506**

2.1.24.2.7 Bolts, nuts and washers

(a) Bolts, nuts and washers for flanged joints, detachable couplings and flange adapters shall comply with the following:
   i. ISO metric black hexagon bolts, screws and nuts : **BS 4190**
   ii. Metal washers for general engineering purposes : **BS 4320**.

(b) The bolts, nuts and washers shall be hot-dip galvanised in accordance with **BS EN ISO 1461** or treated with other suitable coating approved by the Engineer.

(c) Stainless steel bolts and nuts shall comply with **BS EN ISO 3506**, steel Grade A4 and property Class 80. Washers shall be Grade 316 S 31 in the softened condition complying with **BS EN 10029**.

(d) Spheroidal graphite iron bolts shall be Grade 500/7 metal complying with **BS EN 1563**.

(e) Bolts, nuts and washers shall be insulated from electrochemically dissimilar metal by non-metallic washers and sleeves.

(f) Bolts and nuts shall be compatible with the type of joint and, unless otherwise approved by the Engineer, shall be obtained from the same manufacturer as the joint.

2.1.24.2.8 Elastomeric joint rings

(a) Elastomeric joint rings shall comply with **BS EN 681-1**. The rings shall be compatible with the type of joint and, unless otherwise approved by the Engineer, shall be obtained from the same manufacturer as the joint.

(b) Elastomeric joint rings for flanged pipes shall be the inside diameter bolt circle type. The rings shall be natural rubber with a thickness of 3.2 mm and with other dimensions complying with **BS EN 1514**.

2.1.24.2.9 Detachable couplings and flange adapters

(a) Detachable couplings and flange adapters shall be a proprietary type approved by the Engineer.
(b) Detachable couplings and flange adapters shall accommodate the angular deflection and straight draw for the different nominal diameters of pipes connected.

2.1.24.2.10 Anticorrosion tape

(a) Anticorrosion tape shall be a proprietary type approved by the Engineer. The tape shall be a rubber/bitumen compound with fabric reinforcement and shall be backed with PVC film. The tape shall have a high resistance to cathodic disbonding, acids and alkalis.

(b) Anticorrosion tape shall be applied to valves, flanged joints, slip-on couplings and flange adapters. Type 1 shall be used for pipes smaller than 700 mm diameter and Type 2 shall be used for pipes 700 mm diameter and above.

(c) Primer and mastic filler for use with anticorrosion tape shall be compatible with the tape and shall be a type recommended by the manufacturer of the tape and approved by the Engineer.

2.1.24.2.11 Bituminous coatings

(a) Bituminous coatings shall comply with the following:

i. Bitumen based hot applied coating material for protecting iron and steel including suitable primers where required : **BS EN 10300**
ii. Black bitumen coating solutions for cold application: **BS 3416**, Type II.

(b) Bituminous coatings used for repairing joints and coatings shall be compatible with the adjacent coating.

2.1.24.2.12 Aggregates for granular bed and granular fill

(a) Granular bed shall be Type A material and granular fill shall be Type B material.

(b) Type A or Type B material shall consist of hard, clean, crushed slag, gravel, crushed rock, crushed concrete or crushed inert demolition material having a grading within the limits of Table 2.1.24.2. The ten percent fines values shall be at least 50 kN. The material passing the 425 µm BS test sieve shall be non-plastic when tested in accordance with **BS 1377**.

(c) Type A and Type B materials shall be obtained from a source approved by the Engineer.

(d) Aggregates for granular bed shall have the compacting fraction values stated in Clause 2.1.24.22.4.

Table 2.1.24.2: Range of grading of Type A and Type B materials

BS test sieve	**Percentage by mass passing**	
Metric	*Type A*	*Type B*
63 mm	-	100
37.5 mm	100	85-100
20 mm	-	0-20
10 mm	45-100	0-5
3.35 mm	25-80	-
600 µm	8-45	-
75 µm	0-10	-

Table 2.1.24.3: Joint filler for concrete bed, haunch and surround

Nominal diameter of pipe	Thickness of joint filler (mm)
less than 450 mm	18
450 mm - 1200 mm	36
exceeding 1200 mm	54

2.1.24.2.13 Joint filler and compressible padding

(a) Joint filler for joints in concrete bed, haunch and surround shall be a firm, compressible, single thickness, non-rotting filler. The thickness of the filler shall be as stated in Table **2.1.24**.3.

(b) Compressible padding between pipes and supports shall be bitumen damp-proof sheeting complying with **BS 743**.

2.1.24.2.14 Polyethylene sheeting

(a) Polyethylene sheeting shall be impermeable and shall have a nominal thickness of 0.125 mm.

2.1.24.2.15 Precast concrete manholes

(a) Precast concrete manhole units shall comply with **BS 5911-3** and **BS EN 1917**. Cover slabs and reducing slabs shall be reinforced as required to comply with the load test requirements stated in **BS 5911-3**.

2.1.24.2.16 Chambers and gullies

(a) Precast concrete chambers and gullies shall comply with **BS 5911-4:2002+A2:2010**. Cover slabs shall be reinforced as required to comply with the load test requirements stated **in BS 5911-4:2002+A2:2010.** The types of cement for the manufacture of precast concrete chambers and gullies, and cover slabs shall be as stated in **BS 5911-4:2002+A2:2010**, or a combination of PFA and OPC complying with BS 12, or PPFAC. The PFA content shall not exceed 40% by mass of the cementitious content.

(b) Vitrified clay gullies shall comply with **BS 65**.

2.1.24.2.17 Step irons

(a) Step irons shall comply with **BS EN 13101**. Step irons shall be malleable cast iron complying with **BS EN 1562** and shall be hot-dip galvanised in accordance with **BS EN ISO 1461**.

2.1.24.2.18 Manhole covers, gully gratings and kerb overflow weirs

(a) Manhole covers, gully gratings and kerb overflow weirs shall be Grade 150 cast iron complying with **BS EN 1561**; bolts and nuts shall comply with **BS 4190**.

(b) Covers, gratings and weirs shall be cleanly cast, free from air holes, sand holes, cold shuts and chill and shall be neatly dressed and fettled. Castings shall be free from voids whether due to shrinkage, gas inclusions or other causes. Bolts and nuts shall not be over tightened.

(c) The dimensions of the different types of covers, gratings and weirs shall be as stated in the Contract; the test loads which the covers and gratings are required to withstand, and the minimum masses of covers gratings and weirs, shall be as stated in Table 2.1.24.4 and Table 2.1.24.5.

(d) Covers, gratings and weirs shall have the manufacturer's name cast integrally with the unit in a raised form and shall be protected with bituminous coating. Covers shall have a raised design on the top surface as stated in the Contract.

Table 2.1.24.4: Details of manhole covers and frames

Type of manhole cover and frame	Minimum mass(kg)	Grade	Test requirements	
			Diameter of block (mm)	Test load (t)
Double triangular manhole cover and frame	180	Medium duty	100	5
Double triangular manhole cover for sewers	130	Heavy duty	300	30
Double triangular manhole cover for sewers frame	105	Heavy duty	300	30
Double triangular desilting manhole cover for sewers frame	290	Heavy duty	300	30
Double triangular desilting manhole cover for sewers frame	165	Heavy duty	300	30
Double seal terminal manhole cover for sewers	-	Medium duty	300	20
	-	Medium duty	300	20
	-	Heavy duty	100	5
	-	Heavy duty	100	5

Table 2.1.24.5: Details of gully gratings and frames

Type of manhole cover and frame	Minimum mass(kg)	Grade	Test requirements	
			Diameter of block (mm)	Test load (t)
Grating for hinged gully grating	28.0	Heavy duty	300	20
Grating for hinged gully grating frame	24.5	Heavy duty	300	20
Grating for double triangular grating	57.5	Heavy duty	300	20
Shallow frane				
-adjacent to kerb	33.5	Heavy duty	300	20
-away from kerb	36.5	Heavy duty	300	20
Deep frame				
-adjacent to kerb	40.5	Heavy duty	300	20
-away from kerb	44	Heavy duty	300	20
Grating for hinged gully	61.5	Heavy duty	300	20

Grating for hinged gully frame	37	Heavy duty	300	20

2.1.24.2.19 Penstocks

(a) Penstocks shall comply with the following requirements:

i. Frames and gates shall be cast iron complying with **BS 1452**, Grade 220.
ii. Stems shall be stainless steel complying with **BS EN 10095** and **BS END 10250-4**. Operating nuts shall be gunmetal complying with **BS EN 1982**, Grade LG2.
iii. Sealing faces shall be phosphor bronze complying with **BS EN 12167**.
iv. Sealing strips at inverts of flush invert penstocks shall be elastomer complying with ASTM D 2000.
v. Assembly and fixing nuts and bolts shall be stainless steel complying with Clause 2.1.24.2.7 (c).
vi. Adjustable wedges shall be phosphor bronze complying with **BS EN 12167**, Grade PB 102 or stainless steel complying with **BS EN 10095**.

(b) Penstocks shall be designed for on-seating pressure or off-seating pressure or both on-seating and off-seating pressures as stated in the Contract.

(c) Sealing faces shall be of rectangular sections and shall be fixed to the frames and gates using taperhead screws of the same material as the sealing faces.

(d) Adjustable wedges shall have sufficient contact areas with the gates to minimise wear.

(e) Frames shall include guide rails or guide faces for gates.

(f) Clearance within guides shall be as small as practicable such that the gates will not vibrate under flow conditions.

(g) Penstocks shall have rising stems unless otherwise stated in the Contract. Rising stems shall have perspex protection tubes with open/close indicators.

2.1.24.2.20 Gate valves

(a) Gate valves shall comply with **BS END 1171:2002** and with the following requirements:

i. Bodies and wedges shall be cast iron complying with **BS 1452**, Grade 220 and shall have renewable gunmetal seat rings.
ii. Gunmetal for renewable seat rings shall be Grade LG2 complying with BS EN 1982.
iii. Stem nuts shall be gunmetal complying with **BS EN 1982**, Grade LG2.
iv. Stems shall be aluminium bronze complying with **BS EN 12167**.
v. Assembly and fixing nuts and bolts shall be stainless steel complying with Clause 2.1.24.2.7 (c).

(b) Gate valves shall be double flange-ended solid wedge type with nominal pressure designation PN 16. Flanges shall be PN 16 complying with **BS EN 1092-1**.

(c) Gate valves shall have outside screw rising stems unless otherwise stated in the Contract. Rising stems shall have perspex protection tubes with open/close indicators.

(d) Gate valves shall be fitted with a plate showing the operating position of the valve in the closed, quarter closed, half closed, threequarters closed and open positions.

(e) Chains for chain operated gate valves shall be mild steel complying with **BS EN 10095, BS EN 10250-4** and hot-dip galvanized in accordance with **BS EN ISO 1461**; the chains shall be continuous.

2.1.24.2.21 Flap valves

(a) Flap valves shall comply with the following requirements:

i. Frames and flaps shall be cast iron complying with **BS 1452**, Grade 220.
ii. Sealing faces and hinge pins shall be gunmetal complying with **BS EN 1982**, Grade LG2.

(b) The flap shall be hung with double hinges and secured with hinge pins.

(c) Flanges for flange mounting types of flap valves shall be PN 16 complying with **BS EN 1092-1**.

2.1.24.2.22 Sludge valves

(a) Sludge valves shall comply with the following requirements:

i. Bodies and valve sections shall be cast iron complying with **BS 1452**, Grade 220.
ii. Sealing faces and stem nuts shall be gunmetal complying with **BS EN 1982**, Grade LG2.
iii. Stems shall be aluminium bronze complying with **BS EN 12167**.

(b) The stems of sludge valves shall operate through non-rising stem nuts housed in bridges bolted over the body sections.

(c) Outlet flanges of sludge valves shall be PN 16 complying with **BS EN 1092-1**.

2.1.24.2.23 Air valves

(a) Air valves shall be of the elongated body type and shall have a pressure rating of 3 bars unless otherwise stated in the Contract.

(b) Dual orifice air valves shall have:
i. a small orifice valve for releasing air at working pressure, and
ii. a large orifice valve for allowing air to pass at atmospheric pressure during emptying and filling of pipework.

(c) The bodies and covers of small and large orifice valves shall be cast iron complying with **BS 1452**, Grade 220; the trim and float shall be stainless steel complying with **BS EN 10095**.

(d) Small orifice valves shall have an adjustable Vitron orifice button to ensure positive sealing. Large orifice valves shall have a Buna-N seat.

(e) The valve inlet of small orifice valves shall be 75 mm diameter and the valve outlet shall be 25 mm diameter; the venting orifice shall be 5 mm diameter. The valve inlet and the valve outlet of large orifice valves shall be 75 mm diameter.

(f) Air valves shall be provided with isolating gate valves.

2.1.24.2.24 Fittings for penstocks and valves

(a) Handwheels and tee keys for penstocks and valves shall turn in a clockwise direction for closing. Handwheels shall have smooth rims and the direction of opening and closing shall be clearly cast on the handwheel.

(b) The opening effort required at any point on the handwheel rim shall not exceed 250 N when operated against the full unbalanced pressure.

(c) Extension stems for penstocks and valves shall be stainless steel of the same grade as the stems; extension stems shall be connected by muff couplings.

(d) Handwheels, tee keys, headstocks, guide brackets for stems, supporting brackets, surface boxes and other fittings for penstocks and valves shall be cast iron complying with **BS EN 1561**.

(e) Bolts and nuts for fixing penstocks and valves to structures shall be stainless steel complying with 2.1.24.2.7 (c). Bolts shall be indented foundation bolts.

(f) Grout for filling rebates and box-outs shall be a proprietary type approved by the Engineer and shall contain a non-shrink admixture.

2.1.24.2.25 Filling abandoned pipes and manholes

(a) Foam concrete for filling abandoned pipes, culverts, manholes and voids shall be composed of OPC (or PPFAC), fine aggregate, water, admixtures for accelerating or retarding the setting time and foam to reduce the density and to produce a flowing self levelling material.

(b) As an alternative to foam concrete when permitted by the Engineer, a grout of OPC/PFA and water may be used. Sand and admixtures may not be used in the OPC/PFA grout unless approved in writing by the Engineer.

(c) The OPC/PFA grout shall consist of 15 parts of PFA to 1 part of OPC by mass together with the minimum amount of water necessary to achieve a consistency suitable for flowing into the pipes, culverts, manholes and voids.

2.1.24.3 Submissions

2.1.24.3.1 Particulars of pipes, joints and fittings

(a) The following particulars of the proposed pipes, joints and fittings for drainage works shall be submitted to the Engineer:

i. manufacturers' literature, including details of:
- manufacturing process
- pressure and temperature ratings
- permissible values of straight draws and angular deflection of flexible joints
- recommendations for handling, storage, laying, jointing and repair
- drilling and tapping equipment for connections to pipes, and

ii. a certificate for each material showing the manufacturer's name, the date and place of manufacture and showing that the material complies with the requirements stated in the Contract and including results of tests required in accordance with the Contract.

(b) The particulars, including certificates, shall be submitted to the Engineer at least 14 days before the first delivery of the material to the Site. Certificates shall be submitted for each batch of the material delivered to the Site.

2.1.24.3.2 Particulars of anticorrosion tape and joint filler

(a) The following particulars of the proposed anticorrosion tape and joint filler for drainage works shall be submitted to the Engineer:

i. manufacturer's literature for anticorrosion tape, and
ii. certificates for anticorrosion tape and joint filler showing the manufacturers' name, the date and place of manufacture and showing that the material complies with the requirements stated in the Contract and including results of tests in accordance with the Contract.

(b) The particulars, including certificates, shall be submitted to the Engineer at least 14 days before the first delivery of the material to the Site. Certificates shall be submitted for each batch of the material delivered to the Site.

2.1.24.3.3 Particulars of aggregates for granular bed

(a) A certificate for each type of aggregate showing the source of the aggregate and showing that the aggregate complies with the requirements stated in the Contract, and including the results of tests in accordance with the Contract, shall be submitted to the Engineer for the proposed aggregates for granular bed for drainage works.

(b) The particulars, including certificates, shall be submitted to the Engineer at least 14 days before the first delivery of the aggregate to the Site and thereafter each time the source is changed.

2.1.24.3.4 Particulars of manholes, chambers and gullies

(a) The following particulars of the proposed materials for manholes, chambers and gullies for drainage works shall be submitted to the Engineer:

i. a certificate for each type of manhole and chamber unit and for each type of gully showing the manufacturer's name, the date and place of manufacture and showing that the materials comply with the requirements stated in the Contract and including results of tests required in accordance with the Contract,

ii. a certificate for step irons showing the manufacturer's name, the date and place of manufacture and showing that the step irons comply with the requirements stated in the Contract, and including results of tests required in accordance with the Contract, and

iii. a certificate for each type of manhole cover, gully grating and kerb overflow weir showing the manufacturer's name, the date and place of manufacture and showing that the materials comply with the requirements stated in the Contract and including results of tests in accordance with the Contract.

(b) The particulars, including certificates, shall be submitted to the Engineer at least 14 days before the first delivery of the material to the Site. Certificates shall be submitted for each batch of the material delivered to the Site.

2.1.24.3.5 Particulars of penstocks and valves

(a) The following particulars of the proposed penstocks and valves for drainage works shall be submitted to the Engineer:

i. manufacturer's literature, including details of:
- materials;
- pressure ratings;
- recommendations for handling, storage and installation.

ii. drawings showing details of the penstocks and valves, including lengths of stems and details of handwheels, tee keys, extension stems, headstocks, guide brackets

for stems, supporting brackets, surface boxes and other fittings, and positions and sizes of rebates and box-outs.

The particulars shall be submitted to the Engineer at least 28 days before the first delivery of the material to the Site.

2.1.24.3.6 Particulars of foam concrete and OPC/PFA grout

(a) The following particulars of the foam concrete and grouting procedure for filling abandoned pipes, culverts, manholes and voids shall be submitted to the Engineer:

i. proportions of each constituent,
ii. source of supply,
iii. details of mixing,
iv. setting time,
v. strength,
vi. shrinkage expected (for OPC/PFA grout),
vii. details of mixing and grouting equipment, and
viii. method of grouting, including details of trials.

(b) The particulars shall be submitted to the Engineer at least 7 days before grouting starts.

2.1.24.3.7 Particulars of tests

The following particulars of the proposed procedures for tests on pipelines and penstocks for drainage works shall be submitted to the Engineer:

i. test equipment and method of setting up the equipment,
ii. calibration certificates for pressure gauges,
iii. procedure for carrying out the test, and
iv. programme for testing.

The particulars shall be submitted to the Engineer at least 14 days before the test starts.

2.1.24.3.8 Particulars of CCTV inspections

The following particulars of the proposed procedure for CCTV inspections shall be submitted to the Engineer:

i. names and experience of persons carrying out or supervising
ii. the inspections,
iii. details of equipment,
iv. details of the format of report, and
v. examples of video films and photographs obtained from inspections employing the same equipment.

The particulars of the procedure shall be submitted to the Engineer at least 28 days before the inspection starts.

2.1.24.3.9 Particulars of diversions of flow

(a) Unless otherwise permitted by the Engineer particulars of the proposed procedures for diversions of existing flows shall be submitted to the Engineer at least 14 days before the diversion starts.

2.1.24.4 Transport, handling and storage of materials

2.1.24.4.1 Transport, handling and storage of pipes, joints and fittings

(a) Pipes, joints and fittings for drainage works shall be transported, handled and stored in accordance with the manufacturers' recommendations and in a manner which will not result in damage or deformation to the pipes, joints and fittings or in contamination of the pipes, joints and fittings.

(b) Pipes, joints and fittings shall be protected from damage and damaged pipes, joints and fittings shall not be used in the permanent work unless permitted by the Engineer.

(c) UPVC pipes, joints and fittings shall be protected from exposure to conditions which may affect the material.

(d) Bolts and nuts shall be packed in sealed metal containers.

(e) Elastomeric joint rings shall be packed in bags and lubricant for joints shall be stored in sealed containers marked to identify the contents.

(f) The rings and lubricant shall be protected from exposure to conditions which may affect the material.

2.1.24.4.2 Handling of pipes and fittings

(a) Pipes and fittings shall be handled manually or by using lifting appliances or chains, wire rope or canvas slings of a type recommended by the pipe manufacturer and agreed by the Engineer; hooks shall not be used.

(b) Slings shall be placed around the pipes and fittings and padding shall be provided at points of contact between pipes and fittings and metal lifting appliances or slings. Pipes shall not be handled by means of metal slings passed through the pipes.

(c) Pipes and fittings shall not be subjected to rough handling, shock loading or dropping and shall not be rolled down ramps unless permitted by the Engineer; if permitted, the ramps shall be padded.

2.1.24.4.3 Storage of pipes

(a) Pipes shall be stored horizontally at least 75 mm above the ground on wedged timber bearers. The bottom layers and the outer pipes in each layer shall be securely wedged to prevent sideways movement.

(b) Socket and spigot pipes shall be stored with the sockets alternating and in such a manner that loads are not applied to the sockets.

(c) The height of stacks of pipes shall not exceed 2 m unless recommended by the manufacturer and permitted by the Engineer.

(d) Pipes shall not be strung out along the route of the pipeline unless permitted by the Engineer.

2.1.24.4.4 Storage of anticorrosion tape and joint filler

(a) Anticorrosion tape and joint filler shall be stored in accordance with the manufacturer's recommendations in a dry, weatherproof store with a raised floor.

2.1.24.4.5 Handling and storage of aggregates for granular bed

(b) Aggregates for granular bed shall not be handled or stored in a manner which will result in mixing of the different types and sizes or in contamination of the aggregates. Different types and sizes of aggregates shall be stored in separate stockpiles.

2.1.24.4.6 Handling and storage of units for manholes, chambers and gullies

(a) Units for manholes, chambers and gullies shall be lifted only at the lifting points recommended by the manufacturer and shall not be subjected to rough handling, shock loading or dropping.

(b) Units for manholes, chambers and gullies shall be stored off the ground on level supports and in a manner which will not result in damage to the units or in contamination or deformation of the units. The units shall be protected from damage and damaged units shall not be used in the permanent work unless permitted by the Engineer.

2.1.24.4.7 Storage of covers, gratings, weirs penstocks and valves

(c) Manhole covers, gully gratings, kerb overflow weirs, penstocks and valves, including fittings, shall be stored off the ground on level supports and in a manner which will not result in damage to the units or in contamination or deformation of the units. The units shall be protected from damage and damaged units shall not be used in the permanent work unless permitted by the Engineer.

2.1.24.5 Excavation

2.1.24.5.1 Excavation

(a) Excavation for any section of a trench for drainage works shall not commence until the nature, location and size of existing utilities which may be affected by the excavation have been ascertained and the setting out details have been approved by the Engineer.

(b) The effective trench width of trenches for drainage works shall not exceed the relevant effective trench widths stated in Table 2.1.24.6 for the different diameters of pipe. The effective trench width shall be measured as stated in the Contract.

Table 2.1.24.6: Effective trench widths

Nominal diameter of pipe (mm)	Effective trench width (mm)
100	550
150	600
225	750
300	1050
375	1150
450	1200
525	1350
600	1450
750	1500
825	1600
900	1900
975	2000
1050	2050
1125	2200
1200	2300
1350	2450

1500	2600
1650	2800
1800	2950
1950	3150
2100	3350
2250	3400
2400	3500
2550	3650
2700	3800
2850	3950
3000	4150

2.1.24.6 Laying and bedding pipes

2.1.24.6.1 Laying pipes

(a) The Contractor shall allow the Engineer to inspect trenches, bedding, pipes, joints, fittings and valves before pipelaying for drainage works starts. The Contractor shall inform the Engineer 24 hours, or such shorter period agreed by the Engineer, before pipelaying starts in any part of the permanent work.

(b) The permission of the Engineer shall be obtained before pipelaying starts in any part of the permanent work.

(c) The Contractor shall inspect pipes, joints, fittings and valves, including internal and external coatings, immediately before and after pipelaying; valves shall be inspected to ensure that they are in working order and are capable of being fully opened and closed. Deleterious material shall be removed and damage shall be repaired immediately before and after pipelaying.

(d) The inside of pipelines shall be kept clean and free from water, dirt, stones, debris and deleterious material. Except when pipes are being jointed, the open ends of pipelines shall be sealed with a wooden plug or stopper or by other methods agreed by the Engineer.

(e) Measures shall be taken to prevent flotation of pipes.

(f) Pipelaying, testing and backfilling shall follow as closely as practicable on excavation of the trench.

(g) Unless otherwise permitted by the Engineer, pipelines shall be laid in an uphill direction with sockets facing uphill.

(h) Pipes shall be laid in such a manner that water will not pond in locations with zero or shallow gradients and such that the pipes will comply with the specified tolerances.

2.1.24.6.2 Bedding pipes

(a) Surfaces on which pipes for drainage works will be laid shall be cleaned and objects which may damage the pipes shall be removed before pipes are laid.

(b) The bottom of trenches on which pipes will be laid directly shall be shaped to support the pipes uniformly along the length of the barrel; holes shall be dug to prevent pipes resting on the sockets and to allow the pipes to be jointed.

2.1.24.7 Cutting pipes

2.1.24.7.1 Cutting pipes

(a) Pipes for drainage works shall be cut and the ends shall be prepared in accordance with the manufacturers' recommendations; purpose-made equipment recommended by the manufacturer or approved by the Engineer shall be used for cutting the pipes.

(b) Cut ends of pipes shall be square or cut to the correct angle and without damage to the pipe or coating. Cut ends shall be trimmed and chamfered to suit the type of joint and in such a manner that elastomeric joint rings will not be damaged by the cut end.

(c) Pipes requiring to be cut to form closing lengths shall not be cut until adjacent pipes have been laid and jointed and the length to be cut can be accurately measured.

(d) Reinforcement in precast concrete pipes which are cut shall be cut back flush with the concrete and protected with epoxy resin or by other methods agreed by the Engineer.

(e) Pipes which terminate at the inside face of structures shall be cut such that the end of the pipe is flush with the face.

2.1.24.8 Jointing pipes

2.1.24.8.1 Jointing pipes

(a) Pipes for drainage works shall be jointed in accordance with the manufacturers' recommendations and using jointing equipment and jointing materials recommended by the manufacturer or approved by the Engineer.

(b) The Contractor shall inspect pipes, joints, fittings and valves, including internal and external coatings, immediately before and after jointing. Deleterious material shall be removed and damage shall be repaired immediately before and after jointing. Surfaces which are to be jointed and jointing materials shall be cleaned immediately before jointing. Pipes shall be cleaned out with clean water.

(c) All joints in pipelines shall be watertight.

(d) The widths of gaps at joints shall be in accordance with the manufacturers' recommendations and shall be achieved by marking the outside of the pipe, by using metal feelers or by other methods agreed by the Engineer. The position of elastomeric joint rings shall be checked by using metal feelers after jointing.

(e) Gaps at joints in pipes shall be protected after jointing, by methods agreed by the Engineer, to prevent dirt, stones or other material entering the joint.

2.1.24.8.2 Flanged joints

(a) Flanged joints in pipes for drainage works shall be made as stated in Clause 2.1.24.8.2(b) and (c).

(b) Bolts holes in flanged joints and joints incorporating bolted components shall be correctly orientated before the bolts are tightened. The correct size of bolts and nuts shall be used. Bolt threads shall be lubricated and bolts shall be tightened using the correct size of

spanner. Bolts shall be tightened in diametrically opposite pairs working around the bolt circle until all bolts are tightened to the torque recommended by the manufacturer.

(c) Bolt holes in flanged joints shall be orientated symmetrically about the vertical diameter with no bolt holes on the vertical diameter. Elastomeric joint rings shall be the correct size and shall not protrude into the bore of the pipe. The rings may be temporarily fixed to the face of the flange using a minimum amount of adhesive of a type recommended by the manufacturer; jointing compound or paste shall not be used for this purpose.

2.1.24.8.3 Flexible collar joints

(a) Flexible collar joints in pipes for drainage works shall be made as stated in Clause 2.1.24.8.3(2) to (4).

(b) The elastomeric joint rings shall be placed in position inside the grooves of the sleeve. The ends of the pipes shall be well smeared with lubricant over a distance of at least 100 mm from the end of the pipe.

(c) The sleeve shall be placed on the end of the laid pipe and pushed home to the location mark on the pipe; the location mark shall be at a distance of half the length of the sleeve minus 3 mm from the end of the pipe unless otherwise recommended by the manufacturer.

(d) The pipe which is to be jointed to the laid pipe shall be placed in the sleeve and pushed home to the location mark on the pipe.

2.1.24.8.4 Push-in joints

(a) Push-in joints in pipes for drainage works shall be made by smearing the elastomeric joint ring with lubricant and placing the ring in position on the spigot end of the pipe. The spigot shall be placed in the socket of the laid pipe and pushed home.

2.1.24.8.5 Detachable joints

(a) Detachable joints in pipes for drainage works shall be jointed as stated in Clause 2.1.24.8.5 (b) and (c).

(b) Both CI flanges, the elastomeric joint rings and the central collar shall be placed over the ends of the pipes before the pipes are placed to the required line and level; a gap of between 5 mm and 6 mm shall be left between the ends of the pipes.

(c) The flanges, elastomeric joint rings and central collar shall be moved into position at the ends of the pipes; the central collar shall be positioned centrally over the gap between the ends of the pipe before the bolts are tightened.

2.1.24.8.6 Flange adapters

(a) Joints with flange adapters in pipes for drainage works shall be made by placing the flange adaptor on the plain end before the bolts are tightened.

2.1.24.8.7 Solvent welded joints

(a) Solvent welded joints in pipes for drainage works shall be made by applying solvent cement to the pipes to be jointed and pushing the pipes home. Excess solvent shall not be applied and surplus solvent shall be removed after jointing. Solvent welded pipes jointed outside the trench shall not be placed in the trench until the solvent setting period recommended by the manufacturer has elapsed. In addition, any material or thing contaminated by the solvent shall not be left in the pipe or trench.

2.1.24.8.8 Screw joints

(a) Screw joints in pipes for drainage works shall be made using a threaded coupler. The threaded surfaces of the pipes and coupler shall be cleaned and the threads shall be painted with two coats of bituminous paint. The pipe thread shall be wrapped with three turns of spun yarn or other material approved by the Engineer and the joint tightened using purpose made tools. Coal tar compounds or white lead paint shall not be used.

Locking nuts to branch connections shall be tightened. Branch connections shall not protrude inside the pipe.

2.1.24.9 Protection of joints

2.1.24.9.1 Protection of joints

(a) Flanged joints, detachable couplings and flange adapters on buried pipes for drainage works shall be protected as stated in Clause 2.1.24.9.1 (b) to (d).

(b) The joint, including bolts and nuts, shall be cleaned to remove all moisture, dust, oil, grease and deleterious material. Bolts and nuts shall be painted with two coats of bituminous point and the joint shall be coated with primer. Mastic filler shall be applied in such a manner that all depressions, corners and voids between the bolts and nuts are filled and a smooth surface is available on which to apply the anticorrosion tape.

(c) At least two layers anticorrosion tape shall be applied to all parts of the joint and to the adjacent pipe for at least 200 mm beyond each end of the joint. The tape shall be applied in accordance with the manufacturer's recommendations and shall be wrapped spirally around the joint and pipe with at least 55% overlap per spiral.

(d) The tape shall be moulded manually after application to take up the contours of the parts being protected.

2.1.24.10 Repairs to coatings and linings

2.1.24.10.1 Repairs to coatings and linings

(a) Damage to coatings and linings of pipes for drainage works shall not be repaired unless permitted by the Engineer. If permitted, repairs shall be carried out using materials recommended by the manufacturer and approved by the Engineer.

2.1.24.11 Thrust and anchor blocks

2.1.24.11.1 Thrust and anchor Blocks

(b) Thrust or anchor blocks shall be used to resist forces at bends, branches and stopends in pressure pipelines for drainage works except where self anchoring joints are used. Concrete for thrust and anchor blocks shall be Grade 20.

(c) The bearing face, and other faces stated in the Contract, of concrete anchor and thrust blocks shall be cast directly against undisturbed ground; the faces of excavations shall be trimmed to remove loose material before concreting. Excavation required for the block beyond the trench width shall be carried out after the pipe or fitting has been jointed. Excess excavation beyond the face at the block shall be filled with concrete of the same Grade as the block.

(d) Internal pressure shall not be applied to the pipeline until thrust and anchor blocks have developed the specified grade strength.

2.1.24.12 Bed, haunch and surround

2.1.24.12.1 Granular bed

(a) Granular bed to pipelines for drainage works shall be constructed as stated in Clause 2.1.24.12.1 (b) to (d).

(b) Aggregates for granular bed shall be deposited in the trench in layers not exceeding 150 mm thick and for the complete width of the trench. Each layer shall be compacted using a plate vibrator or by other methods agreed by the Engineer.

(c) Holes shall be dug in the granular bed to prevent pipes resting on the sockets and to allow the pipes to be jointed. The pipes shall be laid directly on the granular bed; temporary supports shall not be used.

(d) After the pipes have been jointed, aggregate shall be deposited in layers not exceeding 150 mm thick equally on both sides of the pipe to the specified level for the complete width of the trench. Each layer shall be compacted using a plate vibrator or by other methods agreed by the Engineer.

2.1.24.12.2 Concrete bed, haunch and surround

(a) Concrete bed, haunch and surround to pipelines for drainage works shall be constructed as stated in Clause 2.1.24.12.2 (b) to (g).

(b) Concrete for concrete bed, haunch and surround shall be Grade 20.

(c) Polyethylene sheeting or a blinding layer shall be placed on the trench bottom before concreting.

(d) Pipes shall be supported at the required level by Grade 20 precast concrete wedges, blocks or cradles or by other methods agreed by the Engineer. One support shall be placed adjacent to each end of each pipe and the spacing between supports shall not exceed 3 m. Compressible sheeting shall be placed between the pipes and supports.

(e) Flexible joints shall be formed in concrete bed, haunch and surround at flexible joints in pipelines. Joint filler shall be placed next to the flexible joint in the pipeline and shall extend for the complete thickness of the bed, haunch and surround.

(f) Concrete shall be placed evenly over the complete width of the bed and over the complete length of the pipe being concreted up to a level of 25 mm below the underside of the pipe. Concrete shall then be placed on one side of the pipe only and worked under the pipe until the concrete spreads under the pipe. Concrete shall then be placed equally on both sides of the pipe to the specified level.

(g) Pipes for drainage works which are 1 m or less below the surface of a carriageway shall be protected with Grade 20 concrete surround.

(h) The aggregate for Grade 20 concrete stated in Clause 2.1.24.12.2 (a) to (g) shall be natural stone, crushed rock or crushed concrete.
Such Grade 20 concrete shall have the following minimum cementitious content:

Exposure condition*	Minimum cementitious content (kg/m3)
Moderate	280
Severe	330

[* Exposure condition shall be as stated in the Contract]

2.1.24.12.3 Fill material surround

(a) Fill material surround to pipelines for drainage works shall comply as stated in Clause 2.1.24.12.3 (b) to (e).

(b) Except as stated in Clause 2.1.24.12.3(d), fill material deposited within 0.5m of a structure or utility shall be fine fill material unless otherwise stated in the Contract. In addition, the material may contain up to 5% by weight of fresh, slightly decomposed or moderately decomposed rock fragments of up to 200 mm provided that these do not cause any damage to structures, nor do they interfere with the compaction requirements.

(c) Fill material shall not be deposited adjacent to or above structures or utilities until the construction of the structure or utility is sufficiently advanced to accept the imposed forces without disturbance or damage.

(d) Fill material shall be deposited evenly on all sides of structures and utilities and in such a manner that the structure or utility is not disturbed or damaged.

(e) Unless otherwise stated in the Contract, fill material around water, sewage and drainage pipes which are constructed as part of the permanent work shall be special fill material. They shall be deposited in layers not exceeding 100 mm thick to a level of 300 mm above the top of the pipe. The fill material shall be deposited in such a manner that the layer on one side of the pipe is not more than 100 mm higher than the layer on the other side.

2.1.24.13 Tolerances

2.1.24.13.1 Tolerances: pipelines for drainage works

(a) Except as stated in Clause 2.1.24.13.1 (b), pipelines for drainage works shall comply with the following requirements:

i. The line of gravity pipelines shall be within 20 mm of the specified line.
ii. The invert level of gravity pipelines shall be within 6 mm of the specified invert level and shall be such that there is no backfall at any point.
iii. The line of pressure pipelines shall be within 50 mm of the specified line.
iv. The invert level of pressure pipelines shall be within 20 mm of the specified invert level.

(b) Termination pipes in pipelines for drainage works which are designed to connect to pipes or fittings laid by others shall comply with the following requirements:

i. The position of the centre of the termination face of the pipe in the longitudinal direction shall be within 10 mm of the specified position.
ii. The position of the centre of the termination face of the pipe in the lateral direction shall be within 3 mm of the specified position.
iii. The gradient of the termination pipe shall be within 0.5° of the specified gradient.
iv. The invert level at the termination face of the pipe shall be within 3 mm of the specified invert level.

2.1.24.14 Connections

2.1.24.14.1 Connections to Structures

(a) The joints between pipes for drainage works and structures into which the pipes are built shall be watertight; protective coatings shall be removed over the length to be built in before the pipe is built in. Pipe collars and sockets shall not be built in to structures.

(b) Two flexible joints shall be provided in pipelines adjacent to the outside faces of structures into which pipes will be built. The distances from the outside face of the structure to the first joint and from the first joint to the second joint shall be as stated in Table 2.1.24.7.

(c) The ends of pipes which are built in to structures shall be temporarily sealed with a blank flange, brickwork or timber boarding as instructed by the Engineer. The temporary seals shall be left in position until the Engineer instructs their removal.

Table 2.1.24.7: Flexible joints at structures

Diameter of pipe from structure	**Position of first flexible joint from structure**		**Distance of second flexible joint from first flexible joint**
	Minimum	**Maximum**	
not exceeding 450 mm	150 mm	500 mm or diameter of pipe, whichever is less	450 mm - 800 mm
exceeding 450mm but not exceeding 1050 mm			900 mm – 1200 mm
exceeding 1050 mm			1500 mm – 1800 mm

2.1.24.14.2 Connections to pipes

(a) Pipe saddles shall be connected to concrete or vitrified clay pipes by bedding the saddle on a cement mortar bed and forming a cement mortar fillet to provide at least 50 mm cover to the base of the saddle. Cement mortar shall consist of cement and sand in the proportions 1:3 by mass.

(b) UPVC pipe saddles shall be fixed to UPVC pipes using a purposemade mechanical clip or solvent cement of a type recommended by the manufacturer and approved by the Engineer.

(c) Unless otherwise agreed by the Engineer, branch pipelines shall be connected to main pipelines using Y-junctions of the same type and strength as the stronger of the pipes being jointed; the angle of the Y-junction shall be between 30° and 45°.

(d) Pipes which are to be connected to concrete or clay pipes without a Y-junction or purpose made pipe saddle shall be cut on a splay to form a junction such that the incoming pipe is at an angle of between 30° and 60° to the main pipe upstream of the joint. The hole which is cut in the main pipe to which a connection is to be made shall be of a suitable elliptical shape to suit the cut end of the branch pipe. The length of the branch pipe shall be such that:

i. the cut end of the pipe rests on the outside barrel of the main pipe, and

ii. the cut pipe does not project inside the main pipe.

(e) The joint between the cut pipe and the main pipe shall be sealed externally and, unless otherwise permitted by the Engineer, sealed internally flush with the main pipe with cement mortar. Cement mortar shall consist of cement and sand in the proportions 1:3 by mass.

(f) The positions of the pipe junctions relative to the manhole or structure immediately downstream shall be measured and recorded before backfilling.

(g) The ends of connecting pipes which are not required for immediate use shall be sealed with a blank flange, brickwork or other methods instructed by the Engineer and the position measured and recorded before backfilling.

2.1.24.15 Manholes, chambers, gullies and channels

2.1.24.15.1 Manholes, chambers and gullies

(a) Bases, inverts and benching for precast concrete manholes shall be constructed in-situ using Grade 20 concrete, unless otherwise stated in the Contract.

(b) Precast concrete units for manholes and chambers shall be set vertically with step irons staggered and vertically aligned above each other. Joints between precast units shall be the rebated type and shall be sealed with cement mortar; lifting holes shall be filled with cement mortar.Surplus cement mortar shall be removed and joints shall be pointed.

(c) Concrete surround to manholes, chambers and gullies shall be Grade 20 concrete. Joints in concrete surround shall be staggered by at least 150 mm from joints in the precast units. Concrete surround to gullies shall be placed up to the sides of the excavation.

(d) The frames for manhole covers and gully gratings shall be set to the same levels as the surrounding surface, allowing for falls and cambers, using brickwork and/or concrete as specified in the Contract. The number of courses of brickwork used below frames shall not exceed three and the minimum grade for concrete shall be Grade 20.

(e) Cement mortar for fixing manhole covers and gully gratings in position and bonding brickwork shall consist of cement and sand in the proportions 1:3 by mass.

(f) Excavations around manholes and chambers in carriageways shall be filled using Grade 10 concrete up to the carriageway formation level.

(g) Fill material for excavations around other manholes and chambers shall be fine fill material.

2.1.24.15.2 Concrete open channels

(a) The top surfaces of side walls of concrete open channels shall be constructed to the same levels as the adjoining permanent works. Excess excavation beyond the channel walls shall be filled with Grade 10 concrete.

2.1.24.16 Marker blocks

2.1.24.16.1 Marker blocks

(a) The ends of pipes which do not terminate at a manhole, chamber, gully or structure shall be marked with marker blocks. The blocks shall be 150 mm x 150 mm x 150 mm and shall be constructed using Grade 20 concrete.

(b) A wire shall be connected from a hook on the underside of the block to the plug on the end of pipes.

(c) Marker blocks shall be set flush with level of the adjacent permanent works and shall have the letters `CD' marked on the upper surface.

2.1.24.17 Installation of penstocks and valves

2.1.24.17.1 Installation of penstocks and valves

(a) Penstocks and valves shall be installed in accordance with the manufacturer's recommendations and in the closed position.

(b) Frames for penstocks shall be fixed in position leaving a 20 mm gap between the frame and the concrete surface. Contact between the penstock door and frame shall be checked using a feeler gauge 0.1 mm thick or other size recommended by the manufacturer.

(c) Box-outs and rebates for penstock and valve frames and gaps between frames and concrete surfaces shall be filled with cement mortar.

(d) After installation, penstocks and valves shall be cleaned and moving parts shall be lightly greased and checked for ease of operation. Penstocks and valves shall be left in a closed position.

2.1.24.18 Pipes and manholes to be abandoned

2.1.24.18.1 Pipes and manholes to be abandoned

(a) If the top of a pipe or culvert, or the bottom of a manhole, chamber or gully, which is to be abandoned is 1 m or less below the finished ground level, the pipe, manhole, chamber or gully shall be removed and disposed of unless otherwise permitted by the Engineer. The void shall be filled with foam concrete, granular fill material or special fill material as directed by the Engineer.

(b) If the top of a pipe or culvert, or the bottom of a manhole, chamber or gully, is more than 1 m below the finished ground level, the pipe, culvert, manhole, chamber or gully shall be filled with foam concrete or grout as stated in Clause 2.1.24.2.25.

(c) Manholes, chambers and gullies which are to be abandoned shall be demolished to 1 m below finished ground level unless otherwise stated in the Contract. Abandoned pipes, culverts, manholes, chambers and gullies shall be filled with foam concrete or grout, by pumping or by gravity. The lowest point of abandoned pipelines shall be sealed with concrete, bricks or by other methods approved by the Engineer. Filling shall start from the lowest point and shall continue until all voids are completely filled.

2.1.24.19 Cleaning of pipelines

2.1.24.19.1 Cleaning of pipelines

(a) Pipelines for drainage works shall be cleaned by pigging, by high pressure water jetting or by other methods agreed by the Engineer; manholes and chambers shall be cleaned and washed. Cleaning shall be carried out after:

i. the pipeline has been tested,
ii. Temporary Works required for testing have been removed, and
iii. parts of the pipeline removed for testing have been reconnected.

(b) Unless otherwise permitted by the Engineer, pipelines shall be cleaned not more than 7 days before the pipeline is handed over.

2.1.24.20 Inspection of pipelines

2.1.24.20.1 Inspection of pipelines

(a) Unless otherwise permitted by the Engineer, the cleanliness, bore, linearity and joints of pipelines of 450 mm diameter or less shall be checked by pulling a mandrel through the completed pipeline, or parts of the pipeline if permitted by the Engineer, after cleaning. The mandrel shall be 750 mm long and 12 mm less in diameter than the nominal diameter of the pipe.

2.1.24.20.2 Inspection of pipelines by CCTV

(a) The procedure for internal inspection of pipelines by CCTV shall be as stated in Clause 2.1.24.20.1.

2.1.24.21 Testing: pipes for drainage works

2.1.24.21.1 Batch: pipes for drainage works

(a) A batch of pipes or fittings for drainage works is any quantity of pipes or fittings of the same type and nominal diameter, manufactured by the same manufacturer, covered by the same certificates and delivered to the Site at any one time.

2.1.24.21.2 Samples: pipes for drainage works

(a) Unless otherwise required by the Engineer, one sample of pipe for drainage works and each type of fitting shall be provided from each 50 pipes or fittings or part thereof in a batch.

2.1.24.21.3 Testing: pipes for drainage works

(a) Unless otherwise permitted by the Engineer, each sample of pipes and fittings for drainage works shall be tested in accordance with the relevant British Standard.

(b) The method of testing shall be in accordance with the following:

Concrete pipes and fittings :	**BS 5911: Part 100**
Vitrified clay pipes, fittings and joints :	**BS 65**
Ductile iron pipes and fittings :	**BS EN 545**
Grey iron pipes and fittings :	**BS 4622**
UPVC pipes for industrial purposes :	**BS 3506**
UPVC soil and ventilating pipes, fittings and accessories :	**BS 4514**
UPVC rainwater goods :	**BS EN 12200-1**
UPVC underground drain pipes and fittings :	**BS 4660**
Plastic waste pipes and fittings :	**BS 5255**
UPVC pipes and fittings for gravity sewers :	**BS EN 1401-1**.

2.1.24.21.4 Non-compliance: pipes for drainage works

(a) If the result of any test required in accordance with the relevant British Standard for pipes and fittings for drainage works does not comply with the specified requirements for the test, one additional sample shall be provided from the same batch and additional tests for the property shall be carried out.

(b) The batch shall be considered as not complying with the specified requirements for the property if the result of any additional test does not comply with the specified requirements for the property.

2.1.24.22 Testing: aggregates for granular bed

2.1.24.22.1 Batch: aggregates for granular bed

(a) A batch of aggregates for granular bed is any quantity of aggregates for granular bed of the same type, produced at the same time in the same place, covered by the same certificates and delivered to the Site at any one time.

2.1.24.22.2 Samples: aggregates for granular bed

(a) Unless otherwise permitted by the Engineer, one sample of aggregates for granular bed shall be provided from each batch of aggregates for granular bed delivered to the Site.

(b) The size of each sample shall be 40 kg.

(c) The method of sampling shall be in accordance with **BS 812: Part 102.**

(d) The moisture content of the sample shall be representative of the moisture content of the material in the batch.

2.1.24.22.3 Testing: aggregates for granular bed

(a) Each sample of aggregates for granular bed shall be tested to determine the particle size distribution and the ten percent fines value in accordance with BS 812:Part 103 and BS 812:Part 111, and the compaction fraction value.

2.1.24.22.4 Compliance criteria: compaction fraction value

(a) The results of tests for compaction fraction value of aggregates for granular bed shall comply with the following requirements:

i. The compaction fraction value for bed for pipes not exceeding 300 mm nominal diameter shall not exceed 0.3.
ii. The compaction fraction value for bed for pipes exceeding 300 mm nominal diameter shall not exceed 0.15.

2.1.24.23 Testing: precast concrete units for manholes, chambers and gullies

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2.1.24.23.1 Batch: manholes, chambers and gullies

(a) A batch of precast concrete units for manholes, chambers or gullies is any quantity of precast concrete units for manholes, chambers or gullies of the same type and size, manufactured by the same manufacturer, covered by the same certificates and delivered to the Site at any one time.

2.1.24.23.2 Samples: manholes, chambers and gullies

(a) Unless otherwise permitted by the Engineer, one sample of precast units for manholes, chambers or gullies shall be provided from each 50 precast concrete units for manholes, chambers or gullies or part thereof in a batch.

2.1.24.23.3 Testing: manholes, chambers and gullies

(a) Unless otherwise permitted by the Engineer, each sample of precast concrete units for manholes, chambers or gullies shall be tested in accordance with the relevant British Standard.

(b) The method of testing shall be in accordance with the following:

i. Precast concrete units for manholes : **BS 5911: Part 200**
ii. Inspection chambers and gullies : **BS 5911: Part 2**.

2.1.24.23.4 Non-compliance: manholes, chambers and gullies

(a) If the result of any test required in accordance with the relevant British Standard for precast concrete units for manholes, chambers or gullies does not comply with the specified requirements for the test, one additional sample shall be provided from the same batch and additional tests for the property shall be carried out.

(b) The batch shall be considered as not complying with the specified requirements for the property if the result of any additional test does not comply with the specified requirements for the property.

2.1.24.24 Testing: manhole covers, gully gratings and kerb overflow weirs

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2.1.24.24.1 Batch: covers, gratings and weirs

(a) A batch of manhole covers, gully gratings or kerb overflow weirs is any quantity of covers, gratings or weirs of the same type, manufactured by the same manufacturer, covered by the same certificates and delivered to the Site at any one time.

2.1.24.24.2 Samples: covers, gratings and weirs

(a) One sample of manhole covers, gully gratings or kerb overflow weirs shall be provided from each 20 covers, gratings or weirs or part thereof in a batch.

2.1.24.24.3 Testing: covers, gratings and weirs

(a) Each sample of manhole covers, gully gratings or kerb overflow weirs shall be weighed and subjected to a load test.

(b) The method of testing shall be as stated in Clause 2.1.24.29. The test loads shall be as stated in Table 2.1.24 .4 and Table 2.1.24.5.

2.1.24.24.4 Compliance criterion: resistance to fracture of covers and gratings

(a) Manhole covers and gully gratings shall withstand the test load without fracture or cracking.

2.1.24.24.5 Non-compliance: mass of covers, gratings and weirs

(a) If any manhole cover, gully grating or kerb overflow weir does not comply with the specified requirements for mass, every cover, grating and frame in the batch shall be weighed to determine its mass.

(b) If any cover, grating or weir does not comply with the specified requirements for mass, it shall not be used in the permanent work.

2.1.24.24.6 Non-compliance: resistance to fracture of covers and gratings

(a) If any manhole cover or gully grating does not comply with the specified requirements for resistance to fracture, two additional samples shall be provided from the same batch and tested to determine their resistance to fracture.

(b) The batch shall be considered as not complying with the specified requirements for resistance to fracture if the result of any additional test does not comply with the specified requirements for resistance to fracture.

PROPOSED COMPLETION OF THE MAIN ENTRANCE WORKS FOR THE NAIROBI HOSPITAL

2.1.24.25 Testing: watertightness of penstocks

2.1.24.25.1 Testing: watertightness of penstocks

(a) Penstocks which are to be tested shall be tested for watertightness after installation by applying pressure using a head of water applied to one face of the penstock and no head of water on the other face. The test pressure and the face on which the pressure is to be applied shall be as stated in the Contract.

(b) The method of testing shall be as agreed by the Engineer.

(c) The test pressure shall be maintained for 24 hours.

2.1.24.25.2 Compliance criteria: watertightness of penstocks

(a) The results of tests for watertightness of penstocks shall comply with the following requirements:

i. There shall be no leaks through the penstock during the test.
ii. There shall be no leaks or damp patches visible at the joint between the penstock and the structure during the test.

2.1.24.25.3 Non-compliance: watertightness of penstocks

(a) If the result of any test for watertightness of penstocks does not comply with the specified requirements, the Contractor shall investigate the reason.

(b) Remedial or replacement work approved by the Engineer shall be carried out and the penstock shall be re-tested.

2.1.24.26 Testing: gravity pipelines for drainage works

2.1.24.26.1 Testing: gravity pipelines for drainage works

(a) Gravity pipelines for drainage works shall be tested as stated in Clause 2.1.24.26.1 (b) to (e).

(b) Gravity pipelines for sewage shall be tested by the methods stated in Table 2.1.24.8 at the following times:

i. after the pipes have been jointed and the bedding has been placed and immediately before haunch or surround is placed or fill material is deposited, and

ii. after haunch and surround has been placed and fill material has been deposited and compacted, and

iii. not more than 7 days before the pipeline is handed over.

(c) Gravity pipelines for surface water shall be tested by the methods stated in Table 2.1.24.8 at the following times:

i. after the pipes have been jointed and the bedding has been placed and immediately before haunch or surround is placed or fill material is deposited, or

ii. after haunch and surround has been placed and fill material has been deposited and compacted.

(d) Water tests and air tests on pipelines shall be carried out on the complete pipeline between manholes, chambers and structures; pipelines shall not be tested in parts unless permitted by the Engineer or unless the specified test pressure would otherwise be exceeded. Short branch pipelines shall be tested with the main pipeline and long branch pipelines shall be tested separately.

(e) Infiltration tests shall be carried out on the complete pipeline between manholes, chambers and structures, including manholes, chambers and branches within the pipeline system.

(f) The method of testing shall be in accordance with Clause 2.1.24.30.

Table 2.1.24.8: Testing gravity pipelines

Type of pipeline	Diameter of pipeline	Time of test	Method of testing
Sewage	not exceeding 900mm	as Clause 2.1.24.26.1 (b)(i)	Water test or air test
		as Clause 2.1.24.26.1 (b)(ii)	Water test or air test
		as Clause 2.1.24.26.1 (b)(iii)	Infiltration test
Sewage	exceeding 900mm	as Clause 2.1.24.26.1 (b)(i)	Visual inspection
		as Clause 2.1.24.26.1 (b)(ii)	Water test or air test
		as Clause 2.1.24.26.1 (b)(iii)	Infiltration test
Surface	exceeding 900mm	as Clause 2.1.24.26.1 (b)(i)	Water test or air test
		as Clause 2.1.24.26.1 (b)(ii)	
Surface	not exceeding 900mm	as Clause 2.1.24.26.1 (b)(i)	Visual inspection
		as Clause 2.1.24.26.1 (b)(ii)	Water test or air test

2.1.24.26.2 Compliance criteria: gravity pipelines for drainage works

(a) The results of tests on gravity pipelines for drainage works shall comply with the following requirements:

i. The leakage of water from the pipeline determined by the water test shall not exceed the permitted leakage calculated in accordance with Clause 5.4.8 of Appendix 5.4.

ii. There shall be no discernable leakage from the pipe or from any joint during the water test.

iii. The air pressure shall remain above 75 mm head of water at the end of the air test.

iv. There shall be no infiltration or damage to pipes or joints as determined by the visual inspection.

2.1.24.26.3 Non-compliance: gravity pipelines for drainage works

(a) If the result of any test on gravity pipelines does not comply with the specified requirements for the test, the Contractor shall investigate the reason. Remedial or replacement work approved by the Engineer shall be carried out and the pipeline shall be re-tested.

2.1.24.27 Testing: pressure pipelines for drainage works

2.1.24.27.1 Testing pressure pipelines for drainage works

(a) Pressure pipelines for drainage works shall be tested as stated in Clause 2.1.24.27.1 (b) to (g).

(b) The pipeline shall be tested at the following times:

i. after the pipes have been jointed and the bedding has been placed and immediately before haunch or surround is placed or fill material is deposited, and

ii. after haunch and surround has been placed and fill material has been deposited and compacted.

(c) The test stated in Clause 2.1.24.27.1(b)(i) shall not be carried out on parts of a pipeline unless permitted by the Engineer or unless the specified test pressure would otherwise be exceeded. The test stated in Clause 2.1.24.27.1(b)(ii) shall be carried out on the complete pipeline.

(d) The test pressure shall be as stated in the Contract. If the test pressure is not stated in the Contract, the test pressure shall be 1.5 times the maximum working pressure in the part of the pipeline tested.

(e) Tests shall not be carried out simultaneously on more than one pipeline in the same trench.

(f) The method of testing shall be in accordance with Clause 2.1.24.27.

(g) Testing of pressure pipelines by means of tests on individual joints shall not be carried out instead of tests stated in Clause 2.1.24.27.1(b) to (g).

(h) unless permitted by the Engineer; if permitted, the method of testing and the compliance criteria shall be as approved by the Engineer.

2.1.24.27.2 Compliance criteria: pressure pipelines for drainage works

(a) The results of tests on pressure pipelines for drainage works shall comply with the following requirements:

i. The leakage of water from the pipeline determined by the pressure test shall not exceed the permitted leakage calculated in accordance with Clause 2.1.24.31.4 of Clause 2.1.24.312.1.24.31.

ii. There shall be no discernable leakage of water from the pipeline or from any joint during the pressure test.

2.1.24.27.3 Non-compliance: pressure pipelines for drainage works

(a) If the result of any test on pressure pipelines for drainage works does not comply with the specified requirements for the test, the Contractor shall investigate the reason. Remedial or replacement work approved by the Engineer shall be carried out and the pipeline shall be re-tested.

2.1.24.28 CCTV inspection of pipelines

2.1.24.28.1 Scope

(a) This method covers the internal inspection of pipelines by means of closed circuit television.

2.1.24.28.2 Equipment

(a) The following equipment is required:

i. A CCTV colour camera with integral lighting unit. The camera shall be a type designed and constructed for the specified purpose and shall be capable of operating in 100% relative humidity. The camera shall be fitted with a rotating mirror for complete circumferential viewing. The system shall be capable of producing a clear and high quality picture of the entire periphery of the pipe on the monitor screen and recording tape. The camera and lighting unit shall be mounted on a self-propelled crawler or on skids linked to a manual or power operated winch.

ii. A monitor screen which displays the camera view during the inspection. The monitor screen shall be housed in covered accommodation with facilities for inspection by the Engineer and others.

iii. A screen writer which displays on the monitor screen details of the inspection including date, location, pipe material, diameter of pipe, direction of view and comments on the condition of the pipe.

iv. A measuring device which displays the camera location automatically on the monitor screen. The device shall be capable of measuring the location to within an accuracy of 0.1% of the length of the pipeline or ±0.3 m whichever is the greater.

v. A control unit which controls camera movement, lighting intensity, focusing and recording.

vi. A DVD video recording system to record the inspection and information displayed on the monitor screen.

vii. A 35 mm single lens reflex (SLR) camera capable of producing photographs with the date.

2.1.24.28.3 Procedure

(a) The procedure shall be as follows:

i. The camera shall be moved through the pipeline in the direction instructed by the Engineer at a speed not exceeding 0.15 m/s. If the camera cannot pass through the complete pipeline in one operation, the inspection may be carried out from both ends of the pipeline.

ii. The camera shall be stopped whenever instructed by the Engineer to allow inspection by the Engineer.

iii. The video system shall be operated during the complete inspection to provide a continuous record of the inspection and information on the monitor screen.

iv. Photographs of the monitor screen shall be taken whenever instructed by the Engineer.

2.1.24.28.4 Recording of results

(a) Records of the inspections shall be kept by the Contractor on the Site and a report shall be submitted to the Engineer within 14 days of completion of the inspection. The report shall contain the following details:

i. key map showing pipelines inspected and associated manholes, chambers and structures,

ii. tables listing details of inspection, including date, location, pipe material, diameter of pipe, chainage, manholes, junctions and other features and the condition of pipes and joints; the condition of pipes and joints shall be illustrated by a coding systems in accordance with the `Manual of Sewer Condition Classification' (2004) published by the U.K. National Water Council, and

iii. a summary showing the number and type of defects in each pipeline inspected.

(b) The following items shall be submitted at the same time as the report:

i. video film providing a continuous record of the inspection and information on the monitor screen, and photographs of the monitor screen including date and chainage;

ii. the photographs shall be 3R size and shall be mounted in photograph albums.

2.1.24.29 Determination of the resistance to fracture of manhole covers and gully gratings

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2.1.24.29.1 Scope

(a) This method covers the determination of the resistance to fracture of manhole covers and gully gratings by means of a load test.

2.1.24.29.2 Equipment

(a) The following equipment is required:

i. The manufacturer's recommended frame for the manhole cover or gully grating or a fabricated test frame of a type agreed by the Engineer which will simulate the normal conditions of use of the cover or grating.

ii. A circular hardwood bearing block faced with hard rubber or other resilient material. The diameter of the block shall be as stated in Table 2.1.24.4 or Table 2.1.24.5 for the relevant cover or grating. The block shall be sufficiently rigid to ensure that the load is equally distributed over the whole area of the block.

iii. Test loads. Equipment for measuring the loads applied, readable and accurate to 0.05 t or 2% of the specified test load, whichever is greater.

2.1.24.29.3 Procedure

(a) The procedure shall be as follows:

i. The full bearing area of the frame shall be rigidly supported.
ii. The cover or grating shall be placed in the frame. The bearing block shall be placed centrally on the cover or grating.
iii. The specified test load as stated in Table 5.6 and 5.7 shall be applied without shock.
iv. The specified test load shall be maintained for at least 30 seconds and removed.

2.1.24.29.4 Reporting of results

(a) The following shall be reported:

Identification of sample.
The load applied, to the nearest 0.05 t or 2% of the specified test load, whichever is greater.
Details of any fracture or cracks.
That the test method used was in accordance with this Specification.

2.1.24.30 Tests on gravity pipelines for drainage works

2.1.24.30.1 Scope

(b) This method covers water tests, air tests, visual inspections and infiltration tests on gravity pipelines for drainage works.

(c) The following equipment is required:

i. Expanding disc stoppers, air bags or other methods of sealing pipes agreed by the Engineer.
ii. Struts and wedges.
iii. Force pump for water test.
iv. Standpipe for water test.
v. Measuring vessel for water test, readable and accurate to 0.01 litre.
vi. U-tube for air test.
vii. Trolleys to obtain access inside pipelines for visual inspections.
Mechanical fans shall be provided to ensure that an adequate air supply is available; engine driven fans shall be fitted with a flexible exhaust or other methods of keeping exhaust fumes clear of the fresh air intake.

2.1.24.30.2 Procedure: before tests and inspections

(a) The procedure before tests and inspections shall be as follows:

i. Debris and water shall be removed from the pipeline.
ii. Openings to the pipeline shall be sealed using expanding disc stoppers, air bags or other methods agreed by the Engineer and the seals secured against movement.

2.1.24.30.3 Procedure: water test

(a) The procedure for the water test shall be as follows:

i. The pipeline shall be filled with water and shall be kept filled for two hours before testing starts to allow absorption to take place.

ii. A test pressure of 1.2 m head of water above the soffit of the pipe at the high end shall be applied at the standpipe and maintained for 30 minutes; the test pressure applied shall not exceed 6 m head of water at the invert of the low end of the pipe.

iii. The head of water at the standpipe shall be topped up at 5 minute intervals during the test, and shall be filled to the specified head at the end of the test period; the amounts of water added to the standpipe shall be measured using the measuring vessel.

iv. The leakage of water from the pipeline shall be measured as the amount of water added to maintain the specified head of water.

2.1.24.30.4 Procedure: air test

(a) The procedure for the air test shall be as follows:

i. Air shall be pumped into the pipeline until a test pressure of slightly more than 100 mm of water is registered on a U-tube manometer connected to the pipeline. Five minutes shall be allowed for stabilisation of the air temperature, and the air pressure shall then be adjusted to 100 mm of water.

ii. The pressure shall be read from the U-tube at the end of a five-minute period without further pumping.

2.1.24.30.5 Procedure: visual inspection

(a) The inside of the pipeline shall be inspected visually, and infiltration or damage to pipes or joints shall be recorded.

2.1.24.30.6 Procedure: infiltration test

(a) The procedure for the infiltration test shall be in accordance with **BS 8005: Part 1** Clause 13.6.

2.1.24.30.7 Calculation

(a) The permitted leakage of water from the pipeline during the water test shall be calculated from the equation:

Permitted leakage = $d \times l \times t/_{60}$ litre
where:
- d is the internal diameter of the pipe (m),
- l is the length of pipeline tested (m),
- t is the test period (min).

2.1.24.30.8 Reporting of results

(a) The following shall be reported:

i. The nominal internal diameter of the pipe.
ii. The location and length of pipeline tested to the nearest 0.3 m.
iii. The test pressure applied during the water test to the nearest 0.01 m, and during the air test to the nearest 1 mm head of water.
iv. The test period to the nearest 1 min.

v. The leakage and permitted leakage for the water test to the nearest 0.1 litre.
vi. The amount of infiltration for the infiltration test to the nearest 0.1 litre.
vii. Details of any discernable leakage of water from the pipe or from any joint during the water test.
viii. That the test method used was in accordance with this Specification.

2.1.24.31 Tests on pressure pipelines for drainage works

2.1.24.31.1 Scope

(a) This method covers the determination of the leakage of water from pressure pipelines for drainage works by means of a pressure test.

2.1.24.31.2 Equipment

(a) The following equipment is required:

i. Blank flanges or caps.
ii. Struts and wedges.
iii. Temporary concrete blocks or other anchors.
iv. Force pump.
v. Pressure gauge, readable and accurate to 0.01 m head of water. The gauge shall be either a conventional circular type of at least 300 mm diameter or shall be a digital indicator type.
vi. Measuring vessel, readable and accurate to 0.01 litre.

2.1.24.31.3 Procedure

(a) The procedure shall be as follows:

i. Pipes and valves shall be cleaned and the operation of valves shall be checked. Air valves shall be isolated.

ii. Blank flanges or caps shall be fixed to the ends of the pipeline, or part of the pipeline, to be tested. Tests shall not be made against closed valves unless permitted by the Engineer.

iii. The blank flanges and caps and closed valves against which tests are made shall be secured with struts and wedges against temporary concrete blocks or other anchors. The blocks shall be completed

iv. and shall have hardened sufficiently before testing starts. Thrust and anchor blocks, pipe straps and other devices required to prevent movement of pipes and fittings shall be completed before testing starts.

v. The pipeline shall be filled with water and all air shall be removed; measures shall be taken during filling to provide free outlets for air and to prevent water hammer.

vi. The pressure in the pipeline shall be increased to working pressure and the pipeline shall remain filled at this pressure for 2 hours to allow absorption to take place and to achieve conditions which are as stable as practicable.

vii. The pressure in the pipeline shall be increased slowly by pumping water into the pipeline using a force pump until the specified test pressure is reached at the lowest part of the pipeline being tested.

viii. The pressure in the pipeline shall be maintained at the specified test pressure, using the force pump if necessary, for a period of at least 1 hour.

ix. At the end of the 1 hour period the pressure shall be increased, if necessary, to the specified test pressure and pumps and water supply points shall be disconnected.

x. The pipeline shall be left in this condition for a test period of 1 hour; no water shall be allowed to enter the pipeline during the test period.

xi. At the end of the test period the pressure in the pipeline shall be recorded.

xii. The pumps and water supply points shall be reconnected and the pressure shall be increased to the specified test pressure.

xiii. Water shall be drawn off from the pipeline until the pressure in the pipeline is the same as at the end of the test period. The leakage of water from the pipeline shall be measured as the amount of water drawn off.

2.1.24.31.4 Calculation

(a) The average test pressure (P) shall be calculated as the average of the specified test pressure and the pressure at the end of the test period.

(b) The permitted leakage of water from the pipeline during the pressure test shall be calculated from the equation:

Permitted leakage = $d \times l \times t/_{12} \times P$ litre
where:
- d is the nominal internal diameter of the pipe (m),
- l is the length of pipeline tested (km),
- t is the test period (hr),
- P is the average test pressure (m).

2.1.24.31.5 Reporting of results

The following shall be reported:

i. The nominal internal diameter of the pipe.
ii. The location and length of pipeline tested to the nearest 0.3 m.
iii. The test period to the nearest one minute.
iv. The specified test pressure to the nearest 0.01 m head of water.
v. The pressure at the end of the test period to the nearest 0.01 m head of water.
vi. The average test pressure to the nearest 0.01 m head of water.
vii. The leakage and permitted leakage to the nearest 0.1 litre.
viii. Details of any discernable leakage of water from the pipeline during the test.
ix. That the test method used was in accordance with this Specification.

2.1.24.32 References and Standards

BS 5911-1(2002+A2:2010): Concrete pipes and ancillary concrete products. Specification for unreinforced and reinforced concrete pipes (including jacking pipes) and fittings with flexible joints. (Complementary to BS END 1916:2002)

BS END 1916 (2002): Concrete pipes and fittings, unreinforced, steel fibre and reinforced.

BS 5911-3 (2010): Concrete pipes and ancillary concrete products. Specification for unreinforced and reinforced concrete manholes and soakaways. (Complementary to BS END 1917:2002)

BS END 1917(2002): Concrete manholes and inspection chambers, unreinforced, steel fibre and reinforced

BS 65 (1991): Specification for vitrified clay pipes, fittings and ducts, also flexible mechanical joints for use solely with surface water pipes and fittings.

BS END 545 (2010): Ductile iron pipes, fittings, accessories and their joint for water pipelines. Requirements and test methods.

BS END 1092-1(2007+A1:2013): Flanges and their joints. Circular flanges for pipes, valves, fittings and accessories, PN designated. Steel flanges

BS 4662 (2006+A1:2009): Boxes for flush mounting of electrical accessories. Requirements, test methods and dimensions

BS 3506 (1969): Specification for unplasticized PVC pipe for industrial uses.

BS 4320 (1968): Specification for metal washers for general engineering purposes. Metric series

BS END ISO 3506 (1998): Mechanical properties of corrosion resistant stainless steel fasteners.

BS END 10029 (2010): Hot-rolled steel plates 3 mm thick or above. Tolerances on dimensions and shape

BS END 1563 (2011): Founding. Spheroidal graphite cast iron.

BS END 10300 (2005): Steel tubes and fittings for onshore and offshore pipelines. Bitumen hot applied materials for external coating.

BS 3416 (1991:2000): Specification for bitumen-based coatings for cold application suitable for use in contact with potable water.

BS 4346-1 (1969:1998): Injection moulded unplasticized PVC fittings for solvent welding for use with pressure pipes including potable water supply.

BS 21(1985): Specification for pipe threads for tubes and fittings where pressure-tight joints are made on the threads (metric dimensions).

BS END 10241 (2000): Steel threaded pipe fittings.

BS END ISO 1461 (2009): Hot dipped galvanised coatings on fabricated iron and steel articles. Specifications and test methods.

BS 4514 (2001): Unplasticized PVC soil and ventilating pipes of 82.4 mm minimum mean outside diameter, and fittings and accessories of 82.4 mm and of other sizes. Specification.

BS 1377(1990): Methods of test for soils for civil engineering purposes.

BS END 13101(2002): Steps for underground man entry chambers. Requirements, marking, testing and evaluation of conformity.

BS END 1562 (2012): Founding. Malleable cast irons.

BS END 1982 (2008): Copper and copper alloys. Ingots and castings.

BS END 12167 (2011): Copper and copper alloys. Profiles and bars for general purposes

BS END 12200-1(2000): Plastics rainwater piping systems for above ground external use. Unplasticized poly (vinyl chloride) (PVC-U). Specifications for pipes, fittings and the system

BS 4660 (2000): Thermoplastics ancillary fittings of nominal sizes 110 and 160 for below ground gravity drainage and sewerage.

BS END 1401-1(2009): Plastic piping systems for non-pressure underground drainage and sewerage. Unplasticized poly(vinyl chloride) (PVC-U). Specifications for pipes, fittings and the system

BS 4190 (2001) ISO metric black hexagon bolts, screws and nuts. Specification

BS END 13602 (2013): Copper and copper alloys. Drawn, round copper wire for the manufacture of electrical conductors

BS END 1561(2011): Founding. Grey cast irons.

BS END 13602 (2002): Copper and copper alloys. Drawn, round copper wire for the manufacture of electrical conductors

BS END 10095(1999): Heat resisting steels and nickel alloys

BS END 10250-4 (2000): Open steel die forgings for general engineering purposes. Stainless steels

BS END 1171(2002): Industrial valves. Cast iron gate valves.

BS END 10255 (2004):Non-alloy steel tubes suitable for welding and threading. Technical delivery conditions

BS 5255 (1989): Specification for thermoplastics waste pipe and fittings

BS END 681-1 (1996): Elastomeric seals. Material requirements for pipe joint seals used in water and drainage applications. Vulcanized rubber

BS 743 (1970): Specification for materials for damp-proof courses

BS 5911-4 (2002+A2:2010): Concrete pipes and ancillary concrete products. Specification for unreinforced and reinforced concrete inspection chambers (complementary to BS END 1917:2002)

BS END ISO 1452-3 (2010): Plastics piping systems for water supply and for buried and above-ground drainage and sewerage under pressure. Unplasticized poly(vinyl chloride) (PVC-U). Fittings

BS 812-124 (2009): Testing aggregates. Method for determination of frost heave

2.1.25 FENCING

2.1.25.1 Materials

2.1.25.1.1 Wire

(a) Wire for fencing, including plastic coated wire, shall be galvanized mild steel complying with **BS 4102**.

(b) Barbed wire shall consist of two line wires and point wire formed in accordance with **BS 4102**, Clause 4.1.

(c) Galvanized coatings to steel wire shall comply with **BS EN 10244**.

(d) Plastic coatings to steel wire shall be green and shall comply with **BS 4102**, Section 6.

2.1.25.1.2 Chain link fence

(a) Chain link fence shall comply with **BS 1722: Part 1** unless otherwise stated in this Section.

2.1.25.1.3 Plywood

(a) Plywood for hoardings shall comply with **BS EN 636** and shall have a Grade 2 veneer. The bonding adhesive between veneers shall be phenol formaldehyde resin adhesive classified as weather-proof and boil-proof in accordance with **BS 1203**.

2.1.25.1.4 Timber

(a) Timber for fencing shall be of mature growth and shall be seasoned and free from large, loose or dead knots, wood wasp holes, infestation, splits and other defects which will reduce the strength or produce blemishes. The moisture content in timber at the time of fabrication shall not exceed 20%.

(b) Hardwood shall be camphor and shall have a density of at least 720 kg/m^3 at 15% moisture content.

(c) Softwood shall be cedar or cypress.

(d) Timber which is not to be painted shall be preserved with coal tar creosote. The creosote shall comply with BS 144 and shall be applied by pressure impregnation in accordance with **BS 144**.

2.1.25.1.5 Steel

(a) Steel for fencing shall comply with the following:

Hot rolled sections :	**BS 4: Part 1**
Hot rolled structural steel sections	
- equal and unequal angles :	**BS EN 10056-1**
- hollow sections :	**BS EN 10210-2**
Weldable structural steels :	**BS 7668**.

2.1.25.1.6 Bolts, nuts, washers and fittings

(a) Bolts, nuts and washers for fencing shall comply with the following:

ISO metric black hexagon bolts, screws and nuts :	**BS 4190**
ISO metric black cup and countersunk head, bolts andscrews with hexagon nuts :	**BS 4933**
Metal washers for general engineering purposes :	**BS 4320**

(b) The length of bolts shall be such that the threaded portion of each bolt projects through the nut by at least one thread and by not more than four threads.

(c) Fittings, including eye bolt strainers, cleats, winding brackets, stretcher bars, extension arms, hook bolts and base plates, shall be galvanized mild steel.

(d) Bolts, nuts, washers and fittings for fixing to concrete and timber shall be galvanized. Bolts, nuts, washers and fittings for fixing to steel shall have the same protective treatment as the steel.

(e) Staples shall be D-section galvanized wire.

2.1.25.2 Fabrication of fencing

2.1.25.2.1 Fabrication of steelwork

(a) Steelwork for fencing shall be fabricated in accordance with **BS END 1090-2:2008+A1:2011**

2.1.25.2.2 Galvanizing to steel

(a) Steel which is to be galvanized shall be hot-dip galvanized in accordance with **BS EN ISO 1461** to a coating thickness of at least 500 g/m^2.

(b) Galvanizing to steel shall be applied as far as possible after welding, drilling and cutting are complete.

2.1.25.2.3 Welding steel

(a) Welds to steel for fencing shall be full depth fillet welds. Weld surfaces shall be clean and flush before application of the protective coating.

(b) Steel shall not be welded after galvanizing unless permitted by the Engineer; if permitted, the welded areas shall be free from scale and slag and shall be treated with an alternative galvanizing or zinc coating system approved by the Engineer.

2.1.25.3 Posts and gates for fencing

2.1.25.3.1 Concrete posts

(a) Concrete posts and struts for fencing shall be precast using Grade 30/10 concrete. The finish to formed surfaces shall be Class F4 and the finish to unformed surfaces shall be Class U5. The tops of posts and all arrises shall be rounded or chamfered.

(b) Reinforcement for concrete posts and struts shall be Grade 250 plain round steel bars.

2.1.25.3.2 Gates

(a) Steel gates shall be of welded construction. The frame shall be square with the corners mitred or saddled.

(b) Chain link infilling in gates shall be of the same type and size as in the adjoining fence and shall be attached to the framework by stretcher bars.

2.1.25.4 Submissions

2.1.25.4.1 Particulars of fencing

(a) The following particulars of the proposed fencing shall be submitted to the Engineer:

i. drawings showing the fabrication details of gates, and

ii. details of the source, type and properties of timber.

(b) The particulars of the proposed fencing shall be submitted to the Engineer at least 14 days before the fencing is erected.

2.1.25.4.2 Samples of materials

(a) The following samples of the proposed materials shall be submitted to the Engineer at the same time as particulars of the proposed fencing are submitted:

i. each type of wire and fitting,

ii. chain link,

iii. plywood, and

iv. precast concrete, steel and timber posts.

2.1.25.5 Storage of materials

2.1.25.5.1 Storage of fencing

(a) Plywood and timber posts, rails and struts for fencing shall be stored on level supports in a dry weatherproof store.

(b) Gates and concrete and steel posts and struts for fencing shall be stored off the ground on level supports and in a manner which will not result in damage or deformation to the materials or in contamination of the materials.

(c) Fencing shall be protected from damage and damaged fencing shall not be used in the permanent work unless permitted by the Engineer.

2.1.25.6 Erecting fencing

2.1.25.6.1 Alignment of fencing

(a) Fencing shall be erected to a smooth alignment with no abrupt irregularities. The ground shall be trimmed or filled in such a manner that the bottom of the fence will approximately follow the level of the ground. The distance between the bottom of chain link mesh and hoardings and the ground shall not exceed 100 mm.

2.1.25.6.2 Posts for fencing

(a) Straining posts for fencing shall be provided at all ends and corners, at changes in direction, at abrupt changes in level, at gate posts and at intervals not exceeding 30 m along straight lengths of fencing. Struts shall be fitted to straining posts in the direction of each wire secured to the post.

(b) Intermediate posts shall be provided at intervals not exceeding 3.5 m.

2.1.25.6.3 Erecting posts for fencing

(a) Posts and struts for fencing shall be set in excavations for foundations and the excavations shall be filled with Grade 30/20 concrete up to 50 mm below ground level.

(b) Struts shall be fitted into slots in timber posts and concrete posts; struts shall be bolted to steel posts.

(c) The ground surface around posts shall be made good with the same material as in the adjoining area.

2.1.25.6.4 Fixing wire for fencing

(a) Line wire, chain link mesh and barbed wire for fencing shall be strained tightly between straining posts. Winding brackets shall be used for straining between steel posts and winding brackets or eye bolt strainers shall be used for straining between concrete and timber posts. The tension in the wire on each side of straining posts shall be equal. Wire shall not be strained until at least 14 days after concrete has been placed in the foundation.

(b) Chain link mesh shall be secured at each straining post by a stretcher bar and shall be tied to the line wire by tying wire at 150 mm intervals.

(c) Each line wire and each line of barbed wire shall be secured to each intermediate post by one of the following methods as stated in Table 20.1.

i. A hairpin staple shall be passed through a hole in the post and secured to the wire by three complete turns on each side of the post.

ii. A stirrup shall be passed through a hole in the post and the ends bent over twice.

iii. The wire shall be threaded through a hole in the post.

iv. The wire shall be stapled to the post.

v. A hook bolt shall be passed through a hole in the post and secured with a nut and washer.

Table 20.1: Method of securing wire to intermediate posts

Type of fence	Type of wire	Type of post	Method of securing wire
Strained wire	Line wire	Concrete	(i), (ii) or (iii)
		Steel	(i), (ii) or (iii)
		Timber	(i), (ii) or (iv)
	Barbed wire	Concrete	(i), (ii)
		Steel	(i)
		Timber	(ii), (iii) or (iv)
Chain link	Line wire Mesh wire	Concrete	(i), (ii) or (v)
		Steel	(i) or (iii)
		Timber	(iv)
	Barbed wire	Concrete	(i), (ii) or (v)
		Steel	(i)
		Timber	(iv)

2.1.25.6.5 Fixing gates

(a) Gates shall be hung plumb and shall not be installed until the wire has been strained.

2.1.25.6.6 Fixing timber for fencing

(a) The ends of timber rails for fencing shall be closely butted together and the rails shall be securely nailed to each post. The ends of plywood sheets in hoardings shall be closely butted together and the sheets shall be securely nailed to each post and to the horizontal rails.

2.1.25.7 Tolerances

2.1.25.7.1 Tolerances: fencing

(a) Fencing shall comply with the following requirements:

i. The position of posts shall be within 75 mm of the specified position.

ii. The level of the top of posts shall be within 25 mm of the specified level.

iii. Posts shall be vertical to within 5 mm in the height of the post.

2.1.25.8 References and Standards

BS END 10223-1 (2012): Steel wire and wire products for fencing and netting. Zinc and zinc alloy coated steel barbed wire

BS 1722-1 (2006): Fences. Specification for chain link fences.

BS END 636 (2012): Plywood specifications.

BS 1203 (2001): Hot-setting phenolic and aminoplastic wood adhesives. Classification and test method

BS 144 (1997): Specification for coal tar creosote for wood preservation.

BS 4-1 (2005): Structural Steel sections. Specification for hot rolled sections
.
BS END 10210-2 (2006): Hot finished structural hollow sections of non-alloy and fine grain steels. Tolerances, dimensions and sectional properties.

BS 7668 (2004): Weldable structural steels. Hot finished structural hollow sections in weather resistant steels. Specification

BS END 13602 (2013): Copper and copper alloys. Drawn, round copper wire for the manufacture of electrical conductors

BS 4933 (2010): Specification for ISO metric black cup and countersunk head bolts and screws with hexagon nuts.

BS 4320 (1968): Specification for metal washers for general engineering purposes.Metric series

BS END 1090-2 (2008+A1:2011): Execution of steel structures and aluminium structures. Technical requirements for steel structures

BS END ISO 1461 (2009): Hot dipped galvanised coatings on fabricated iron and steel articles. Specifications and test methods.

BS 4102 (1998):Specification for steel wire for general fencing purposes

BS END 10244-1 (2009):Steel wire and wire products. Non-ferrous metallic coatings on steel wire. General principles

BS END 10056-1 (1999): Specification for structural steel equal and unequal angles. Dimensions

BS 4190 (2001): ISO metric black hexagon bolts, screws and nuts. Specification

2.1.26 PAVEMENTS

This Section covers the construction of sub base, base course, shoulders and wearing course from natural gravel or partially crushed gravel and bituminous materials.

2.1.26.1 Pavement; Graded Crushed Stones Base

2.1.26.1.1 Scope

This Section covers the procuring, furnishing and placing of approved crushed aggregate base course layers in accordance with the requirements of these Specifications.
This Section covers the requirements for the following types of material:

- **GCS1** crushed, fresh, quarried rock compacted to a percentage of the maximum dry density of the material at BS-Vibrating hammer compaction, with enhanced requirements for workmanship during construction
- **GCS2** crushed stone or quarried rock compacted to a percentage of the maximum dry density of the material at BS-Vibrating hammer compaction, with normal requirements for workmanship during construction

2.1.26.1.2 Materials

(a) Source of material, crushing and screening

(i) General

The aggregate used for crushed aggregate course shall contain no contamination or deleterious material such as decomposed rock, clay or shale. The Contractor shall take all necessary measures to prevent segregation of the material, including watering during crushing and screening and any other measures required in the opinion of the Engineer.

(ii) GCS1 class of crushed aggregate

Crushed aggregate class GCS1 shall be made of clean, hard, durable and fresh rock fragments from the crushing of quarried rock or boulders of minimum 0.3 m diameter. Single stage crushing shall not be allowed and all particles shall be crushed; no soil fines are allowed. If the multi-stage crushing does not directly and continuously provide materials complying with the grading requirements specified in Table 26.1 the crushed material shall be screened into a sufficient number of fractions GCS2 class of crushed aggregate and reconstituted and mixed thoroughly in a pug mill or by other suitable means to ensure compliance with the grading requirements.

(iii) GCS2 class of crushed aggregate

Crushed aggregate class GCS2 shall be made of hard, durable and un-weathered fragments made by the crushing of stones, boulders, oversize from borrow pits or quarried rock. Minimum 50% by mass of particles larger than 5 mm shall have at least one crushed face. Maximum 30% by mass of material passing 5 mm can be approved soil fines.

(b) Soluble salts

The Contractor shall discard the material or fulfil all requirements for appropriate construction techniques and timing of operations to the satisfaction of the Engineer if assessments of soluble salt contents in base course materials show deleterious values. Such assessments are only required where the pavement is going to receive a bituminous seal as the only surfacing. No additional payment will be made for any measures taken, or for any alterations of the material utilisation, due to presence of soluble salts in materials or construction water.

(c) Material requirements – class GCS1

Materials for base course layers of material class GCS1 crushed aggregate as specified on the Drawings shall meet the requirements for grading given in Table 26.1.

(d) Material requirements – class GCS2

Materials for base course layers of material class GCS2 crushed aggregate as specified on the Drawings shall meet the requirements for grading given in Table 26.1.

2.1.26.1.3 Construction

(a) Preparation of the sub base

No base course shall be placed until approval is obtained from the Engineer and the sub base is placed, compacted and finished in accordance with the Specifications and is tested and found acceptable to the full satisfaction of the Engineer. Before placing the base course, the sub base shall be inspected and proof rolled as required by the Engineer in order to establish whether there is any damage, wet spots or other defects. Any such defect shall be rectified to the satisfaction of the Engineer before the next layer is placed. Pre-tipping of material prior to sub base processing shall be over a maximum distance of 300m.

(b) Shoulders

Bitumen surfaced shoulders made with the same base course material as the carriageway shall be the preferred method for construction of shoulders. Where the shoulders are nevertheless to be constructed with a different material than the carriageway, or where any other obstruction such as kerbstones could impair drainage of the base course, all work shall be so constructed that the base course will be adequately drained at all times during and after construction by means of sufficient drainage pipes through the obstructions or by the use of freely draining materials passing through shoulders. The Contractor shall not start constructing the base course of any part of the road before he/she has ensured sufficient drainage through the shoulders to the satisfaction of the Engineer.

(c) Spreading and mixing

Crushed aggregate complying with the requirements specified above shall be placed in quantities sufficient to ensure that the completed layer will comply with all the requirements in regard to layer thickness, level, cross-section and density. Segregation of the aggregate during spreading shall be prevented by appropriate choice of working method to the satisfaction of the Engineer. Allowance shall be made for sufficient extra material to enable the layer to be properly trimmed.
The maximum compacted thickness of any layer of crushed aggregate base course compacted in one process shall be 200 mm, unless otherwise specified or permitted by the Engineer.
The dumps of material shall be spread out to a flat-surfaced layer with a thickness that will be suitable for mixing. The required quantity of water shall then be added and the material mixed until a homogeneous mixture is obtained.

Table 0.1 Requirements For Class GCS1 Crushed Aggregate Base Course

Material properties	Material class: GCS1		
Atterberg limits: 1)			
Max Plasticity Index KS 999: Part 2	Non plastic		
Max Linear Shrinkage KS 999: Part 2			
Grading: KS 999: Part 2			
Sieve size (mm)	Grading limits – GCS1 (% passing sieve) 2)		
	0/20	0/30	0/40
50	-	-	100
37.5	-	100	90-100
28	100	90-100	75-95
20	90-100	65-95	60-90
10	60-75	40-70	40-75
5	40-60	30-55	30-63
2	30-45	20-40	20-45
1.18	15-30	15-32	15-35
0.425	13-27	10-24	10-26
0.075	4-10	4-10	4-12
Particle strength and shape:			
Minimum TFVdry KS 1238-12	110 kN		
Ratio dry to soaked value of KS 1238-12	TFVsoaked shall be minimum 60% of the corresponding TFVdry value		
Maximum flakiness index KS 1238-6	30		
It is emphasised that the Atterberg limits shall be measured according to KS 999: Part 2. Other laboratory test procedures and equipment may not give comparable results and shall not be used unless proper correlation to BS has been carried out to the satisfaction of the Engineer. The base course material on the road after final compaction shall comply with above grading limits.			

(d) Compaction

(i) General

After mixing, the crushed aggregate material shall be placed to the correct thickness and level and thoroughly compacted by suitable equipment so that the specified density is obtained throughout the entire layer.

The finally compacted layer shall be free from surface laminations, portions exhibiting segregation of the fine and coarse aggregate, corrugations, or other defects that may adversely affect the performance of the layer.

(ii) Compaction requirements

The minimum required compacted density for pavement layers made of crushed aggregate shall be as given in Table 26.2. The Contractor's attention is drawn to the high density requirements for class GCS1 materials and the required high standards of workmanship necessary to achieve these on site.

Table 0.2Compaction Requirements For Base Course Of Crushed Aggregate

Material class specified	Minimum dry density, lower specification limit, KS 999: Part 4, Vibrating Hammer
GCS1	98%
GCS2	96%

GCS1 crushed aggregate base material shall, unless otherwise specified in the Special Specifications, be laid by an approved type of self-propelled mechanical spreader and finisher capable of laying to the required widths, thicknesses, profile, camber or cross-fall, without causing segregation, dragging or other defects.
The Engineer may, if so specified in the Special Specifications, allow that nuclear method to be used for control of density and moisture content.
Compaction method specifications shall not be used for compaction control of crushed aggregate base course.

(e) Processing of class GCS1 materials

Class GCS1 shall be slushed as described herein to achieve the required field density. After completion of the compaction described above, short sections of the surface shall be thoroughly watered, rolled and slushed by means of steel-wheeled rollers with a mass of not less than 12 tonnes each, or with pneumatic-tyre rollers. The process shall continue until all excess fines are brought to the surface. The grout thus formed shall be uniformly broomed over the surface with stiff brooms to correct any areas still deficient in fines.
Thereupon the excess fines shall be broomed from the surface of the layer. This process shall continue until all excess fines in the mixture have been brought to the surface of the layer and its specified density has been reached. Excess fines and loose aggregate shall then be swept from the surface while the surface is still damp. The layer shall then receive final rolling with pneumatic-tyre rollers and the layer shall then be allowed to dry out. During slushing operations, care shall be taken not to roll the surface out of shape.
The slushing process shall be carried out on each section in one continuous process, and each section shall be completed before the next is proceeded on.
The completed layer shall be firm and stable with a closely-knit surface of aggregate exposed in mosaic and free from nests of segregated material, laminations or corrugations.

Table 0.3 Requirements For Class GCS2 Crushed Aggregate Sub-Base Course

Material properties	Material class: GCS2	
Atterberg limits: *1)*		
Max Plasticity Index KS 999: Part 2	6	
Max Linear Shrinkage KS 999: Part 2	3	
Grading: KS 999: Part 2		
Sieve size (mm)	Grading limits - GCS1 (% passing sieve) 2)	
	0/40	0/60
75	-	100
63	-	95-100
50	100	85-100
37.5	90-100	75-95
28	75-95	60-87
20	60-90	50-80
10	35-75	30-67
5	25-63	23-58
2	15-45	13-40
1.18	8-35	7-32
0.425	4-23	4-20
0.075	0-12	0-10
Particle strength and shape		

Minimum TFV_{dry} KS1238-12	90 kN
Ratio dry to soaked value of KS1238-12	TFV_{soaked} shall be minimum 75% of the corresponding TFV_{dry} value
Maximum flakiness index KS1238-6	35%
It is emphasised that the Atterberg limits shall be measured according to KS 999: Part 2. Other laboratory test procedures and equipment may not give comparable results and shall not be used unless proper correlation to BS has been carried out to the satisfaction of the Engineer. The base course material on the road after final compaction shall comply with above grading limits.	

2.1.26.1.4 Protection and maintenance

The Contractor shall protect and maintain the completed layer at his/her own expense until the surfacing is applied. Maintenance shall include the immediate repair of any damage to or defects in the layer and shall be repeated as often as is necessary. Repairs shall be so made as to ensure an even and uniform surface to be restored after completion of the repair work. Traffic shall not be allowed directly on any un-primed crushed aggregate layer unless so authorised or directed by the Engineer.

2.1.26.1.5 Construction tolerances and testing

The completed crushed aggregate layer shall comply with construction tolerances and testing requirements specified in Section 3.4.

2.1.26.2 Pavement; Natural material for subbase

2.1.26.2.1 Scope

This Section covers the construction of subbase from natural gravel or partially crushed gravel.

This Section covers the requirements for the following types of material:

- G30 natural gravel with minimum soaked CBR value of 30%

2.1.26.2.2 Materials

(a) General

Gravel material shall be obtained from approved sources. Any test results provided in design documents such as the Materials Report, read in conjunction with these Specifications, may give a preliminary indication as to the purpose for which cut or borrow material may be used as well as the treatment, if any, which the roadbed shall receive. Any test results or recommendations of method of work in the Materials Report are solely for information. The Contractor shall undertake his/her own assessment and any tests required and submit his/her proposed methods of work and test results of all material he/she intends to use for the approval of the Engineer.

The material type given in the Drawings denotes the minimum quality for a particular use in the Works, either specified in the Drawings or as instructed by the Engineer. In the cases where a minimum quality of earthworks material is not specified, the following guidelines shall apply and the Engineer's instruction shall be the applied standard to which materials quality control is applied:

Irrespective of the minimum required quality specified or the above guidelines, the highest quality of approved gravel for pavement layers available at economical haul distances,

complying with the requirements of the Specifications and Drawings, shall be selected for fill, improved subgrade and the individual pavement layers.

Materials for subbase layers of G30 materials as specified on the Drawings shall meet the requirements given in TABLE 26.4 below.

Table 0.4 Requirements for subbase layers of G30 materials

Material properties	Material class G30	
	General requirements	Coral gravel
CBR: KS 999: Part 4		
CBR (%)	Minimum 30 after 4 days soaking ***1)***	
CBR-swell (%)	Maximum 1.0 measured at BS-Heavy compaction	
Atterberg limits: 2)		
Max Liquid limit KS 999: Part 2	45	45
Max Plasticity Index KS 999: Part 2	16	18
Grading: KS 999: Part 2		
Requirements:	Grading modulus, GM shall be minimum 1.2	

1) CBR values shall be measured at the specified field density for the layer.
2) It is emphasised that the Atterberg limits shall be measured according to KS 999: Part 2. Other laboratory test procedures and equipment may not give comparable results and shall not be used unless proper correlation to BS has been carried out to the satisfaction of the Engineer. Limits specified are for 'wet' areas: for 'dry' areas, some relaxation is permitted: see Kenya Design Manual Part III.

2.1.26.2.3 Construction

(a) Requirements applying prior to placing of the layer

No pavement layer shall be placed until approval is obtained from the Engineer and the underlying layer is placed, compacted and finished in accordance with the Specifications and is tested and found acceptable to the full satisfaction of the Engineer. Before placing any pavement layer the underlying layer shall be inspected and proof rolled as required by the Engineer in order to establish whether there is any damage, wet spots or other defects. Any such defect shall be rectified to the satisfaction of the Engineer before the next layer is placed.

(b) Processing to improve quality

The Contractor may elect to crush, screen or mix materials from different sources or undertake other processing of materials to meet the specified material requirements. No additional payment will be made for any such processing unless stated in the Special Specifications and the Bill of Quantities.

(c) Shoulders

Where the shoulders and the base course are to be constructed from the same material, they shall be constructed simultaneously.

Where the base course is to be constructed from a different material than the shoulders, the shoulders shall first be constructed and then neatly cut to the required line to provide lateral support for the base course. Care shall be taken not to contaminate the base course material with the shoulder material. Where the base course is made of a bituminous mix, the base course may however be constructed before the shoulders. Work shall be so constructed that the road will be adequately drained at all times by means of sufficient drainage pipes passing through the shoulders. The Contractor shall not start constructing the final bituminous surfacing of any part of the road before he/she has completed the shoulders of such section to the satisfaction of the Engineer.

Shoulder material shall be spread, broken down as required, watered, mixed and compacted in accordance with the Specifications, and shall be compacted to a density of not less than 95% of BS-Heavy or as directed by the Engineer.

(d) Subbase and base course materials

Subbase or base course materials respectively shall be spread, broken down as required, watered, mixed and compacted in accordance with the Specifications, and shall be compacted to a density of not less than 95% of BS-Heavy

2.1.26.2.4 Protection and maintenance

The compacted layers shall be adequately drained and shaped to prevent water from standing on or along or causing damage to the completed work. Windrows shall be removed to facilitate the drainage of water from the surface.

No material for a subsequent layer shall be placed if the underlying layer has been softened by excessive moisture and requires repair in the opinion of the Engineer.

2.1.26.3 Pavement; Concrete Pavement

2.1.26.3.1 Scope

The work covered in this chapter consists of furnishing of all plant, labour, equipment and material and in performing all operations in connection with the construction of concrete slabs on a previously constructed sub grade, complete, in place and accepted, subject to the terms and conditions of the contract.

2.1.26.3.2 General

(a) Formwork and finishes

Formwork and finishes to concrete for concrete carriageways shall comply with the general specification for concrete works under buildings.

(b) Reinforcement

Steel reinforcement for concrete carriageways shall comply with the general specification for concrete works under buildings..

(c) Concrete

Concrete for concrete carriageways shall comply with the general specification for concrete works under buildings.

(d) Curing compound

Curing compound for concrete carriageways shall comply with the general specification for concrete works under buildings.

(e) Earthworks

Earthworks for concrete carriageways shall comply with the general specification for Earthworks works under buildings.

2.1.26.3.3 Materials

(a) Reinforcement

1. Fabric reinforcement shall be steel fabric complying with BS 4483. The fabric shall be manufactured from steel wire which complies with BS 4482 and which has a type 2 bond classification.
2. Dowel bars, tie bars, cradles and tie bars for cradles shall be Grade 250 plain round steel bars complying with CS 2. Dowel bars and tie bars shall be straight. Both ends of dowel bars and one end of tie bars shall be sawn square with all burrs removed.

(b) Cement mortar for cradles

Cement mortar for supporting cradles shall consist of 1 part of cement to 3 parts of fine aggregate together with the minimum amount of water necessary to achieve a consistency suitable for the required work. Fine aggregates shall be sand or crushed rock to BS 1200 and shall pass a 5 mm BS test sieve.

(c) Fine aggregate

Fine aggregate for concrete shall be natural river-deposited sand consisting of at least 95% by mass of quartz grains or clean, hard and durable crushed rock in accordance with Section 16.

(d) Polyethylene sheeting

Polyethylene sheeting shall be impermeable and shall have a nominal thickness of 0.125 mm.

(e) Joint filler

Joint filler shall be of a proprietary type approved by the Engineer and shall be a firm, compressible, single thickness, non-rotting filler.

(f) Joint sealant

(1). Joint sealant shall be of a grade suited to the climatic conditions of Nairobi and shall perform effectively over a temperature range of 0°C to 60°C.
(2). Joint sealant shall be a cold poured two-part polymer-based sealant complying with BS 5212, Type N.
(3). Primers and caulking material for use with joint sealant shall be of proprietary types recommended by the joint sealant manufacturer and approved by the Engineer.

(g) Bond breaker tape

Bond breaker tape shall be of a proprietary type recommended by the joint sealant manufacturer and approved by the Engineer. The tape shall be a polyethylene film with adhesive applied on one side and shall be the full width of the groove.

(h) **Groove forming strip**

(1). Groove forming strip shall be of a proprietary type approved by the Engineer. The strip shall be a firm compressible strip of either ethylene vinyl acetate foam with a density of at least 90 kg/m3 or synthetic rubber.
The strip shall be 25 mm deep and 5 mm thick and shall be sufficiently rigid to remain in position during concreting without deforming or stretching.
(2). Adhesive for groove forming strip shall be of a proprietary type recommended by the groove forming strip manufacturer and approved by the Engineer.

(i) Sleeves for dowel bars and tie bars

Sleeves for dowel bars and tie bars shall be uPVC and shall have a nominal wall thickness not exceeding 1.5 mm. The sleeves shall fit tightly to the bars.

(j) Epoxy resin grout

Epoxy resin grout shall be of a proprietary type approved by the Engineer.

2.1.26.3.4 Concrete

(a) Concrete mix

Concrete for concrete carriageways shall comply with the following requirements:

a) Concrete shall be Grade 40/20 and shall be a designed mix.
b) The concrete mix shall contain either PFAC or a minimum of 265 kg of PC plus a minimum of 85 kg of PFA per m3 of compacted concrete.
c) The percentage by mass of fine aggregate to total aggregate shall be at least 30%.
d) The workability in terms of designed slump value shall not exceed 30 mm.

(b) Cementitious content of concrete

The minimum cementitious content of concrete for concrete carriageways shall be 350 kg/m3.

2.1.26.3.5 Submissions

(a) Particulars of materials for joints

(1). The following particulars of the proposed materials for joints in concrete carriageways shall be submitted to the Engineer:

a) (a) Manufacturer's literature and a certificate for joint filler showing the manufacturer's name, the date and place of manufacture and showing that the joint filler complies with the requirements stated in the Contract and including results of tests for:
   - Disintegration and shrinkage
   - Recovery value and reduction in mass
   - Extrusion,
b) (b) Manufacturer's literature for joint sealant, including details of the method and time required for mixing the different components, and a certificate showing the manufacturer's name, the date and place of manufacture and showing that the sealant complies with the requirements stated in the Contract and including results of tests for:
   - Application life
   - Tack-free time
   - Resistance to flow
   - Recovery
   - Adhesion and cohesion in tension and compression
   - Resistance to heat ageing,
c) Manufacturer's literature and a certificate for groove-forming strip showing the manufacturer's name, the date and place of manufacture and showing that the groove forming strip complies with the requirements stated in the Contract and including results of tests for density, and
d) Particulars of primers and caulking material for joint sealant, adhesive for groove forming strip, bond breaker tape and sleeves for dowel bars and tie bars.

(2). The particulars, including certificates, shall be submitted to the Engineer at least 14 days before the first delivery of the material to the Site. Certificates shall be submitted for each batch of the material delivered to the Site.

(b) Particulars of methods of construction

Particulars of proposed methods of construction for concrete carriageways shall be submitted to the Engineer at least 7 days before the trial length is constructed.

(c) Samples of materials

Samples of the following proposed materials shall be submitted to the Engineer at the same time as particulars of the material are submitted:
(a) Polyethylene sheeting,
(b) Joint filler,
(c) Bond-breaker tape,
(d) Groove-forming strip, and
(e) Sleeves for dowel bars, including compressible filler, and for tie bars.

2.1.26.3.6 Trials

(a) Compliance criteria: trial-mix concrete

The results of the tests on trial-mix concrete for concrete carriageways shall comply with the following requirements:

- Each of the six slump values shall not exceed 40 mm, and the average of the six slump values shall not exceed 35 mm.

(b) Trial length

(1). A trial length of concrete carriageway shall be constructed to demonstrate that the proposed materials, mix design, methods of production and methods of construction will produce a concrete carriageway which complies with the specified requirements.
(2). The trial length shall be constructed using the materials, mix design, methods of production and methods of construction submitted to the Engineer.
(3). If it is not stated in the Contract that the trial length is to be constructed in a location separate from the permanent carriageway, the trial length shall be the first 30 m of the permanent carriageway, or such other length agreed by the Engineer. The trial length shall be constructed over a width of two bays and shall include at least one expansion joint, one contraction joint and the longitudinal joint between the bays.
(4). The Contractor shall inform the Engineer at least 48 hours, or within a shorter period agreed by the Engineer, before constructing the trial length.
(5). The trial length shall be completed in sufficient time before the permanent carriageway is constructed to allow the Engineer a period of at least 7 days to determine if the specified requirements have been complied with in the trial length.
(6). The trial length shall be protected from damage and shall be left in position unless the Engineer instructs its removal. A trial length which forms part of the permanent carriageway and which complies with the specified requirements shall not be removed.

(c) Testing: trial length

(1). The trial length shall be tested to determine the accuracy of the alignment and level, the surface regularity and the texture depth.
(2). Concrete cores shall be cut from the trial length to determine the thickness of the slab, the positions of the reinforcement and joint components, the amount of segregation of the constituents and the presence of voids.

(d) Non-compliance: trial length

(1). If the result of any test on the trial length does not comply with the specified requirements for the trial length, particulars of proposed changes to the materials, mix design, methods of production or methods of construction shall be submitted to the Engineer. Further trial lengths shall be constructed until the result of every test on the trial length complies with the specified requirements for the trial length. Further trial mixes shall be made unless in the opinion of the Engineer non-compliance of the trial length was not due to the concrete mix.
(2). Unless otherwise permitted by the Engineer, trial lengths, or parts of trial lengths, which do not comply with the specified requirements for the trial length shall be removed.

(e) Commencement of concreting

(1). Concrete shall not be placed in the permanent carriageway other than in a trial length until the result of every test on the trial length complies with the specified requirements for the trial length.
(2). Concrete may be placed in the permanent carriageway before the results of tests for compressive strength of the trial mix are available provided that the result of every other test on the trial mix and trial length complies with the specified requirements for trial mix concrete and for the trial length.

(f) Changes in materials and methods of construction

Unless permitted by the Engineer, the materials mix design, methods of production and methods of construction used to produce a trial length which complies with the specified requirements shall not be changed.

2.1.26.3.7 Storage of materials

(a) Storage of materials for joints and polyethylene sheeting

(1). Joint sealant, primer for joint sealant and adhesive for groove forming strip shall be stored in sealed containers marked to identify the contents and protected from exposure to conditions that may adversely affect the material. The materials shall be stored in accordance with the manufacturers' recommendations and shall not be used after the recommended shelf life has been exceeded.
(2). Polyethylene sheeting, joint filler, bond breaker tape, groove forming strip and sleeves for dowel bars and tie bars shall be stored in accordance with the manufacturers' recommendations in a dry, weatherproof store with a raised floor. Joint filler shall be stored in sealed plastic bags and shall not be exposed to moisture or air.

2.1.26.3.8 Preliminary work

(b) Installation of utilities

(1) Pipes, cables, manholes, chambers, gullies and other utilities below concrete carriageways shall be completed and fill material shall be deposited and compacted in trenches before the carriageway is constructed. Openings to manholes, chambers and gullies shall be protected by temporary covers or by other methods agreed by the Engineer.
(2) Box-outs shall be formed in concrete carriageways for covers, frames and other hardware. The covers, frames and other hardware shall be fixed in position after the main slab has been concreted and before the infill slab is concreted.

(c) Preparation of formation and sub-base

Construction of concrete carriageways shall start as soon as practicable after the formation or sub-base has been completed. The formation and the sub-base shall be protected until construction of the carriageway starts.

(d) Laying polyethylene sheeting

Polyethylene sheeting below concrete carriageways shall be laid flat without creases. Laps shall be at least 300 mm and there shall be no gaps at the edges of bays.

2.1.26.3.9 Formwork

(a) Formwork

(1). Unless otherwise approved by the Engineer, formwork for concrete carriageways shall be steel. The finish to concrete surfaces for transverse and longitudinal joints shall be Class F3. The finish to concrete surfaces for other edges of the carriageway shall be Class F2.
(2). Concrete shall not be placed against excavated surfaces or against kerbs unless permitted by the Engineer.
(3). Formwork shall not be loosened or removed until at least 7 hours after concreting has been completed.

2.1.26.3.10 Forming joints

(a) Forming joints

(1). Materials for joints in concrete carriageways shall be used in accordance with the manufacturers' recommendations or as otherwise stated in the Contract.
(2). Dowel bars, tie bars and their sleeves shall be securely fixed in position through holes in the formwork before concreting. The bars shall be parallel to the top surface of the slab and to each other. Bars at transverse joints shall be parallel to the adjacent longitudinal joint or to the longitudinal axis of the carriageway if there is no longitudinal joint or to other lines instructed by the Engineer.
(3). Joint filler shall be cut to size before fixing and shall be securely fixed in position to the existing concrete surface before concreting. There shall be no gaps between the joint filler and the formation. Holes in joint filler for dowel bars shall be cut to form a sliding fit to the sleeved bar.
(4). Joints shall be formed perpendicular to the top surface of the slab.

(b) Transverse joints

(1). Unless otherwise permitted by the Engineer, transverse joints in concrete carriageways shall be straight and perpendicular to the longitudinal axis of the carriageway.
(2). Transverse expansion joints and transverse contraction joints shall be formed only at the specified positions. The joints shall be continued across longitudinal joints and shall be in line and of the same type on both sides of the longitudinal joint. The joints shall be continued through kerbs, edgings and quadrants and their foundation and backing. The joint dimensions and materials shall be the same as the transverse joints with the omission of dowel bars. The location of additional contraction joints shall be as instructed by the Engineer. (3) The joint filler and groove for joint sealant at transverse expansion joints shall provide complete separation of adjacent slabs.

(c) Longitudinal joints

Longitudinal joints in concrete carriageways shall be formed only at the specified positions.

(d) Isolation joints

Isolation joints shall be formed in concrete carriageways at manholes and chambers.

(e) Forming grooves

(1). Grooves in concrete carriageways for joint sealant shall be straight, shall have parallel sides and shall be perpendicular to the top surface of the slab. The bottom of the groove shall be flat and shall be parallel to the top surface of the slab.
(2). Grooves at transverse expansion joints and at isolation joints at manholes and chambers shall be formed by sawing the groove to the specified width and depth not less than 7 days after concreting. The grooves shall be located over the joint filler such that the upper surface of the joint filler is entirely contained in the groove.
(3). Grooves at transverse contraction joints shall be formed using one of the following methods:

(i) Method 1:

An initial groove shall be sawn as soon as practicable after concreting without causing spalling of the edges.
The width of the initial groove shall be less than the specified width of the final groove and the depth of the initial groove shall be between 1/4 and 1/3 of the thickness of the slab. The final groove shall be sawn to the specified width and depth not less than 7 days after concreting. The center-lines of the initial and final grooves shall coincide.

(ii) Method 2:

The final groove shall be sawn to the specified width and depth as soon as practicable after concreting without causing spalling of the edges.

(1). Grooves at transverse construction joints shall be formed by fixing groove-forming strip with adhesive to the concrete already placed before concreting the adjacent slab.

(f) Protection of grooves

Before permanent sealing, grooves in concrete carriageways for joint sealant shall be protected from contamination by a temporary sealing strip or by other methods agreed by the Engineer.

(g) Sealing joints

(1) The permanent sealing of joints in concrete carriageways shall be carried out at least 7 days after concreting unless otherwise permitted by the Engineer.
(2) Immediately before permanent sealing, groove forming strips, temporary seals, dirt and loose material shall be removed from the groove and the sides of the groove shall be cleaned and roughened by water jetting, sand blasting or by other methods agreed by the Engineer.
(3) Caulking material shall be firmly packed in the bottom of the groove if the joint sealant is not required to extend to the bottom of the groove.
(4) Bond breaker tape shall be fixed continuously and evenly along the bottom of the groove for the full width and length of the groove.
(5) Primer for the joint sealant shall be applied to the sides of the groove in accordance with the manufacturer's recommendations.
(6) Joint sealant shall be applied between the minimum and maximum drying times of the primer recommended by the manufacturer. The components of the sealant shall be thoroughly mixed in accordance with the manufacturer's recommendations using a power operated paddle mixer for sufficient time to produce a homogeneous mass without entrapped air.
The sealant shall be dispensed into the groove as soon as practicable after mixing and within the time recommended by the manufacturer.
(7) The groove shall be clean and dry at the time of applying the primer and joint sealant.
(8) Excess joint sealant shall be removed by using a purpose made finishing tool such that the finished surface of the sealant is between 4 mm and 6 mm below the surface of the slab.

2.1.26.3.11 Placing and compacting concrete

(a) Placing and compacting concrete

(1). Concrete shall be placed continuously between the joints in concrete carriageways unless otherwise permitted by the Engineer.
(2). Concrete in unreinforced slabs shall be placed and compacted to the full thickness of the slab in one operation.
(3). Unless otherwise permitted by the Engineer, concrete in reinforced slabs shall be placed and compacted to the specified level of the fabric reinforcement. The fabric reinforcement shall be placed in position and concrete shall be placed and compacted to the remaining thickness of the slab. The time between compaction of the first layer and placing of the remaining layer shall not exceed 30 minutes unless in the opinion of the Engineer the

concrete already placed is sufficiently workable and the permission of the Engineer has been obtained. If permission is not obtained, a construction joint shall be formed. Concrete shall not be placed against the concrete already placed for at least 24 hours unless permitted by the Engineer.

(4). Concrete in infill slabs at covers, frames and other hardware shall be placed and compacted after the covers, frames and hardware have been fixed in position and shall not be placed at the same time as the concrete in the main slab.

2.1.26.3.12 Construction joints

(a) Construction joints

(1). Construction joints shall be formed in concrete carriageways only where approved by the Engineer or in cases of emergency if concreting is interrupted by adverse weather, plant breakdown or similar circumstances. Construction joints shall not be formed within 2.5 m of an existing or planned expansion or contraction joint.

(2). Transverse construction joints shall be formed by either:
   (a) Using formwork and cast-in tie bars, or
   (b) Breaking back from an unformed edge and fixing the tie bars and sleeves with epoxy resin grout in drilled holes.

2.1.26.3.13 Surface finish

(a) Surface regulation

(1). Unless combined double beam compactor-levellers are being used, then after compaction, the concrete in concrete carriageways shall be struck off to slightly above the levels of the formwork and the surface shall be regulated by a regulating machine or a vibrating beam.

(2). Regulating machines shall be purpose made and shall span the full width of the slab either transversely or obliquely. The machine shall be equipped with at least two oscillating-type transverse screeds and shall be supported on a carriage.

(3). Vibrating beams shall have a steel or aluminium surface and shall be mounted on a separate carriage. The beam shall be driven by a motor to provide a vibration frequency of at least 3500 cycles per minute.

(4). After regulation by the regulating machine or vibrating beam, the surface of the carriageway shall be regulated by at least two passes of a scraping straight edge with a blade length of at least 1.8 m. Scraping straight edges that operate in conjunction with regulating machines shall pass across the surface at right angles to the longitudinal axis of the carriageway. If the surface is torn by the straight edge, the surface shall be regulated again by the regulating machine or vibrating beam and by the scraping straight-edge.

(5). Wooden floats may be used to tamp and regulate small areas of the carriageway as agreed by the Engineer. Steel floats or trowels shall not be used.

(b) Surface texturing

(1). After the surface of the concrete carriageway has been regulated and before the curing compound is applied, the surface, other than the surface of channels and edges of slabs that do not require to be textured, shall be textured by brushing with a wire broom.

(2). The wire broom shall be at least 450 mm wide and shall have two rows of tufts. The rows shall be 20 mm apart and the tufts in each row shall be at 10 mm centres and in line with the centre of the gaps between the tufts in the other row. The tufts shall contain an average of 14 wires, each of 32 gauge and initially 100 mm long. The broom shall be replaced if any tuft wears down to a length of 90 mm.

(3). The surface texture shall be produced by brushing evenly across the slab in one direction at right angles to the longitudinal axis of the carriageway. Brushing shall be carried out after the moisture film has disappeared from the concrete surface and before the initial set is complete.

2.1.26.3.14 Curing concrete

(a) Curing concrete

The surface and edges of concrete carriageways shall be protected by one of the methods approved by the Engineer except that covering with hessian, sacking, canvas or other absorbent material as stated in Method 2 shall not be used. If Method 1 is used, the curing compound shall be applied to the surface immediately after the surface has been textured and shall be applied to the edges immediately after the formwork has been removed.

2.1.26.3.15 Protection of concrete carriageway

(a) Protection of concrete carriageway

(1). Immediately after the curing system has been applied, the concrete carriageway shall be fenced off from pedestrian traffic and covered with protective sheeting for at least 24 hours. The sheeting shall be lapped and securely held in position in such a manner that the surface of the carriageway will not be damaged.
(2). Loads from materials not forming part of the permanent work or from construction plant or other vehicles shall not be applied to the concrete carriageway until at least 14 days after concreting has been completed and until all grooves at joints have been temporarily or permanently sealed or protected.

2.1.26.3.16 Tolerances

(a) Tolerances: sub-base

The level of the sub-base below concrete carriageways shall not be more than 10 mm higher, and shall not be more than 20 mm lower, than the specified level.

(b) Tolerances: formwork

(1). The line of formwork for concrete carriageways shall be within 10 mm of the specified line of the concrete carriageway.
(2). The level of the top of the formwork shall be within 3 mm of the specified level of the concrete carriageway.
(3). Abrupt irregularities in the line of the formwork and in the level of the top of formwork shall not exceed 3 mm.

(c) Tolerances: reinforcement

The cover to fabric reinforcement in concrete carriageways shall be within 10 mm of the specified cover.

(d) Tolerances: dowel bars and tie bars

(1). Dowel bars at joints in concrete carriageways shall be within 20 mm of the mid-depth of the slab.
(2). Dowel bars shall be parallel to within 3 mm in half the length of the bar to:
   a) The longitudinal joint, or the longitudinal axis of the concrete carriageway if there is no longitudinal joint,
   b) The top surface of the slab, and
   c) Adjacent dowel bars.

(e) Tolerances: grooves

Unless otherwise recommended by the manufacturer of the joint sealant the depth of grooves for joint sealant in concrete carriageways shall be within 3 mm of the specified depth.

(f) Tolerances: covers, frames and other hardware

The level of covers, frames and other hardware shall not be higher than, and shall not be more than 3 mm lower than, the surface of the adjacent carriageway.

(g) Tolerances: alignment of concrete carriageway

(1) The best-fit straight line of straight joints and of straight edges of concrete carriageways shall be within 25 mm of the specified line. The line of straight joints and of straight edges of concrete carriageways shall be within 10 mm of the best-fit straight line.
(2) The best fit curved line of curved joints and of curved edges of concrete carriageways shall be as agreed by the Engineer and shall be within 25 mm of the specified line. The line of curved joints and of curved edges of concrete carriageways shall be within 10 mm of the best-fit curved line.

(3) Joints in concrete carriageways shall be continuous across intersections of joints to within 5 mm of the best fit straight lines or best fit curved lines of each joint.

(h) Tolerances: level of concrete carriageway

(1). The levels of the surface of concrete carriageways shall be determined 200 mm from the edges of each bay at 10 m centres in the longitudinal direction and at 2 m centres in the transverse direction.
(2). The level of the surface of concrete carriageways shall be within 6 mm of the specified level. In low lying and flat areas the Contractor shall pay special attention to level control to ensure that falls on the surface of the carriageway are in the specified direction.
(3). The difference in level of the surface of concrete carriageways across joints shall not exceed 3 mm.
(4). The thickness of concrete carriageway slabs shall not be less than the specified thickness minus 10 mm.

2.1.26.4 Pavement; Reflective Marking

2.1.26.4.1 Glossary of terms

(i) Road Markings

Road markings are white or yellow continuous or intermittent lines, letters, characters, figures, arrows or symbols marked on the carriageway to guide road users and pedestrians.

2.1.26.4.2 Materials

(a) Hot-applied thermoplastic material

(1). Hot-applied thermoplastic material shall comply with BS EN 1871:2000. In particular,
  (a) The luminance factor when tested in accordance with Annex E of BS EN 1871: 2000 shall be Class LF4 for white material and Class LF2 for yellow material.
  (b) The softening point when tested in accordance with Annex F of BS EN 1871: 2000 shall be Class SP2.
(3). Solid glass beads shall be included in the supplied mixture of hot applied thermoplastic material.
(4). Thermoplastic material shall be of a solvent-free marking substance supplied in block, granular or powder forms, which can be heated to a molten state and then applied with an appropriate hand or mechanical applicator, and form a cohesive film by cooling.
(5). Thermoplastic material shall belong to either of the following types:
  - Type 'A'-Standard hot applied thermoplastic material.
  - Type 'B'-Alkyd resin hot applied thermoplastic material.

(b) Cold-applied preformed material

(1). Cold-applied preformed material for road markings shall be of a proprietary type approved by the Engineer

(2). Solid glass beads shall be applied to cold-applied preformed material at the place of manufacture.

(c) Cold plastic road marking

Cold plastics road marking material shall comply with BS EN 1871: 2000. In particular, when applied at the manufacturer's stated thickness and tested in accordance with Annex A of BS EN 1871: 2000, the luminance factor shall be Class LF4 for white material and Class LF2 for yellow material.

(d) Paint for road markings

Road-marking paint material, including water-based road-marking paint, shall comply with BS EN 1871: 2000. In particular,

(a) The luminance factor when tested in accordance with annex A of BS EN 1871: 2000 shall be Class LF6 for white material and Class LF2 for yellow material.
(b) The difference in luminance factor after UV ageing shall be Class UV1.
(c) The difference in luminance factor after bleed resistance test shall be Class BR1.

(e) Solid glass beads

(1). Drop-on glass beads shall comply with BS EN 1423: 1998. In particular, the refractive index of the glass beads shall conform to Class A when determined in accordance with Annex A of BS EN 1423: 1998.
(2). Premix glass beads shall comply with BS EN 1423: 1998. In particular, the refractive index of the glass beads shall conform to Class A when determined in accordance with Annex A of BS EN 1423: 1998.

(f) Functional life of the material

The functional life of the road-marking material as defined in BS EN 1436: 1998 shall be not less than 1 year after laying is carried out.

2.1.26.4.3 Submissions

(a) Test certificate and routine testing

(1). When required by the Engineer, the Contractor shall submit the test certificate prepared and signed by a local or overseas independent laboratory to the Engineer before commencing the Works in order to certify that the samples taken from the materials to be used in the Contract comply with BS EN 1871: 2000.
(2). The Contractor shall supply all samples of materials for testing. He shall render such assistance as may from time to time be required by the Engineer in taking and packing them in bags, which are to be provided by the Contractor, and dispatching them to Public Works Central Laboratory for testing.

2.1.26.4.4 Delivery and storage of materials

(a) Delivery and storage of thermoplastic material

Each container for keeping thermoplastic road marking material shall be clearly and indelibly marked with the following information:

(a) The name, trade mark or other means of identification of the manufacturer;
(b) Batch number;
(c) Date of manufacture;
(d) The number and date of the Standard, i.e. BS EN 1871: 2000;
(e) Whether reflectorized;
(f) Color (white, yellow, or black);
(g) Chemical description and type of resin;

(h) Maximum application temperature and maximum safe heating temperature;
(i) Relative density;
(j) If applicable, the class of its contents
(k) If applicable, a warning about the use of lead pigment.

(b) Storage of road marking paint material

Road-marking paint material shall be discarded after expiry of the shelf life.

(c) Storage of preformed material

Cold-applied preformed material shall be stored in accordance with the manufacturer's recommendations.

2.1.26.4.5 Laying road markings

(a) Preparation of surfaces

(1). Road markings shall not be laid over loose detritus, mud or similar extraneous matter. Oil and grease shall be removed from the surface of carriageways on which road markings will be laid.
(2). Curing compound shall be removed from the surface of new concrete carriageways on which road markings will be laid, by wire brushing or by other methods agreed by the Engineer.
(3). Existing road markings that are to be replaced by a different type of material shall be removed by high pressure water jetting, shot blasting, rotary grinding or by other methods agreed by the Engineer. The existing markings shall not be masked using black paint or similar methods.
(4). Existing road markings that are to be renewed using a similar type of material shall be roughened by a method agreed by the Engineer until the thickness of the existing material is reduced by approximately 50%.
(5). A tack coat shall be applied to the surface of concrete carriageways before hot thermoplastic material is laid. The tack coat shall be compatible with the road marking material and shall be applied in accordance with the manufacturer's recommendations
(6). Rotary grinding machines shall not be used to remove or roughen existing road markings within 100 mm of longitudinal or transverse joints on concrete carriageways.

(b) Laying hot-applied thermoplastic material

(1). Hot-applied thermoplastic material shall be prepared and laid in accordance with BS 3262: Part 3, Clauses 4 and 5. The material shall not be laid when the surface of the carriageway is wet, or the air ambient temperature in the shade is less than 10°C.
(2). Hot-applied thermoplastic material shall be laid by machine or by screeding methods. The machine or apparatus shall be capable of producing a marking to a uniform thickness and width. The marking shall have clean edges and shall be free of streaks and blisters.
(3). The thickness of road markings, not including surface applied solid glass beads, shall comply with the following:
   (a) Screed markings : 4 mm
   (b) Sprayed lines other than yellow edge lines : ≥ 1.5 mm
   (c) Sprayed yellow edge lines : ≥ 0.8 mm
   The thickness shall be measured in accordance with BS 3262: Part 3, Appendix B.

(c) Laying cold-applied preformed material

(1). Cold-applied preformed material shall be laid in accordance with the manufacturer's recommendations. The material shall not be laid when the surface of the carriageway is wet.
(2). The thickness of road markings shall be at least 1.5 mm

(d) Use of road- marking paint

(1) Road-marking paint may only be used on roads or areas where the use of other road marking materials, such as thermoplastic, will affect the functional performance of the road markings and the use shall be subject to written approval of the Engineer.
(2) Road-marking paint shall be applied in accordance with the manufacturer's recommendations.
(3) Road-marking paint shall not be used for temporary road markings and shall not be used to temporarily cover up existing road markings.

(e) Road marking performance for road users

Performance of the road marking during its functional life shall comply with BS EN 1436:1998. In particular,
(a) The minimum luminance coefficient under diffuse illumination measured in accordance with Annex A of BS EN 1436: 1998 shall be Class Q2 and Q3 on asphaltic surface and concrete surface respectively for white markings, and shall be Class Q1 for yellow markings.
(b) The minimum coefficient of retro reflected luminance for dry road markings measured in accordance with Annex B of BS EN 1436: 1998 shall be Class R2 and R1 for permanent white and yellow markings respectively, and shall be Class R3 for temporary markings.
(c) The minimum luminance factor for dry road markings measured in accordance with Annex C of BS EN 1436: 1998 shall be Class B3 for white markings and B2 for yellow markings.

(f) Temporary road markings

(1). Cold-applied preformed material shall be used for temporary road markings. Where existing road markings have to be masked temporarily to facilitate roadwork, the proprietary black tape approved by the Engineer shall be used.
(2). Temporary road markings shall be disposed of by the Contractor after removal. All traces of tape shall be removed from the surface of the carriageway and existing permanent road markings shall be made good such that in the opinion of the Engineer it is safe to allow traffic to use the road.

(g) Skid resistance level

The minimum skid resistance of the road marking measured in accordance with Annex D of BS EN 1436: 1998 shall be Class S1.

2.1.26.4.6 Tolerances

(a) Tolerances

The lengths, thicknesses and widths of road markings shall comply with the following requirements:
(a) The thickness of screed markings shall be within 1 mm of the specified thickness.
(b) The length and width of screed markings and sprayed lines shall be within +10%, -5% of the specified dimension.

2.1.26.4.7 Removing road markings

(a) Shot-Blasting Machine

Where existing road marking is directed by the Engineer to be removed by steel shot-blasting, the removal of road marking materials shall be carried out by a shot-blasting machine approved by the Engineer. The machine
shall be self-propelled, and shall have a minimum cleaning path of 350 mm.

2.1.26.5 Pavement; Interlocking Concrete Blocks

2.1.26.5.1 Definition

Block paving is the term applied to flexible surfacing consisting of precast concrete paving blocks laid on a laying course.
Laying course is the layer of material on which paving blocks are bedded.
Surface course is the layer of interlocked paving blocks.
Edge restraint is that part of the construction such as raised or flush kerb or channel, which prevents sideways movement of the blocks and prevents loss of material from the laying course.

2.1.26.5.2 Materials

(a) Precast Concrete Blocks

Precast concrete blocks shall be heavy duty type complying with BS EN: 2003.
Compressive crushing strength: 45N/mm2
Colour: Silver Grey.

(b) Jointing Material

Moisture Content: < 0.5%
Jointing Material: Sand to BSEN 13242:2002 or BS EN 12620
Grading: See table 26.5 below

Nominal Sieve Size (mm)	Percentage by Mass Passing (%)
2.36	100
1.18	90-100
600µm	60-90
300µm	30-60
150µm	15-30
75µm	5-10

Table 0.5 Jointing Material-Sieve size Specification

(c) Laying Course

Bedding: Sand. See table 26.6 for sieve size specifications
Nominal thickness after compaction: 50mm
Moisture content: 4-8% at the time of laying

Nominal Sieve Size (mm)	Percentage by Mass Passing (%)
10mm	100
5mm	85-100
2.36	65-100
1.18	40-98
600µm	25-72
300µm	10-35
150µm	0-15
75µm	0-10

Table 0.6

(d) Hand Packed Stones

All open-graded granular sub-base material shall comprise crushed gravel rock possessing well defined edges. Rounded gravels shall not be used. The sub-base material shall be sound, clean, non-friable and free from clay.

2.1.26.5.3 Method of Construction

(a) Laying Course

After completion of the specified sub base and approval by the Engineer, the Contractor shall spread the laying course material in a loose uncompacted layer to approximately required final depth below the surface profile. The loose thickness must be such that after compaction it forms a layer approximately 20mm thick below the paving blocks. In no case shall the material be less than 20mm thick at any point.
The moisture content of the laying course material shall be between 80 and 105% of the optimum moisture content for that material. Any material which gets saturated following rain or for any reason shall be removed and dried out to bring the moisture content to acceptable limits.
After evenly spreading the material, the layer shall be compacted using a vibrating plate compactor until the surface achieves uniform density and compaction. Upon completion of the compaction and inspection and approval by the Engineer, the Contractor shall spread a further layer of material about 15mm thick and screed it to create a loose surface on which the paving blocks can be placed.

(b) Surface Course

Paving blocks shall be laid such that the surface layers are within the tolerances specified below. Prior to commencing, the Contractor shall obtain the Engineer's written approval of the bond pattern adopted. The bond pattern shall be either Herringbone, Stretcher type as shown on the Drawings, or as directed by the Engineer.
The order of laying shall be such that an open working face is maintained. The first row of blocks shall be aligned against the edge restraint or by using a string line. Alignment of the blocks shall be checked by the Contractor as the work proceeds and adjustment made where necessary.
The bond pattern shall be maintained at all times. Joint width for sand filling shall be in the range of 2mm to 5mm. The area to be laid shall be completed as far as possible with whole blocks. Formation of boundaries and changes in direction shall be carried out using blocks trimmed to shape and size for the purpose. In no case shall pieces less than one third the size of a full block be inserted.

To work round any obstruction, the latter shall be surrounded with concrete using maximum aggregate size of 10mm and a compression strength of 40 N/mm^2 to form a regular shape and paving blocks trimmed to abut the obstructions shall be completed as the laying proceeds and before compaction commences.

(c) Compaction

After laying of the blocks is possible is complete, the surface course shall be compacted using a vibrating plate compactor with a plate area of not less than $0.25mm^2$ transmitting an effective force of not less than 75 kN/m^2 of plate at a frequency of vibration in the range of 75 Hz to 100 Hz. Alternative compaction equipment to achieve the same degree of compaction shall be to the approval of the Engineer.
Compaction shall be carried out as soon as possible after laying but not within 1 metre of any laying surface. No area of paving shall be left uncompacted at the completion of the day's work. No paving shall be laid in inclement weather conditions as instructed by the Engineer.

(d) Joint Filling

After compaction of the surface course, dry sand or crushed rock fines complying with the grading specified above shall be spread over the surface and brushed into the joints. The surface shall be vibrated using the vibratory plate compactor to ensure complete filling of the block-to block joint by the sand or fines. Where necessary, further sand or fines shall be added and surface re-vibrated.

(e) Tolerance

Tolerance on surface course shall be as follows:

Overall	±6mm

Flatness	10mm under a 3m straightedge 2mm between adjacent blocks
Adjacent gullies, Surface drainage Channels & outlets	6m, 0mm

2.1.26.5.4 Measurement and Payment

Concrete block paving shall be measured in square metres as the net plan area instructed by the Engineer to be laud.

The rate shall include for all works necessary to comply with the requirements of subclause 2301, 2302 and 2303 above.

2.1.26.6 Sidewalks and Other Paved Areas

2.1.26.6.1 Reinforced Concrete Sidewalk

Construction methods for embankment, subbase and base course, and pavement as specified in shall be used for reinforced concrete side walk, where applicable.

2.1.26.6.2 Stone Surfaced Tile Sidewalk

Materials and construction of embankment and bases shall be as specified. Embankment and bases shall be compacted to not less than 95% dry maximum density per AASHTO Standards. The tiles shall be gravel surfaced tile, sized 400 x 400 x 50 mm or other sizes as shown on the Drawings. Joints between each piece of tile shall be sealed with sand cement mortar, ratio 1:1, and shall be treated to match with the sidewalk surfaces. Joint lines shall be perpendicular to concrete kerbs.

2.1.26.6.3 Paving Block Sidewalk

Materials and construction of embankment and bases shall be as specified. Embankment and bases shall be compacted to not less than 95% dry maximum density per AASHTO Standards. Paving block shall have the pattern as specified and shall be constructed as follows:

(1) Level sand bedding to the required slopes, allowing for settlement after compaction.

(2) Lay paving blocks to form an interlocking resistance between the blocks.

(3) After the paving blocks have been laid in place, sand shall be placed over the blocks and swept to fill the gaps between the blocks. Plate vibrator shall be applied to compact sand in the gaps.

2.1.26.6.4 Concrete Tile Pavement

The relevant provisions of the Specifications shall apply for concrete of tiles. The concrete shall be grade C25.

Before ordering any tiles the Contractor shall have samples tested, as specified by the Engineer, by a testing authority nominated by the Engineer.

No tile shall be laid within 8 weeks after its casting.

The tiles shall be laid on a base of fill of at least 200mm thick. The fill shall be brought to true profile and level immediately before laying the tiles thereon. The tiles shall each be supported on their whole area by the fill material and after the tiles are laid the difference in height between the top edges of any 2 adjoining tiles shall not be more than 1mm. The tiles shall be laid tightly against each other in stretcher bond or in a pattern as specified by the Engineer.

During the Period of Maintenance the Contractor shall inter alia replace any tiles showing any cracks or any other damage or defects with tiles complying with the Specifications and lay again in accordance with the Specifications any tiles displaced due to settlement or otherwise.

2.1.26.6.5 Limit of Construction and Allowable Tolerances

Sidewalks and paving shall be constructed to the full width and length with the provision of spaces for tree planting or grassing and indicated on the drawings and in the particular specifications.
After construction is completed, levels along the line parallel to the centre line of the side walk shall not deviate more than 10mm every 3.00 m. The elevation shall be deviated from the specified elevation not to exceed 10mm. The allowable tolerances stated above shall not apply to ramp or bending sections.

2.1.26.6.6 Other Requirements

In the laying of the end rows of stone tiles or paving blocks it may be necessary to cut the tiles or the blocks to fit the available spaces. The cutting shall be done by a hydraulic spitter.
Upon completion of sidewalk or paving construction, the gaps between the tiles/blocks and concrete kerbs, manhole walls, building walls and at any locations shall not be more than 10mm wide.
Where concrete kerbs or gutters are constructed in the same contract, the construction of concrete kerbs and gutters must be complete before the construction of side walk is started.

2.1.26.7 Pavement: Kerbs, Edgings and Quadrants

2.1.26.7.1 Materials

(a) Concrete kerbs, edgings and quadrants

(1). Concrete for kerbs, edgings and quadrants shall be Grade 30/20. Concrete for foundations and backings to kerbs, edgings and quadrants shall be Grade 20/20.
(2). Precast concrete kerbs, edgings and quadrants shall comply with BS 7263: Part 1 except that the requirement for testing of water absorption shall not be applied. The nominal length of kerbs shall be 1 m and the nominal length of edgings shall be 750 mm.

(b) Granite kerbs, edgings and quadrants

(1). Granite kerbs, edgings and quadrants shall be worked straight or circular. Corners shall be square and the top front and back edges shall be parallel. The length of granite kerbs and edgings shall be at least 600 mm.
(2). The ends of the kerbs, edgings and quadrants shall be chisel-dressed square to form a close butt-joint with adjacent kerbs. Kerbs shall be chisel-dressed to a depth of at least 140 mm on the front face, at least 75 mm on the back face and for the full width of the top face.

2.1.26.7.2 Construction of kerbs, edgings and quadrants

(a) Construction of precast concrete and granite kerbs, edgings and quadrants

(1) Precast concrete and granite kerbs, edgings and quadrants shall be laid and bedded on a regulating layer of cement mortar. The thickness of the layer shall be at least 10 mm and shall not exceed 40 mm.
(2) Except as stated in this clause, joints between each kerb, edging and quadrant shall not exceed 10 mm in width and shall be filled and flush pointed with cement mortar. Joints in kerbs, edgings and quadrants at expansion joints on bridge decks shall be as stated in the Contract.
Transverse expansion and contraction joints in kerbs, edgings and quadrants laid on or adjacent to concrete carriageways shall be in accordance with Clause 4.6
(3) Radius kerbs shall be used for curves less than 10 m external radius.

(b) Construction of in-situ kerbs, edgings and quadrants

(1). In-situ concrete kerbs, edgings and quadrants shall be constructed in accordance with BS 5931 and shall be laid by an automatic extrusion machine of a type approved by the Engineer.
(2). In-situ concrete kerbs, quadrants and edgings shall have regular sides, edges, arrises and chamfers. The finish to the concrete surface shall be Class U5. Kerbs, edges and quadrants shall not be finished or dressed with cement mortar.
(3). Contraction joints shall be formed at intervals not greater than approximately 4 m. Transverse expansion and contraction joints in kerbs, edgings and quadrants which are laid on or adjacent to concrete carriageways shall be in accordance with Clause 4.6 Joints shall be flush pointed with cement mortar.

2.1.26.7.3 Tolerances

(a) Tolerances: kerbs, edgings and quadrants

(1). The line of kerbs, edgings and quadrants shall be within 3 mm of the specified line.
(2). The level of the top of kerbs, edgings and quadrants shall be within 3 mm of the specified level.

2.1.26.8 Pavement; Traffic Signs

2.1.26.8.1 General

(a) Traffic signs

(1). The design of traffic signs, including letters, characters, numbers, symbols and borders, shall be in accordance with conditions and restrictions imposed by the Commissioner for Transport.
(2). Traffic signs shall comply with BS EN 12899: Part 1: 2001 except that the requirements for marking signs shall not apply.
(3). Traffic signs shall be externally illuminated, internally illuminated, retro reflective, non-retro reflective or a combination of these types as stated in the Contract.

2.1.26.8.2 Materials

(a) Steel

Steel for traffic signs shall comply with the following:
Hot finished seamless tubes: BS 6323: Part 3
Hot rolled sections: BS 4: Part 1
Hot rolled structural steel sections
equal and unequal angles : BS 4848: Part 4
Weldable structural steels: BS 4360

(b) Stainless steel

Stainless steel for traffic signs shall be Grade 1.4401 and shall comply with the following:
Technical delivery conditions for sheet/plate and strip of corrosion resisting steels for general purposes: BS EN 10088-2 Amd 3/2010
Stainless steel tubes suitable for threading in accordance with BS 21: BS 6362

(c) Aluminium alloy

(1). Aluminium alloy for traffic signs shall be EN AW-6082 in the T6, T651 or T62 tempers and shall comply with the following table:

Wrought aluminium and aluminium alloys for general engineering purpose
Standards

- Plate, sheet and strip
  BS EN 485: Part 1: 1994, BS EN 485: Part 2: 2004, BS EN 485 Part 3: 2003 and BSEN 485: Part 4: 1994
- - Drawn tube
  BS EN 754: Part 1: 1997, BS EN 754: Part 2: 1997, BS EN 754: Part 3: 1996, BS EN 754: Part 4:1996, BS EN 754: Part 5: 1996, BS EN 754: Part 6: 1996, BS EN 754: Part 7: 1998 and BS EN 754: Part 8: 1998
- - Bars, extruded round tubes and sections
  BS EN 755: Part 1: 1997, BS EN 755: Part 2: 1997, BS EN 755: Part 3: 1996, BS EN 755: Part 4: 1996, BS EN 755: Part 5:1996, BS EN 755: Part 6:1996, BS EN 755: Part 7: 1998, BS EN 755: Part 8: 1998 and BS EN 755: Part 9: 2001

(2). Aluminium alloy shall be anodized to Grade AA 25 in accordance with BS EN 12373: Part 1: 2001.
(3). Aluminium alloy sheet shall be free of twisting, warping and buckling and the surfaces shall be free of blemishes and other defects.

(d) Bolts, nuts, screws, washers and rivets

(1). Bolts, nuts, screws, washers and rivets for traffic signs shall comply with the following:
ISO metric black hexagon bolts, screws and nuts: BS 4190 ISO metric black cup and countersunk head bolts and screws with hexagon nuts : BS 4933 Metal washers for general engineering purposes : BS 4320
Rivets for general engineering purposes: BS 4620
Wrought aluminium and aluminium alloys for general engineering purposes
- rivet, bolt and screw stock : BS 1473
Mechanical properties of corrosion-resistant stainless-steel fasteners.
Bolts, screws and studs : BS EN ISO 3506-1
Mechanical properties of corrosion-resistant stainless steel fasteners. Nuts : BS EN ISO 3506-2 Amd 3/2010
(2). The length of bolts shall be such that after assembly the threaded portion of each bolt projects through the nut by at least one thread and by not more than four threads.
(3). Rag and indented bolts shall comply with BS 1494: Part 2.
Expansion bolts and resin bonded bolts shall be of a proprietary type approved by the Engineer and shall be capable of withstanding the design working load.
(4). Galvanised bolts, nuts, screws, washers and rivets shall be used with traffic signs secured to galvanised pedestrian guard-railing. Aluminium materials shall be insulated from ferrous materials by a non-conductive insulator at least 2 mm thick of a type approved by the Engineer.

(e) Materials for faces of traffic signs

(1). Retro reflective sheeting shall be Class Ref 1 or Class Ref 2 material complying with BS EN 12899: Part 1: 2001, Tables 8 and 9 or Type IX material complying with ASTM D4956-05.
(2). Non-retro reflective sheeting shall comply with BS EN 12899: Part 1: 2001.
(3). Plastic sheeting shall be of a proprietary type approved by the Engineer.
(4). All materials and finishes shall be mutually compatible.

2.1.26.8.3 Fabrication of traffic signs

(a) Posts for traffic signs

(1). Posts for beacons at zebra crossings shall be painted with alternate black and white stripes. Other posts shall be painted grey in accordance with BS 5252F, Code 18B19 or shall be galvanized in accordance with BS EN ISO 1461:1999.

(2). Galvanized areas affected by cutting and drilling shall be treated using a method approved by the Engineer.
(3). Posts other than posts supporting an external luminaire shall not protrude above the top of signs. The length of posts supporting external luminaries protruding above the top of signs shall be as short as practicable.

(b) Backing plates for traffic signs

(1). Backing plates for traffic signs shall be fabricated from 3 mm aluminium sheet. Backing plates for traffic signs not exceeding 1200 mm high x 2400 mm wide shall be fabricated from a single sheet. If more than one sheet is used, the number of sheets shall be kept to a minimum. The separate sheets shall be rectangular and shall be approximately the same size.
(2). Holes in backing plates shall be drilled before the plate is painted and before retro reflective or non-retro reflective sheeting is applied.

(c) Spill screens for traffic signs

(1). Top and bottom light spill screens shall be fabricated from the same material as the backing plate. The spill screens shall extend for the complete width of the backing plate and the corners shall be cut to the same radius as the corners of the backing plate.
(2). Spill screens shall be considered as part of the backing plate and stiffeners and mountings shall be designed to accommodate the combined size.

(d) Faces for traffic signs

(1). Faces for traffic signs shall be formed using retro reflective or non-retro reflective plastic sheeting. Unless otherwise permitted by the Engineer, a single piece of sheeting shall be used. If more than one sheet is used, the number of sheets shall be kept to a minimum. Sheeting shall be fixed in accordance with the manufacturer's recommendations.
(2). Materials for faces of traffic signs, including the background, letters, characters, numerals, symbols and borders, shall be matched for colour in accordance with the sheeting manufacturer's recommendations at the time of fabrication to provide a uniform appearance by day and by night.
(3). Letters, characters, numerals, symbols and borders shall be clear cut and sharp-edged and shall have no cracks.
(4). Sheeting material, including letters, characters, numerals, symbols and borders shall be fully fixed using adhesive. There shall be no air bubbles, creases, cracks or other blemishes.
(5). The back of traffic sign shall be marked with the manufacturer's name and manufacturing date in month/year as shown in the following manner:
- Manufacturer's name
- Month/year

The marking shall either be printed on non-retro reflective self-adhesive material in accordance with BS EN 12899: Part 1: 2001 or stamped by a punch without damaging the front face of traffic sign or other method approved by the Engineer. The letter size shall not be smaller than 12 mm (h) x 8 mm (w).
(6). For each colour of externally illuminated and trans-illuminated signs, the uniformity of luminance, determined by the ratio of the lowest to the highest level measured at any part of the sign, shall be as shown in the following and in accordance with BS EN 12899: Part 1: 2001, Table 12. Illuminated face area Uniformity of luminance
≤ 1.5 m2 U2
> 1.5 m2 U1

(e) Lacquer coatings

Lacquer coatings to faces for traffic signs shall be uniform and continuous and shall be applied at the time of manufacture of the face.

(f) Painting to faces for traffic signs

(1) Faces of traffic signs to which a painted or stoved finish is to be applied shall be thoroughly cleaned and pre-treated before painting and stoving.
(2) Pre-treatment shall be by anodising or by using an etching primer or by a process approved by the Engineer.
(3) At least one undercoat and at least one finishing coat of paint shall be applied and stoved to a thickness of between 0.0315 mm and 0.0375 mm of enamel over a minimum thickness of 0.025 mm of primer. If light colours are to be applied over dark colours, at least two coats of the light colour shall be applied. The final surface shall have a uniform thickness and an egg-shell flat finish and shall be smooth and free of defects.
(4) The colour of the finished coating shall be uniform. The colours, including white, shall comply with the chromaticity and luminance factors of BS EN 12899: Part 1: 2001, Tables 3 and 5 and, for comparative purposes, shall comply with the following gloss paint colours in accordance with BS 381C: 1996:
- Red : No. 537 – signal red,
- Orange : No. 557 – light orange
- Yellow : No. 355 – lemon yellow,
- Blue: No. 109 – middle blue
- Green: No. 225 – light brunswick green

(5) Parts of faces coloured black shall be non-retroreflective and shall have a luminance factor not exceeding 0.03 as specified in accordance with BS EN 12899: Part 1: 2001.
(6) The Volatile Organic Compound (VOC) content of all paint applied on surfaces of traffic signs shall comply with the VOC limits stipulated in the Air Pollution Control (Volatile Organic Compounds) Regulation. Amd 1/2007

2.1.26.8.4 Submissions

(a) Particulars of traffic signs

(1) The following particulars of the proposed traffic signs shall be submitted to the Engineer:
(a) Name of manufacturer, and
(b) Details of materials and finishes to be used in the manufacture of the signs.
(2) The particulars shall be submitted to the Engineer at least 14 days before fabrication of traffic signs starts.

2.1.26.8.5 Storage of materials

(b) Storage of traffic signs

(1). Traffic signs shall be stored in a dry, weatherproof store. Traffic signs that are stored together shall be separated by slip-sheets.
(2). Traffic signs shall be stored in a manner that will not result in damage or deformation to the signs.

2.1.26.8.6 Construction and assembly of traffic signs

(a) Construction and assembly of traffic signs

(1). Fittings for traffic signs shall be non-corrodible material approved by the Engineer.
(2). Joints for framework and stiffeners that are not an integral part of the backing plate shall be welded or joined using brackets, nuts, bolts and washers.
(3). Materials for rivets and other fixings for joining backing plates to framework and stiffeners shall be compatible with the materials to be joined. The spacing of rivets and other fixings shall be uniform. The spacing shall not exceed 150 mm around the outside edge of sheets and shall not exceed 300 mm on cross braces.

(4). An additional washer of neoprene, nylon or other material approved by the Engineer shall be used to protect the faces of traffic signs from metal nuts, bolts, washers and screws.
(5). Backing plates shall be connected to posts by a method approved by the Engineer. Banding systems shall be stainless steel. Drilling of holes in ferrous components shall be completed before finishes are applied.
(6). A lacquer coating shall be applied to the edges of holes drilled in plates with plastic sheeting immediately before rivets and bolts are inserted. The surfaces of rivets and bolts on the faces of traffic signs shall be covered with a material coloured to match the part of the face with which it is in contact.
(7). Fixings for traffic signs erected on road lighting columns shall be compatible with the column cross-section. Columns shall not be drilled.
(8). When backing plates are stiffened with additional reinforcing members, these members shall be fixed to the backing plates in compliance with Class P2 in Table 1 of BS EN 12899: Part 1: 2001.
(9). Protection to sign edges shall be Class E1 in compliance with BS EN 12899: Part 1: 2001, Table 2.

(b) Covering of traffic signs

(1). Traffic signs which are to be blanked out shall be covered by the following methods:
(a) Plate signs shall be covered using a 1.5 mm thick sheet that is compatible with the material in the sign.
(b) Plate signs that are to be blanked out for a period not exceeding one year may alternatively be covered using a self-adhesive plastic film.
(c) Other signs shall be covered using a loose cover sheet of material approved by the Engineer.
(3) Cover sheets shall be fixed using 5 mm diameter stainless steel bolts, washers and nuts or non-ferrous rivets at spacing not exceeding 600 mm. Bolts shall pass through 5 mm x 12 mm diameter plastic distance pieces between the face of the sign and the cover plate. Holes that remain on the finished face of the sign shall be filled using blocked rivets. The face of the rivets shall be coloured by a method approved by the Engineer.
(4) Self-adhesive plastic film shall be compatible with the material in the face of the sign and shall be fixed and removed in accordance with the manufacturer's recommendations.
(5) Loose covers shall be securely fastened to the back of the sign. Tape or other adhesive material shall not be applied to the faces of signs.
(6) Coverings to traffic signs shall be sufficiently opaque to prevent reflection from the covered sign and shall not be removed until the Engineer so instructs.
(7) Unless otherwise permitted by the Engineer, the faces of traffic signs which have been erected and which do not relate either wholly or in part to the traffic situation which applies at that time shall be blanked out as stated in this Clause.

2.1.26.8.7 Testing: traffic signs

(a) Testing:

(1). The number of traffic signs to be tested shall be as stated in the Contract or as instructed by the Engineer.
(2). The number and type of tests to be carried out on the traffic signs shall be as stated in the Contract as instructed by the Engineer.
(3). Testing shall be carried out in such a manner that the traffic sign will not be damaged.
(4). Testing shall be carried out by the Contractor at a laboratory approved by the Engineer.

(b) Compliance criteria:

The compliance criteria for testing traffic signs shall be in accordance with BS 873: Part 1: 1983.

BILL NO. 1 : PRELIMINARIES

Item	Description	Amount
	PRELIMINARIES:	
	PRELIMINARY PARTICULARS OF CONTRACT	
A	Parties to the Contract:	
	The 'Employer' is **THE NAIROBI HOSPITAL,** P.O. BOX 30026-00100, NAIROBI, KENYA.	
	The 'Project Manager' is **PSRM CONSULTANTS,** P.O BOX 60824-00200, NAIROBI, KENYA.	
	The 'Architect' is **MUTISO MENEZES INTERNATIONAL,** P.O BOX 44934-00100, NAIROBI, KENYA.	
	The 'Quantity Surveyor' is **LINEAR PROJECTS LTD,** P.O. BOX 106188-00101, NAIROBI, KENYA.	
	The 'Structural/Civil Engineer' is **NATCONSULT CONSULTING ENGINEERS LTD,** P.O BOX 3975 - 00506, NAIROBI, KENYA.	
	The 'Services Engineer' is **GEOMAX CONSULTING ENGINEERS,** P.O BOX 53748 - 00200, NAIROBI, KENYA.	
	The Consultants above, when performing their respective duties are deemed to be invested with such duties and representative of the Project Manager.	
	The 'Contractor' is the person or persons, partnership, firm or company whose tender for this work has been accepted, and who has or have signed this contract and shall include his or their heirs, executors, successors and duly appointed representatives.	
	Carried to Collection Kshs	

Item	Description	Amount
A	Location of site: The site is located along in Argwings Kodhek, Kilimani area Nairobi and can be accessed from Nairobi Hospital gate 1 or 2 or any other gate that the client may designate for purposes of carrying out these works	
B	Site Visit: The contractor shall visit the site to acquaint himself with the nature and position; nature of ground substrata and other supplies; access roads or any other limitations. If the contractor is unable to locate the site he can seek guidance and information from the Project Manager. No claims whatsoever for extras on account of lack of knowledge in this respect will be considered.	
C	Drawings: The drawings used in preparing these Bills of Quantities are as in Appendix 'A' at the end of these Bills of Quantities. Further drawings may be inspected at the office of the Project Manager or Quantity Surveyor by prior appointment.	
D	Scope of work: The scope of works : a) Demolitions - Wall, Finishes,Joinery, Window and Door demolitions b) New Scope - New walls, Partitions, Doors, Windows and Finishes	
	Carried to Collection Kshs	

Item	Description	Amount
	GENERAL DESCRIPTION OF THE WORKS	
A	Approximate areas	
	The approximate total area is:	
	Maternity Rooms 340 sm	
	Total Area 340 sm	
	The areas are given without warranty and for the tenderer's guidance only	
B	Construction programme of works:	
	The bidders shall provide a proposed programme of works together with their bid documents and the successful bidder will submit a detailed programme of works at the time of signing the contract.	
	Carried to Collection Kshs	

Item	Description	Amount
	CONTRACT PARTICULARS:	
A	Form of Contract:	
	The Contractor will be required to enter into a contract which will be the current Conditions of Contract for Construction for Building and Engineering Works Designed by the Employer (Second Edition 2017) published by International Federation of Consulting Engineers (FIDIC) or as may have been reprinted thereafter (With Quantities), except in so far as varied hereafter. The Form of Contract can be inspected at the offices of the Quantity Surveyors.	
B	The Contractor's attention is drawn to the following Clauses of the Conditions of Contract which shall be read as incorporated herein and shall allow any sums which he considers necessary for the carrying out and observance of such Conditions.	
C	Clause 1 General Provisions	
	The Defects Notification Period (DNP) IS 180 days.	
	The Time for completion shall mean the time agreed in weeks from the from Commencement Date	
	The Agreed methods of electronic transmission All communication shall be in writing and delivered by hand (against receipt), sent by mail or courier. In addition copies of all communication shall be sent by email from the originator to each of the recipients of the original communication using email addresses agreed between contractor, engineer and employer following contract signing. Such email copies shall be for the convenience of the parties only and the contractual version of any communication shall be the version in writing and the date and time of delivery shall be the date and time of the delivery of the version in writing.	
	The governing law shall be the laws of the Republic of Kenya with the ruling language and language for communications being English (UK)	
	Notwithstanding the foregoing, the employer reserves the right to remove any part of the work from the main contractor and have the same executed by a nominated contractor. The Main Contractor shall not be entitled to any claim for loss of profit but will be entitled to profit (2%) and attendance (2%)	
D	Clause 2 The Employer	
E	Clause 3 The Engineer	
	The term Engineer shall collectively mean the Project Manager and any other Professional Consultants engaged by the Employer for their respective roles.	
	All instructions with a cost implication or materially change the nature and scope of the works must be approved by the Employer prior to execution through a variation order. Full justification for such changes shall be provided by the Contractor and the respective Consultants.	
	Carried to Collection Kshs	

Item	Description	Amount
A	Clause 3 The Engineer cnt'd Replacement of the Engineer clause 3.6 Paragraph 3 is **Deleted** and replaced with "The Employer shall have the right to replace the Engineer at any time with or without the consent of the Contractor on the choice of the Engineer".	
B	Clause 4 The Contractor **Highlights to;** **Performance Bond / Security** The performance security will be in the form of an irrevocable and unconditional guarantee from a tier one or tier two Bank approved by the employer The performance security shall remain valid for 180 days from the commencement date and shall be extended should the completion time be extended beyond its validity period. Training to Employer's employees to be provided at the end of the contract and is deemed included within the Contractors tender price. Daily progress reports to be issued complete with progress photos at the Contractor's cost. Before the commencement of the construction, the Contractor shall avail a comprehensive site security plan to the Employer. The Employer, together with any other third party as authorized by the Employer, reserves rights to examine procedures, methods and facilities used by the Contractor to provide security.	
C	Clause 5 Subcontracting	
D	Clause 6 Staff and Labour Before the commencement of the construction, the Contractor shall avail a comprehensive health and safety plan to the Employer. The Employer, together with any other third party as authorized by the Employer, reserves rights to examine procedures, methods and facilities used by the Contractor to provide health and safety to personnel.	
E	Clause 7 Plant Materials and Workmanship	
F	Clause 8 Commencement, Delays and Suspension Extension of Time for Completion; the word 'epidemic' is **Deleted** Maximum amount of delay damages 10% of the Final Contract Price. The damages will automatically be chargeable from expiry of the contract period or extended time of the contract and will be recovered from any amounts due to the Contractor including retention and the performance security. Employer's Suspension **clause 8.9** the first paragraph is **Deleted** and replaced with: "The Employer may issue the Engineer with a notice of suspension instructing the Engineer to suspend the works." Consequences of Employer's Suspension **clause 8.10** the first paragraph is **Deleted**. Payment for Plant and Materials after Employer's Suspension **clause 8.11** is **Deleted**	
	Carried to Collection Kshs	

Item	Description	Amount
A	Clause 9 Tests on Completion	
B	Clause 10 Employer's Taking Over	
C	Clause 11 Defects After Taking Over	
D	Clause 12 Measurement and Valuation Standard Method of Measurements of Building and Associated Civil Works for Eastern Africa, Second Edition 2008, published by the Architectural Association of Kenya. Percentage profit **clause 12.3** shall be a maximum of 15%	
E	Clause 13 Variations and Adjustments Percentage rate to be applied to provisional sums for Overhead charges and profit **clause 13.4(b)** is **Deleted**	
F	Clause 14 Contract Price and Payment Total amount of advance payment (as a percentage of accepted contract amount) **clause 14.2** 18% shall be the maximum percentage of accepted contract sum payable as an advance payment and shall be payable in the currencies and proportions in which the accepted contract amount is payable upon presentation of an irrevocable and unconditional performance guarantee from a bank approved by the employer and presentation of an irrevocable and unconditional advance payment guarantee from a bank approved by the employer. Currency or currencies of advance payment **clause 14.2** shall be Kenya Shillings (Kshs) Repayment of the Advance Payment **clause 14.2.3** The Advance Payment Guarantee shall be provided at the cost of the contractor from a Tier (1) or Tier (2) bank and will be equivalent to the advance payment in value. Period of payment **clause 14.3** When payments are 10% of the accepted contract amount less provisional sums. Number of additional paper copies of statements **clause 14.3(b)** shall be 6no. Percentage of retention **clause 14.3(iii)** shall be 10% of each Interim certificate Limit of retention money (as a percentage of accepted contract amount) **clause 14.3(iii)** shall be 10% of the Accepted Contract Price or Provisional Final Account Whichever is higher. Plant and materials for payment when shipped **clause 14.5 (b) (i)** is N/A	
	Carried to Collection Kshs	

Item	Description	Amount
A	Clause 14 Contract Price and Payment cnt'd	
	Plant and materials for payment **clause 14.5 (c)** (i) All permanent materials shall be payable as materials on site as at when they are delivered on site and upon confirmation on their suitability by the Engineer.	
	Period for payment of advance payment to the Contractor **clause 14.7(a)** shall be 14 days	
	Period for the employer to make interim payments to the Contractor [Interim Certificate] **clause 14.7(b)(i)** shall be 21 days	
	Period for the employer to make interim payments to the Contractor [Final Certificate] **clause 14.7(b)(ii)** shall be 28 days	
	Period for the employer to make final payment to the Contractor **clause 14.7(c)** shall be 28 days	
	Financing charges for delayed payment **clause 14.8** Central Bank of Kenya base lending rate plus 3 percentage points.	
	Number of additional paper copies of draft final statement **clause 14.11.1(b)** shall 6 No	
	Currencies for payment of contract price **clause 14.15** shall be Kenya Shillings (Kshs.)	
	Proportions or amounts of local and foreign currencies **clause 14.15(a)(i)** is N/A	
	Rates of exchange **clause 14.15(f)** is N/A	
G	Clause 15 Termination by Employer	
	Notice to Correct **clause 15.1** The Engineer shall consult with the Employer before issuing Notice to Correct to the Contractor.	
	Termination for Contractor's Default **clause 15.2.2** the days of receiving the Notice have been reduced from 14 days to 7 days	
H	Clause 16 Suspension and Termination By Contractor	
J	Clause 17 Care of the Works and Indemnities	
	Forces of nature, the risks of which are allocated to the Contractor clause **17.2(d)** Supply chain risks, availability of labour and weather	
K	Clause 18 Exceptional Events	
	Carried to Collection Kshs	

Item	Description	Amount
A	Clause 19 Insurance Permitted deductible limits: **clause 19.1** is 100% of the total contract sum Contractors All risk: • Insurance required for the works-Insurance required for goods- • Insurance required for liability for breach of professional duty • Insurance required against liability for fitness for purpose(if any is required) • Insurance required for injury to employees **clause 19.1** Kenya Shillings Five Million (Kshs. 5,000,000.00) per occurrence with unlimited occurrences. • Minimum amount for insurance of the employers risks **clause 19.1** Kenya Shillings Five (Kshs. 5,000,000.00) per occurrence with unlimited occurrences.	
B	Clause 20 Employer's and Construction's Claims	
C	Clause 21 Disputes and Arbitration Time for appointment of dispute avoidance/adjudication board (DAAB) **clause 21.1** An Ad hoc board to be constituted as when required within 5no. Days after notice by either party The DAAB shall comprise **clause 21.1** one member List of proposed members of DAAB **clause 21.1** -proposed by employer -proposed by contractor Both Parties to agree on the list of possible members to be appointed to DAAB at the time of signing the contract. Appointing entity (official) for DAAB members **clause 21.2** shall be : 1. Chartered Institute of Arbitrators 2. Architectural Association of Kenya 3. Institute of Quantity Surveyors of Kenya 4. Institution of Engineers of Kenya 5. Association of Consulting Engineers of Kenya The appointed members of the DAAB or Arbitrator as the case may be shall meet the following qualifications and experience: - Registered Consulting Engineer of 15+ years of experience Registered Architect of 15+ years of experience Registered Quantity Surveyor of 15+ years of experience On the request of the applying party. The entity written to first by the aggrieved party shall take precedence over all other institutions and no further reference shall be made to the other entities by either party including for any subsequent disputes on this contract. Clause 21.6 Delete "The rules of the International Chamber of Commerce and replace with "The current rules of The Chattered Institute of Arbitrators Kenya Branch".	
	Carried to Collection Kshs	

Item	Description	Amount
	GENERAL MATTERS OF CONTRACT	
A	Sufficiency of Tender The Contractor shall be deemed to have satisfied himself before tendering as to the correctness and sufficiency of this tender for the works and of the rates and prices stated in the Priced Bills of Quantities, which rates and prices shall cover all his obligations under the Contract and all matters that are necessary for the proper completion and maintenance of the works.	
B	Stamp Charges and Registration of the Contract. The Contractor shall allow for the payment of all stamp charges and registration in connection with the Contract Agreement. The contractor will also be responsible for registration of project with the National Construction Authority (NCA) which must happen within the 7 days from signing of the contract.	
C	Definitions and Abbreviations The terms used in the Bills of Quantities shall be interpreted as follows: “Approved” shall mean approved by the Project Manager and the Employer in writing. “As directed” shall mean as directed by the Project Manager and the Employer in writing. “B.S.” shall mean the current British Standard Specification published by the British Standards Institution, 2 Park street, London, W.I., England. "K.S" shall mean the current Kenya Standard specification published by the Kenya Bureau of Standards, P.O. Box 54974, NAIROBI, Kenya. “C.M.” Shall mean Cubic Metre. “S.M” Shall mean Square Metre. “L.M.” Shall mean Linear Metre. “mm” Shall mean Millimetre. “No.” Shall mean Number. “Kg.” Shall mean Kilogramme. “DO” or Ditto” shall mean the whole of the preceding description except as qualified in the description in which it occurs. “As described” shall mean as described previously in a foregoing Bill or Trade Preambles of in the Ministry of Public Works, General specification for Building Works 1976 Edition or any subsequent revision thereof.	
	Carried to Collection Kshs	

Item	Description	Amount
A	Progress Schedule The Contractor shall upon receiving instructions to proceed with the work, draw up a time and progress schedule setting out the order in which the works are to be carried out and stating the appropriate dates. This Time and Progress Schedule is to be agreed with the Project Manager and the Employer, and no deviation from the order set out in this schedule will be permitted without the written consent of the Project Manager and the Employer. The Main Contractor will be responsible for agreeing the above programme with all sub-Contractors including the Nominated Sub-Contractors and Nominated Suppliers.	
B	Figured Dimensions: Figured dimensions are to be followed in preference to dimensions scaled from the drawings, but whenever possible dimensions are to be taken on the site or from the buildings. Before any work is commenced by sub-contractors or specialist firms, dimensions must be checked on the site and/or building and agreed with the Contractor, irrespective of the comparable dimensions shown on the drawings. The contractor shall be responsible for the accuracy of such dimensions.	
C	Provisional Work: All "provisional" and other work liable to adjust under this Contract shall be left uncovered for a reasonable time to allow all measurements needed for such adjustment to be taken by the Quantity Surveyor. Immediately the work is ready for measurement the contractor shall give notice to the Quantity Surveyor. If the Contractor makes default in these respects, he shall, if the Project Manager so directs, uncover the work at his own expense to enable measurements to be taken.	
	Carried to Collection Kshs	

Item	Description	Amount
A	Existing Services Prior to commencement of any work the contractor is to ascertain from the relevant authorities the exact position, depth and level of existing electric cables, water pipes or other services in the area and he shall make whatever provisions may be required by the authorities concerned for the support and protection of such services. Any damage or disturbance caused to any service shall be reported immediately to the Project Manager and the relevant authority and shall be made good to their satisfaction at the Contractor's expense.	
B	Transport to and from the site The Contractor shall include in his prices for the transport of materials, workmen, etc. to and from the site of the proposed works, at such hours and by such routes as are permitted by the authorities.	
C	Labour camps No labour camps will be allowed on site. The Contractor may however liaise with adjacent property owners and locate his camp within good distance from the site.	
D	Public and Private Roads, Pavements, etc. The Contractor will be required to make good, at his own expense, any damage he may cause to the present road surfaces and pavements during the period of the works. In particular, all existing lawns, gardens, paths, storm water channels, hedges, fences, etc., which may be destroyed or damaged during the progress of the works are to be made good by the Contractor to the satisfaction & approval of the Project Manager.	
E	Government Acts regarding Workplace, etc. Allow for complying with all Government Acts, Orders and Regulations in connection with the Employment of labour and other matters related to the execution of the works. In particular the Contractor's attention is drawn to the provision of the Factory Act 1950 and his tender must include for all costs arising or resulting from compliance with any Act, Order or Regulation relating to insurance, pension and Holidays for workplace or to the safety, health or welfare of work people. The Contractor must make himself fully acquainted with current Acts and Regulations, including police regulations regarding the movement, housing, security and control of labour, labour camps, passes for transport, etc. It is important that the contractor, before tendering, shall obtain from the relevant authority the fullest information regarding all such regulations and/or restrictions which may affect the organization of the works, supply and control of labour, etc. and allow accordingly in his tender. The Contractor is especially drawn to the requirement to provide workers with protective clothing which shall include but not limited to safety helmet, protective overalls and safety boots. The Employer will enforce this requirement. No claim in respect of want of knowledge in this connection will be entertained. Particular attention is drawn to the Rules published in Legal Notice 179, dated 02 June 1978 (Building operations and Work of Engineering Construction)	
	Carried to Collection Kshs	

Item	Description	Amount
A	Overtime Working The Working hours shall be those generally worked by good employers in the Building and Civil Engineering Trades in Kenya. The contractor shall be responsible for any extra costs for overtime working he considers will be necessary in order to complete the works within the contract period or time for completion apart from overtime working which may be ordered by the Project Manager. If overtime is worked out in accordance with a written instruction issued by the Project Manager, the contractor will be reimbursed in respect of such overtime to the unproductive time payable over and above the basic hourly rates as laid down by the Regulation of wages and Conditions of Employment Act, Building and Construction Industry Wages Council and excluding any bonuses, profits and overheads.	
B	Firm Price Contract Unless otherwise specifically stated no claim for increased costs will be entertained excepting only increased costs arising from fluctuation clause as defined in the Conditions of Contract.	
	MATERIALS AND WORKMANSHIP	
C	Generally: All materials shall be new unless otherwise directed or permitted by the Project Manager and the Employer and in all cases where the quality of goods or materials is not described or otherwise specified, is to be the best quality obtainable in the ordinary meaning of the word "best" and not merely a trade signification of the word. All materials and workmanship shall unless otherwise specified or described conform to the appropriate British Standard Institution Specification current at the date of Tender. The Contractor shall order all materials to be obtained from overseas immediately after the Contract is signed and shall also order materials to be obtained from local sources as early as necessary to ensure that such materials are on site **WHEN REQUIRED** for use in the works. The Contractor shall be responsible for and shall replace or make good at his own expense any materials lost or damaged. The works shall be executed by skilled workmen well versed in their respective trades. The Bills of Quantities shall not be used for the purpose of ordering materials.	
	Carried to Collection Kshs	

Item	Description	Amount
A	Rejected Workmanship or Materials Any workmanship or materials not complying with the specific requirements or approved samples or which have been damaged, contaminated or have deteriorated, must be immediately removed from the site and replaced at the Contractor's expense as required.	
B	Proprietary Materials Where proprietary materials are specified hereinafter the contractor may propose the use of materials of other manufacturer but equal quality for approval by the Project Manager. All materials and goods, where specified to be obtained from a particular manufacturer or supplier, are to be used or fixed strictly in accordance with their instructions.	
C	Samples: The Contractor shall furnish at the earliest possible opportunity before work commences and at his own cost, any samples of materials or workmanship that may be called for by the Project Manager for his approval or rejection and any further samples in the case of rejection until such samples are approved by the Project Manager and such samples when approved shall be the minimum standard for the work to which they apply.	
D	Concrete Tests Concrete test cubes, i.e. per set of three as later described including testing fee, labour and material, mould, transport and handling etc. successful tests only (PROVISIONAL) Sets of three: No. 20 @ Kshs *_____ The cube tests will be done at an approved laboratory. The Structural Engineer reserve the right to conduct non destructive tests at any single time. TEMPORARY WORKS	
E	Areas to be occupied by the Contractor: The Contractor shall obtain the Project Manager's approval for the siting of all temporary buildings; spoil heaps, temporary roads, paths and storage areas for materials.	
	Carried to Collection Kshs	

Item	Description	Amount
A	Telephone: The Contractor shall provide a dedicated mobile/wireless phone for the site which shall be attended at all times, for the period of the works and shall pay all fees and rentals for the same.	
B	Plant, Tools and Scaffolding: The Contractor shall provide all necessary hoists, tackle, plant, vehicles, tools and appliances of every description for the due and satisfactory completion of the works and shall remove the same on completion. The contractor shall provide, erect and maintain all temporary scaffolding, sufficiently strong and efficient for the due and satisfactory performance of the works, alter and adopt all scaffolding as and when required during the works and remove on completion and make good. No timber used for scaffolding, formwork or similar purpose shall be used afterwards in the permanent works. All such plant, tools and scaffolding shall comply with all regulations whether general or local in force throughout the period of the Contract and shall be altered or adapted during the Contract as may be necessary to comply with any amendments in or additions to such regulations. Scaffolding is not measured hereinafter, and the Contractor must allow here or in his rates for the above.	
C	Watching and lighting: The Contractor shall provide at his own expense and risk all watching and lighting as necessary to safeguard the works, plant and materials against damage and theft.	
D	Temporary Roads: The Contractor is to allow for providing where directed, all execution of the works including making good when no longer required.	
	Carried to Collection Kshs	

Item	Description	Amount
A	Existing and Adjacent Property: The Contractor must take all steps necessary to safeguard existing and adjacent property, make good at his own expense any damage to persons or property caused thereon, and hold the Employer indemnified against any claim arising. The Contractor will be held fully responsible for the safety of the existing and adjacent building and for any damage caused in consequence of these works. He must reinstate all damages at his own expense and indemnify the Employer against any loss.	
B	Nuisance: The Contractor must take such steps and exercise such care and diligence so as to minimize nuisance from dust, noise or any other cause, to the occupiers of adjacent properties.	
C	Ordering of Materials: The Contractor must assist in alleviating the effects of possible shortages of materials by advance ordering of materials in order to maintain a continuous supply. Early delivery of materials will be permitted and included in interim certificates and upon request by the Project Manager, the Contractor will be required to produce copies of order forms and invoices to establish that materials have been ordered in sufficient time and to check on material deliveries.	
	DOMESTIC SUB-CONTRACTORS.	
D	Domestic Sub-contractors. The Contractor shall be responsible for domestic sub-contractors in every respect and, in particular, it shall be the Contractor's responsibility to ensure that each sub-contractor commences and completes the work in such a manner and is ready on the site with his materials, labour and special plant at such times also as to conform with the progress schedule, as specified previously and to ensure satisfactory progress. The Contractor shall also accept liability for and bear cost of general attendance on the sub-contractors which he shall be deemed to include for:	
	Carried to Collection Kshs	

Item	Description	Amount
	Allowing the use of standing scaffolding, maintenance and alteration of all scaffolding until such time as all relevant sub-contractor's work are complete, and removal of all scaffolding on completion. Providing space for office accommodation and for storage of plant and materials; allowing use of sanitary accommodation; the supply of necessary water, power, lighting and watching; and clearing away all rubbish. The items for "Attendance" given hereinafter following prime cost sums in respect of subcontractor's work shall be deemed to include all the above. The cutting away for and making good after the work of sub-contractors as may be required will be measured and valued separately by the Quantity Surveyor. The Main Contractor shall choose the domestic sub-contractors from the provided guidance list. However, the main contractor will be at the liberty to choose his own preferred sub-contractors in which case he must first seek approval from the project team.	
A	Nominated Suppliers The cost of (Fix Only) materials to be obtained from nominated suppliers which are covered by prime cost or provisional sums shall include for taking delivery on site, checking with invoices or indents, reporting and claiming damages for shortages and damaged goods, defraying demurrage, signing for as having been received in good order unloading, storing, covering and protecting until the time of fixing, unpacking, replacing anything lost or damaged, sorting assembling, hoisting to required levels and fixing as described. Before placing any order with Nominated suppliers the Contractor must ascertain that the terms and conditions of the quotations and the dates of delivery of materials or execution of work comply with the terms of the contract, and the progress schedule.	
B	Prime Cost Sum Where description of items includes a P.C. rate per unit, this rate is to cover the Net supply cost of the unit only. The Contractor's price must include for the cost of the unit at the rate stated plus waste, taking delivery, storage, fixing in position, profit and overheads. The net cost per unit will be adjusted within the final account against the P.C rate stated.	
	Carried to Collection Kshs	

Item	Description	Amount
	PROTECTION AND CLEANING	
A	Protection of Completed Works The Contractor shall cover up and protect from damage, including damage from inclement rainy weather, all finished work, and unfixed materials including that of sub-contractors, etc. to the satisfaction of the Project Manager until the completion of the Contract. No claim for pumping rain water in basements or other damages occasioned by the above will be allowed.	
B	Protection of Trees The Contractor shall in the course of construction take all necessary precautions to preserve any existing trees. The contractor will not cut down any tree(s) without express authority or written instruction by the Project Manager and relevant authorities. He must at all times liaise with the Project Manager in this regard. The cost of obtaining any necessary permits will be borne by the Contractor.	
C	Materials on site All materials for incorporation in the works must be stored on or adjacent to the site before payment is effected unless specifically exempted by the Project Manager.	
D	Cleaning: The Contractor shall upon completion of the works, at his own expense, remove and clear away all surplus excavated materials, plant, rubbish and unused materials including clearing away and making good all traces of dirt and shall leave the whole of the site and works in a clean and tidy state to the satisfaction of the Project Manager. Particular care shall be taken to leave clean all floors and windows and remove all paint and cement stains. He shall also, at the discretion of the Project Manager, remove all rubbish and dirt as it accumulates. The contractor is to find his own dump and shall pay all charges in connection therewith.	
	Carried to Collection Kshs	

Item	Description	Amount
A	Training Levy The Contractor's attention is drawn to Legal Notice No. 237 of October 1971 which requires payments by the Contractor of a Training Levy at the rate of ¼% of the Contract sum on all contracts of more than Kshs 50,000 in value and his Tender must include for all costs arising or resulting therefrom.	
B	Value Added Tax (VAT) and other taxes The Contractor's attention is drawn to V.A.T Public Notice No. 6 of 5th August 1993 regarding the Finance Bill 1993 which expanded the V.A.T base to cover construction services amongst other items. The Contractor is required to acquaint himself with such notices and allow in his Bills of Quantities rates (excluding P.C and Provisional Sums) for the net tax (i.e. less input tax where applicable) as required by law. The Contractor may seek further direction and assistance regarding the application of this law to the Commissioner of Domestic Tax.	
C	Timely payment for labourers The Contractor shall ensure that his workers are paid their wages promptly and on time. If such payments are effected weekly the Contractor shall ensure that workers are paid on the appointed day to avoid any disruption of work occasioned by the failure of the Contractor to pay workers on time and shall be required to furnish proof to that effect.	
D	Extended Preliminaries In case the Contractor suffers costs due to extended preliminaries as a result of excusable delays. Then the Employer shall compensate the Contractor the **ACTUAL COST** of such extended preliminaries plus 10% administrative costs. Such costs will be proven with payment receipts, payroll etc. No further claims shall be allowed with respect to the same.	
E	Additional Items Any additional items(s) which the Tenderer may wish to price separately and which he considers has not been included in the foregoing conditions, specifications and/or Bills of Quantities. Description: …… …… ……	
	Carried to Collection Kshs	

Item	Description			Amount
	PRELIMINARIES (SUMMARY)			
	COLLECTION			
	From Page	Sec 1, Page 1	Kshs	
	From Page	Sec 1, Page 2	Kshs	
	From Page	Sec 1, Page 3	Kshs	
	From Page	Sec 1, Page 4	Kshs	
	From Page	Sec 1, Page 5	Kshs	
	From Page	Sec 1, Page 6	Kshs	
	From Page	Sec 1, Page 7	Kshs	
	From Page	Sec 1, Page 8	Kshs	
	From Page	Sec 1, Page 9	Kshs	
	From Page	Sec 1, Page 10	Kshs	
	From Page	Sec 1, Page 11	Kshs	
	From Page	Sec 1, Page 12	Kshs	
	From Page	Sec 1, Page 13	Kshs	
	From Page	Sec 1, Page 14	Kshs	
	From Page	Sec 1, Page 15	Kshs	
	From Page	Sec 1, Page 16	Kshs	
	From Page	Sec 1, Page 17	Kshs	
	From Page	Sec 1, Page 18	Kshs	
	Total Amount Carried to Main Summary		**Kshs**	

BILL NO. 2 : MATERNITY ROOMS

ITEM	DESCRIPTION	QTY	UNIT	RATE	AMOUNT
	ELEMENT NO. 1 : DEMOLITIONS (ALL PROVISIONAL) **NOTE : The Contractor is strongly advised to visit the site and fully ascertain the nature and scope of structures hereafter described as for demolition before pricing and is requested to raise any queries that appertain to the structures to be demolished that may affect or influence the pricing, Such queries should be addressed to the project engineer before the tender closing date.** No claims arising from the tenderers failure to fulfil the above requirement shall be considered. The contractor is to allow for all temporary protection required during the works including ordinary and special dust screens, hoarding, barriers, warning signs etc. as directed by the Architect and as necessary for the protection of the existing structure and finishings, workmen employed upon the site and the general public. All protective devices are to be removed on completion of the works and any necessary making good consequent upon this is to be executed to the satisfaction of the Architect. The works shall be executed in such order and sequence as the architect may direct and with as little disruption and inconvenience as possible and shall be caused to the normal functioning of the employer, the staff and the public including the adjacent property occupiers. Demolitions work shall be carefully executed with particular aim of minimizing damage to adjacent finishes, structure or components not measured herewith. All existing works shall be propped, strutted and supported as necessary before the demolition work is commenced. Prices shall include for all necessary preparatory work to structure and finishings and all making good to finishings on completion whether or not specifically described. Unless otherwise described, all arisings, debris and surplus materials resulting from the demolitions shall be set aside for client's use or carted away from the site and prices shall be deemed to include all credit allowances, unless an additional credit is offered by means of a lump sum deduction on the collection page of this bill. All existing work shall be made good up to new surface and cleaned to the entire satisfaction of the Project Manager				
	Total Carried to Collection.				

ITEM	DESCRIPTION	QTY	UNIT	RATE	AMOUNT
	Amounts and rates for demolitions shall include the following in addition to what is described in the particular item. a) Making good i.e. reinstatement of any finishes and structures affected by the demolition work to the original state. b) Clearing debris with speed on daily basis as they arise, cleaning of affected surfaces, and removal of the debris from site to approved dumping sites. Accumulation of debris within the site premises shall not be allowed. c) Allowance for all notices, statutory or otherwise required to be issued before commencement shall be deemed to be included in the pricing. d) The amounts quoted shall be deemed to be inclusive of all handling of the removed items and their removal from the site. e) Materials deemed by the Engineer as reusable shall be salvaged, cleaned down, made good as necessary, stored securely and transported to the premises of the client at a designated area as directed. The contractor shall allow for proper and neat stacking of the materials. f) The Contractor to carefully inspect and demolish the following structures including breaking up foundations with and including reinforced concrete structures, walls, roof and carefully disconnecting and removing all sanitary, electrical or other fixed fittings, joinery, windows and doors, service pipes and conduits. **Demolitions (Including cart away of any debris arising).** **Floor Finishes**				
A	Carefully hack existing ceramic / porcelain floor tile finish including screed & skirting (Approximately 175 SM) and set aside/ cart away as directed.	1	ITEM		
	Masonry walls				
B	Carefully demolish existing 2.7m high masonry walls (Approximately 74 LM) including all wall finishes and cart away debris arising there of as directed.	1	ITEM		
	Dwarf walls				
C	Carefully demolish existing 0.7m high masonry walls complete with timber coping (Approximately 52 LM) including all wall finishes and cart away debris arising there of as directed.	1	ITEM		
	Total Carried to Collection.				

ITEM	DESCRIPTION	QTY	UNIT	RATE	AMOUNT
	Ceiling				
A	Carefully demolish existing gypsum and acoustic ceiling including brandering in all the rooms and set aside for re-use as directed. (Approximately 175 SM)	1	ITEM		
	Doors				
B	Carefully remove existing 4 No. timber size 1100 x 2100mm high including door frame and set aside/ cart away as directed.	1	ITEM		
C	Ditto 6 No. timber size 1000 x 2000mm high including door frame and set aside/ cart away as directed.	1	ITEM		
D	Ditto 1 No. timber size 800 x 1900mm high including door frame and set aside/ cart away as directed.	1	ITEM		
E	Ditto 1 No. aluminium size 600 x 1700mm high including door frame and set aside/ cart away as directed.	1	ITEM		
	Windows				
F	Carefully remove existing 1 No. aluminium window size 2000 x 1500mm high including frame and set aside/ cart away as directed.	1	ITEM		
G	Ditto existing 1 No. aluminium window size 1500 x 1500mm high including frame and set aside/ cart away as directed.	1	ITEM		
H	Ditto existing 1 No. aluminium window size 500 x 1500mm high including frame and set aside/ cart away as directed.	1	ITEM		
I	Ditto existing 2 No. aluminium window size 1300 x 1050mm high including frame and set aside/ cart away as directed.	1	ITEM		
	Wall Tiles				
F	Carefully remove and hack existing wall tiles including cement sand backing (Approximately 55sm) and cart away arising debris as directed.	1	ITEM		
	Shelving				
G	Carefully remove existing high level shelving (Approximately 13 LM) and set aside re use as directed	1	ITEM		
H	Carefully remove existing wardrobe (Approximately 2 LM) and set aside re use as directed	1	ITEM		
	Total Carried to Collection.				

ITEM	DESCRIPTION	QTY	UNIT	RATE	AMOUNT
	Floor Slab				
A	Carefully cut existing 150mm slab for1500 x 1500mm hole into existing slab and cart away debris arising thereof as directed to allow for concrete columns.	4	NO		
	Crash Rail				
B	Carefully remove existing timber crash rail (Approximately 127LM) and set aside re use as directed	1	ITEM		
	Total Carried to Collection.				
	COLLECTION				
	Brought forward from Page 2				
	Brought forward from Page 3				
	Brought forward from Above				
	Total for Demolitions Carried to Main Summary				

ITEM	DESCRIPTION	QTY	UNIT	RATE	AMOUNT
	ELEMENT NO. 02 : SUBSTRUCTURES (ALL PROVISIONAL)				
	Excavations & Disposal including maintaining & supporting sides & keeping free from water, mud etc. and disposal				
	Note : **(1). The Tolerances for excavation works shall be +-10mm, any over excavation shall be corrected with mass concrete class 20 at the contractor's expense.**				
	(2). Excavations for column bases and strip foundations are measured net. No working space is allowed, tenderers allow for working space within their rates.				
	NOTE : Classes of Rock				
	(1) Class 1: Class 1 Rock shall be with compressive strength exceeding 15KN/mm^2 This type of rock contains stones and boulders of untethered or incompletely weathered Tuff, trachyte, black trap or lava with compressive strength exceeding 15N/mm2 in a formation which is massive and geologically homogeneous. A boulder or outcrop with such compressive strength will be deemed to be class 2 rock or Hard rock. The opinion of the Engineer in classifying rock shall be final and binding. Explosives must not be used without the prior written approval of the Engineer. Blasting operations are carried out at the contractor's sole risk and all blasting must be carried out in accordance with government regulations and approval.				
	(2) Class 2: Soft rock of the type know locally as "tuff" or "malady" which in the opinion of the Engineer cannot be considered as hard rock shall be known as rock Class 1 rock. Soft rock shall be rock with compressive strength not exceeding 15N/mm^2. Murram and Kunken are specifically excluded and will be deemed as normal excavation. Extremely weathered and weak tuff shall also be considered as normal excavation.				
	Excavations				
A	Excavation in hard compacted material and hardcore up to a level not exceeding 1.5m from cut level	14	CM		
	Total Carried to Collection Page				

ITEM	DESCRIPTION	QTY	UNIT	RATE	AMOUNT
	Excavations (Continued)				
A	Return, fill, ram selected excavated material around foundations.	5	CM		
B	Dispose surplus excavated material from site.	9	CM		
	Imported Filling & Surface Treatment				
C	300mm thick approved imported hardcore filling spread, levelled, well rammed and consolidated in layers to receive concrete surface bed (m.s).	9	SM		
D	Murram or quarry dust layer to hardcore prepared to receive surface bed 50 mm thick.	9	SM		
	Damp-proof membranes				
E	Damp proof membrane over blinded hardcore including 300mm end & side laps 1000 gauge.	9	SM		
	Anti-Termite Treatment				
F	Chemical anti-termite treatment, executed complete by an approved specialist under a ten-year guarantee, to surfaces of hard-core.	9	SM		
	Concrete Work				
G	Plain concrete class 15; 50mm thick blinding under column bases	9	SM		
	Vibrated reinforced concrete class 25 (20mm aggregate) to:				
H	Column bases	3	CM		
I	Columns	1	CM		
J	150mm thick floor bed	9	SM		
	Steel Reinforcement (All Provisional)				
	High yield deformed steel bar reinforcement to B.S. 4461 including cutting and bending, hoisting into position, tying, stools, spacer blocks and any other accessories all in accordance with the Structural Engineers Details and approval.				
K	Assorted bars	400	KG		
	Total Carried to Collection Page				

ITEM	DESCRIPTION	QTY	UNIT	RATE	AMOUNT
	Mesh fabric reinforcement to B.S 4483 and setting in concrete bed including end laps Ref. A142 weighing 2.22kg/m2 to;				
A	Ground floor slab	9	SM		
	Formwork				
	Formwork finish type II to:				
B	Vertical sides of column bases	7	SM		
C	Vertical sides of columns	7	SM		
	Total Carried to Collection				
	COLLECTION				
	Total Brought forward from Page 5				
	Total Brought forward from Page 6				
	Total Brought forward from Above				
	Total for Substructures carried to Bill Summary				

ITEM	DESCRIPTION	QTY	UNIT	RATE	AMOUNT
	ELEMENT NO. 03: STRUCTURAL STEEL WORKS ***Structural Steelworks complete with all welding and accessories as described in BS 449 Part 2.*** The following in framed structural Steel works complete with and including welded and bolted connections; delivery to site and erection with and including on shop coat red / grey oxide primer; hoisting and fixing in position average height 9,000mm high from ground level and finishing with 3 coats zinc chromate enamel paint or other equal and approved to all exposed surfaces. ***Steel Fabrication Notes*** All Materials shall be tested for thorough thickness properties to the specified Class BS 5920-2001,21.2 Manufacturers Certificate of test and inspection shall be issued conforming to BS EN 10204 stating the process of manufacture and product grade. Preloaded fasteners shall generally be HSFG BOLTS with associated NUTS & WASHERS. Steel casing and forgings shall conform to BS3100. Bedding material for steel bases on concrete foundation shall be done to Engineer's Approval. Structural steel members shall be positively be identified by a marking scheme Cutting shall be by sawing, shearing, cropping or thermal cutting (if permitted). Hand held cutting shall be used only where it is impractical to use machine cutting Cut edges shall be true to profile and free from major notches and cutting serrations. Round hole for pines shall be drills, plasma or laser cut. All weld, boltings and cuttings shall be approved on site before fabrication (prepare sample for erection) All measurements shall be done accurately at all stages. Support to be provided for roof frame units until they are adequately fixed in the position as shown.				
	Total Carried to Collection				

ITEM	DESCRIPTION	QTY	UNIT	RATE	AMOUNT
	Columns & Beams				
A	UC 203 x 203 x 46kg/m	552	KG		
B	UB 254 x 146 x 31kg/m	570	KG		
	Mild Steel Plates				
C	350 x 350 x 3mm base plate, with 8 No holes 22mm holes for M20 bolts	4	NO		
D	150 x 100 x 10mm stiffener plate	16	NO		
E	160 x 405 x 18mm thick end plate welded to UB and UC; with 8 no holes for M16 bolts	18	NO		
	Mild Steel Bolts				
H	600mm long M20 grade 8.8 anchor bolts drilled into the slab with chemical anchor or equivalent	32	NO		
I	65mm long M16 grade 8.8 anchor bolts drilled into masonry wall with chemical anchor or equivalent	64	NO		
	Total Carried to collection				
	Total Brought forward from Page 8				
	Total Brought forward from Above				
	Total for Canopy Carried to Summary				

ITEM	DESCRIPTION	QTY	UNIT	RATE	AMOUNT
	ELEMENT NO. 04: LINTELS AND WALLING				
	Vibrated reinforced concrete class 25 (20mm aggregate) in:				
A	Lintel beams	1	CM		
	Reinforcement (Provisional)				
	High yield deformed steel bar reinforcement to B.S. 4461 including cutting and bending, hoisting into position, tying, stools, spacer blocks and any other accessories all in accordance with the Structural Engineers Details and approval.				
B	Assorted reinforcement bar sizes	100	KG		
	Formwork				
	Formwork finish type II to:				
C	Vertical sides and soffits of beams	8	SM		
	MASONRY WALLING				
	Internal Walling				
	Machine cut natural coursed stone walling obtained from an approved quarry bedded and jointed in gauged mortar (1:3); include hoop iron at every course;				
D	150mm thick	125	SM		
E	100mm thick	31	SM		
	Total for Lintels & Walling Carried to Section Summary.				

ITEM	DESCRIPTION	QTY	UNIT	RATE	AMOUNT
	ELEMENT NO. 05: DOORS				
	Hardwood Timber doors				
	Supply and fix 45mm hardwood door; faced with 3mm thick hardwood veneer on both sides; hardwood lipping on all edges; including all planted mouldings;				
A	Single Leaf, one way swing overall size 1500 x 2700mm high	7	NO		
B	Single Leaf, one way swing overall size 900 x 2700mm high	7	NO		
	Mahogany or other equal and approved hardwood timber as described in:				
C	200 x 50mm rebated door frame with one labour, plugged to wall/beam	84	LM		
D	50 x 25mm splayed architrave	84	LM		
E	25mm diameter quadrant beading	84	LM		
	Ironmongery				
	Supply and fix 'UNION' (made in ENGLAND) or other equal approved ironmongery with matching screws; to architects approval				
F	Stainless steel ball bearing hinges 'HN 2BB-403030'	28	PRS		
G	Cylinder stainless steel floor mounted door stop 'DH005 SS'	14	NO		
H	Stainless steel heavy duty door closer as 'Union 8247 SS'	14	NO		
I	150X150mm aluminium sign plate with room symbol engrave	14	NO		
K	900x 200mm SS kick plates 'KP-800-200 SS'	14	NO		
L	400x 200mm SS push plate	14	NO		
M	Stainless steel coat and hat hook 'DCH0560 SS'	7	NO		
N	Indicator bolt 'Vacant/Engaged' satin steel '80941 SC'	7	NO		
	Prepare and apply one coat wood preservative to woodwork before fixing				
O	Over 100mm but not exceeding 200mm girth	84	LM		
	Prepare and apply three coats of gloss oil paint on timber surfaces				
P	Over 100 but not exceeding 200mm girth	84	LM		
Q	Generally on doors	66	SM		
	Total for Doors Carried to Section Summary.				

ITEM	DESCRIPTION	QTY	UNIT	RATE	AMOUNT
	ELEMENT NO. 06 : WINDOWS				
	Sliding Aluminium Windows				
	Supply and Install Purpose made powder coated aluminium glazed window frame size 50x40x2mm, complete with 6mm one way glass, all ironmongery including, Fasteners, stays and hinges to manufacturer's specifications, mosquito gauze, sample to approval and all to Architect's instructions.				
A	Aluminium sliding window overall size 2000 x 1500mm high	3	NO		
B	Ditto but 1400 x 1500mm high	4	NO		
C	Ditto but 1000 x 1500mm high	1	NO		
	Total for Windows Carried to Section Summary.				

ITEM	DESCRIPTION	QTY	UNIT	RATE	AMOUNT
	ELEMENT NO. 07 : INTERNAL FINISHES				
	Wall Finishes				
	Cement and sand (1:1:6) lime plaster:				
A	12mm thick two coat plaster to masonry surfaces to receive paint (ms)	188	SM		
	Painting and Decoration				
B	Prepare and apply 3 coats vinyl antimicrobial paint to plastered surfaces.	188	SM		
C	Dust, Clean, prepare and apply 2 coats quality matt emulsion antimicrobial paint to existing plastered wall surfaces.	304	SM		
	Cement and sand (1:4) backing as described, finished to receive wall finishes.				
D	12mm thick backing to walls to receive tiles(ms)	138	SM		
	The following ceramic tiles .				
F	600 x 300 x 8mm thick coloured glazed ceramic wall tiles bedded and pointed using an approved tile adhesive and jointed with colour matching water-proof cement grout in kitchenette.	138	SM		
E	Dust and Clean 600 x 300mm existing wall tiles to Architect's instructions	27	SM		
F	Replace any broken ceramic tiles with 600 x 300mm thick ceramic wall tiles including 32mm thick cement sand backing, to match existing wall tile colour, pattern and specifications all to Architect's detailed instructions	15	SM		
	Floor Finishes				
	Cement and Sand Screed				
G	32mm thick cement and sand (1:4) self levelling screed with hardener, finished smooth to receive Gerflor floor (m.s)	167	SM		
H	32mm thick cement and sand (1:4) screed as described, finished to receive porcelain floor tiles (m.s)	30	SM		
	Gerflor Vinyl Flooring				
I	Supply and fix including all accessories and fittings X-tech Gerflor floor finish, homogeneous, Antistatic, Antibacterial, Antiskid Gerflor floor, to floors internally complete with coved junctions between the walls and the floors including coved junction between the wall and the floor all to manufacturer's instructions and Architect's approval.	167	SM		
	Total Carried to Collection				

ITEM	DESCRIPTION	QTY	UNIT	RATE	AMOUNT
A	Supply and fix 600 x 300mm floor tiles laid on backing (m.s),with an appropriate and approved tile adhesive and jointed with colour matching water-proof cement grout.	30	SM		
	Ceiling Finishes				
	Gypsum Ceiling				
B	Supply and fix 9mm thick gypsum board ceiling on 50mm steel studwork complete with metal edge floor and ceiling trims in horizontal suspended ceiling and scheming with 'crown covermatt' or any equal and approved.	162	SM		
C	Supply and fix 9mm thick moisture proof gypsum board ceiling on 50mm steel studwork complete with metal edge floor and ceiling trims in horizontal suspended ceiling and scheming with 'crown covermatt' or any equal and approved.	29	SM		
D	Extra Over for 300mm bulkhead at the boardroom and Reception Area	39	LM		
	Painting and Decoration				
E	Prepare and apply 3 coats silk vinyl antimicrobial paint to gypsum board ceiling	191	SM		
	Crash Rail				
F	1.8mm thick continuous natural aluminium retainer screwed to wall with 2mm high impact PVC customised rail cover to approval including all accessories and fittings	153	LM		
	Total Carried to Collection				
	COLLECTION				
	Total Carried from page 13				
	Total Carried from above				
	Total for Internal Finishes Carried to Section Summary				

ITEM	DESCRIPTION	QTY	UNIT	RATE	AMOUNT
	ELEMENT NO. 7: BUILDER'S WORK IN CONNECTION TO SPECIALIST INSTALLATIONS				
	Electrical Installations (Provisional)				
A	Inspect all drawings and bills of quantities for Electrical Installation works and allow for all Builder's work associated with Electrical Installations, including cutting away for and making good after Electrician installing a concealed conduit system including cutting or leaving all holes, notches, sinkings and chases in both the structure, covering and infills.	1	ITEM		
	Mechanical Installations (Provisional)				
B	Inspect all drawings and bills of quantities for Plumbing, Drainage and Mechanical Installation works and allow for all Builder's work associated with the Installations, including cutting away for and making good after installing a concealed drainage system including cutting or leaving all holes, notches, mortices, sinkings and chases in both the structure and its covering; including but not limited to forming recess in masonry.	1	ITEM		
	Total for Builder's Work in Connection to Specialist Installations Carried to Section Summary.				

ITEM	DESCRIPTION	QTY	UNIT	RATE	AMOUNT
	SECTION SUMMARY				
1	Demolitions				
2	Substructure				
3	Structural Steelworks				
4	Lintels and Walling				
5	Doors				
6	Windows				
7	Internal Finishes				
8	Builder's Work in Connection to Specialist Installations				
	TOTAL FOR MATERNITY ROOM IMPROVEMENTS CARRIED TO BILL SUMMARY				

BILL NO. 3 : SPECIALIST WORKS

ITEM	DESCRIPTION	QTY	UNIT	RATE	AMOUNT
	SPECIALIST WORKS - *ALL Sub-contractors are domestic*				
	Electrical Installations				
A	Allow a Prime Cost sum for General Electrical Installations		SUM		
	Allow a percentage for profit		%		
B	Allow a Prime Cost sum for Structured Cabling Installations		SUM		
	Allow a percentage for profit		%		
C	Allow a Prime Cost sum for Structured Cabling and Security Installations		SUM		
	Allow a percentage for profit		%		
D	Allow a Prime Cost sum for Nurse Call Installations		SUM		
	Allow a percentage for profit		%		
	Mechanical Installations				
E	Allow a Prime Cost sum for General Plumbing, Drainage Installations		SUM		
	Allow a percentage for profit		%		
F	Allow a Prime Cost sum for Heating, Ventilation & Air Conditioning (HVAC) Installations		SUM		
	Allow a percentage for profit		%		
G	Allow a Prime Cost sum for Medical Gases Installations		SUM		
	Allow a percentage for profit		%		
	Total for Specialist Works Carried to Grand Summary				

BILL NO. 4 : PROVISIONAL SUMS

ITEM	DESCRIPTION	QTY	UNIT	RATE	AMOUNT
	PROVISIONAL SUMS				
	Signage				
A	Allow a Provisional sum for all signage and way finding installations			SUM	100,000.00
	Joinery Works				
B	Allow a Provisional sum for joinery works			SUM	1,000,000.00
	Contingency				
C	Allow a provisional sum for contingency to be expedited at the express authority of the Client.			SUM	3,000,000.00
	Total for Provisional Sums Carried to Section Summary				**4,100,000.00**

MAIN SUMMARY

PROPOSED MATERNITY ROOM IMPROVEMENTS AT THE NAIROBI HOSPITAL

MAIN SUMMARY

	DESCRIPTION	BILL NO.	TOTAL (KES)
	GRAND SUMMARY		
1	PRELIMINARIES	Bill No. 1	
2	MATERNITY ROOMS	Bill No. 2	
3	PROVISIONAL SUMS	Bill No. 3	
4	SPECIALIST WORKS	Bill No. 4	
	GRAND SUMMARY CARRIED TO FORM OF TENDER (INCLUSIVE OF VAT)		

TENDERER

Signature of Tenderer.....(Company stamp).....

Name of Tenderer.....

Address of Tenderer.....

Telephone no(office).....Mobile.....

E-mail Address.....

GENERAL ELECTRICAL SPECIFICATIONS

1 GENERAL ELECTRICAL SPECIFICATIONS

1.1 INTRODUCTION

This section specifies the general requirement for plant, equipment and materials forming part of the Contract Works and shall apply except where specifically stated elsewhere in the Specification or on Contract Drawings.

1.2 GENERAL GUIDING REGULATIONS AND STANDARDS

The Contract Works shall comply with the current editions of the following: -

1) Electric Power Act and the Rules made there under
2) The Electricity Supply Authority Byelaws.
3) Regulations for the Electrical Equipment of Buildings issued by the Institution of Electrical Engineers of Britain (I.E.T.) with Kenya amendment.
4) The United Kingdom Chartered Institute of Building Services Engineers (CIBSE) Guide 'K' on electricity in Buildings.
5) The Factories Act for the Kenya Government.
6) Kenya Bureau of Standards (KEBS) standard specifications and code of practice, or other equal and approved standard specifications and codes.
7) The Local Authority Bylaws
8) The Employers Safety Regulations.
9) General Electrical Specifications

1.3 QUALITY OF MATERIALS

The quality of materials required for completion of the electrical installation works shall be as detailed in this specification and contract drawings unless otherwise instructed. All materials shall be new and of best quality and approved origin.

1.4 TYPE OF INSTALLATION-WIRING SYSTEMS

Electrical installation shall be carried in either one of the following wiring systems;

System A – PVC Insulated and Sheathed Cables Clipped to the Surface of the Walls and Roof Members or to the Ceilings.

The installation shall be carried out in an approved type twin or three core PVC insulated and sheathed cables, the conductors of which shall be of copper. Cables shall be securely fixed to the surface of the walls and in the roof spaces, or fixed to the underside of the ceilings when there is no reasonable access above the ceiling. Non-corrodible saddles or buckle clips and nails shall be used for fixing and at intervals not exceeding 225mm. Where cables pass through holes they shall be bushed. Wooden bits or plastic bits shall be used as plugs in walls for firmly fixing the saddles or buckle clips on walls or other surfaces.

Under no circumstances will joints of conductors be permitted in the run of a wiring cable. Cables shall be connected together only by looping into the terminals of switches, ceiling rose junction boxes or other accessories or by approved connectors installed in suitable junction boxes. Under no circumstances will taped joints be permitted.

In all cases the cable sheathing shall be carried into the switch, ceiling rose, junction box or other accessories.

Surface installed cables shall not be installed within 300mm of a metal roof, unless clipped to the lower side of wooden member of the roof or otherwise protected from radiant heat.

System B- PVC Insulated and Sheathed Cables Clipped to Roof Members and Run in Metal or Plastic Conduits Drops Concealed in Walls

The wiring shall be carried out as system A except that cables shall be enclosed in either steel or plastic conduit where drops are required to switches, distribution board, socket outlets or other accessories.

System C – Cables in Steel Screwed Conduit or Trunking Fixed To The Surfaces Of Walls And Ceilings

The wiring shall be carried out in an approved type of single core, plastic insulated cable enclosed in steel screwed conduit or trunking, mechanically and electrically continuous throughout.

Conduit and trunking shall be run on the surface of the walls and ceilings, or in false ceiling spaces. Conduit shall be secured in position by means of steel galvanized spacer bar saddles, and counter sunk brass screws. Conduit shall run horizontally on the walls or vertically to switches or outlets.

System D – Cables Enclosed In Concealed Steel Screwed Conduit Or Trunking

The wiring shall be carried out in approved type of single core, plastic insulated cable, enclosed in steel screwed conduit or trunking mechanically and electrically continuous throughout.

Conduit shall be buried in the wall and floors of the building and either run in roof space or buried in structural slabs.

System E – PVC Insulated Cables With or Without Earth Continuity Conductor Enclosed In Concealed Non-Metallic Conduit or Trunking.

Wiring shall be carried out in an approved type single core, plastic insulated cable with copper conductor with or without earth continuity conductor enclosed in high impact, heavy gauge, non-metallic conduit or trunking of PVC material or equivalent.

Conduit shall be buried in the walls and floors of building, and either run in roof space or buried in structural slabs.

System F – PVC Insulated Cable With or Without Earth Continuity Conductor Enclosed In Non-Metallic Conduit or Trunking Fixed To the Surfaces of Walls and Ceilings

Wiring shall be carried out in an approved type single core plastic insulated cable with or without earth continuity conductor enclosed in high impact, heavy gauge, non-metallic conduit or trunking.

Conduit shall be installed in similar way as system C.

System G- Mineral Insulated Copper Sheathed Cables

The wiring shall be carried out in single core or multi-core mineral insulated copper sheathed cable run on the surfaces of walls and ceilings, in the roof space or concealed in walls and floors.

System H – PVC Insulated Single Wired Armoured and PVC Sheathed (PVC/SWA/PVC), Cable Laid In Ducts, Trenches and Saddles to Walls

Cables shall either be suspended on purpose made frame and hangers, saddled on walls and roof members, drawn through ducts or laid in trenches. Cables suspended on multiple hangers shall be so arranged that one cable can be removed without disturbing the others. Frames, and hangers shall be galvanized or of non-corrosive material and shall not be fixed in contact with other metals with which they are liable to set up electrolytic action. All spacing of cable hangers and support shall not exceed those laid down for the relevant size and type of cable in the current edition of the I.E.E. Regulations or Kenya Bureau of Standard Wiring Regulations.

1.5 CONDUITS AND TRUNKING

3.5.1 PVC Conduits, Trunking and Associated Fittings

For the purposes of these specifications, all non-metallic conduits shall be of high impact quality rigid PVC conforming to B.S 4607 or KS04-179: 1988 and IEE regulations and all conduit fittings and accessories shall be of the same quality.

Conduit outlet and switchboxes shall be able to receive an Earthing terminal and shall have threaded brass inserts for cover fixings

Solid elbows and tees shall not be permitted without the written approval of the Engineer. No conduit smaller than 20mm (nominal) diameters shall be allowed.

Trunking where required should be of high impact quality rigid PVC of an approved type.

3.5.1.1 **Installation of PVC Conduits**

(i) **Conduit shall be installed** buried in plaster works and floor screed except when run on wooden or metal surface, when they will be installed surface supported with saddles every 600mm. Conduits shall be laid at a time during the building construction as may be approved by the Engineer.

(ii) **Conduits run in chase** shall be firmly held in position by means of mild steel pipe hooks to avoid displacement when plastering. It shall be at least 10mm below plaster level. In poured reinforced concrete floors and roof slabs, the conduit shall first be laid before the concrete is cast in situ. It shall be securely fixed in position to prevent displacement during the pouring process and shall be sealed against the ingress of water and cement during in mechanical vibration.

(iii) **The conduit system when installed** and before wiring, shall be kept plugged with well-fitting plugs and when short conduit pieces are used as plugs, they shall be doubled over and tied firmly together with steel wire. Only after the conduit system has been completely cleansed of bungs, burrs and building debris, shall wiring be carried out.

(iv) **Conduits connection** shall either be by a demountable (screwed up) assembly or adhesive fixed and water tight by solution. The conduit and fittings must be clean and free of all grease before applying the adhesive. When connections are made between the conduit and switch boxes circular or non-screwed boxes, care shall be taken that no rough edges of conduit stick out into the boxes. The conduits shall be fixed to the outlet boxes either by gluing the plain end into the marbled spigot of the outlet box or by using a proprietary adaptor (half threaded couplers) and fixing it to thin walled outlet boxes by means of screwed bushes.

(v) **Conduits and trunking** shall be mechanically continuous and water tight from the point of entry into the building to the final conduit outlet boxes and such joints as are required in the conduit shall be made with plain conduit couplers glued in position. Care should be taken to ensure all joints are made watertight by using appropriate adhesive.

(vi) **Conduits shall be bent and formed** in strict conformity with the manufacturer's instructions. Sizes up to 25mm diameter may be bent cold with the use of appropriate sized bending spring. Larger conduits are to be preheated before inserting the rubber cord to prevent kinking. Conduits badly formed or bent or damaged in any way shall not be used and in all cases the inner radius of the bend shall not be less than 2.5 times the diameter of the conduit. Runs between draw in boxes are not to have more than two right angle bends or their equivalent without the approval of the Engineer. The sub-contractor may be required to demonstrate to the Engineer that wiring in any particular run is easily withdrawable and sub-contractor may, at no extra cost to the contract; be required to install additional draw-in-boxes where required. If conduit installed in straight runs is in excess of 6000mm, expansion couplings as manufactured by Egaweld or equivalent shall be used at intervals of 6000mm.

(vii) **Draw-in-boxes** shall be kept to minimum and where they occur of necessity within the floor area, the Engineer shall approve the type in writing.

(viii) **Conduit fittings** of the inspection type shall be so located that they remain readily accessible upon final completion of the building.

(ix) **Where the conduit loop-in-system is employed**, back outlet boxes shall be used and conduits shall normally be laid in the floor screed on the upper side of the slab. Draw in wires shall not be permitted where the loop-in-system is employed and cables will need to be drawn into conduits with a draw-in-steel tape.

(x) **All spare ways in junction boxes** etc. left for possible future extension shall be fitted with stopping plugs. Where conduits runs are to be concealed in pillars and beams the approval of the Structural Engineer shall be obtained. The electrical contractor shall be responsible for determining the accurate position of all holes, chases etc. on site or if the Engineer so directs shall provide the building contractor with dimensional drawings to enable him to mark out and form all holes and chases. Should the electrical contractor fail to inform the building contractor of any inaccuracies in this respect they shall be rectified at the electrical contractor's expense.

(xi) **It will be the contractor's responsibility** to ascertain from site, the details of reinforced concrete or structural steelwork and check from the builder's drawings and positions of walls, structural concrete and finishes. No reinforced concrete or steelwork may be drilled without first obtaining the written permission of the Structural Engineer.

(xii) The drawings provided with these specifications indicated the appropriate position only of points and switches, but it shall be the electrical contractor's responsibility to mark out and centre on site the accurate position of points and switches where necessary in consultation with the Architect and the Engineer.

(xiii) Where it is necessary to feed surface mounted equipment the concealed conduit shall first be terminated in a concealed conduit box.

1.5.1.2 PVC Conduit Boxes and Accessories

(i) All conduit outlets and accessories of non-metallic material including couplers, ordinary clips, saddles, pipe hooks, reducers, stopping plugs, locknuts and male and female bushes shall be manufactured dimensionally to B.S. 31/1940 BS 4607 part 1, 1970 or to KS 04-179 1979 Part 1.

(ii) Solid tees shall not be used while solid inspection elbows or bends or inspection tees shall be used only in exceptional circumstances and then only with the Engineer's approval. Small circular pattern boxes are to be used with conduits up to and including 25mm outside diameter. Rectangular pattern adaptable boxes are to be used for conduits of 32mm outside diameter and larger. For drawing in of cables in exposed runs of conduits, standard pattern through boxes shall be used.

(iii) Boxes shall be not less than 32mm deep and of such dimensions as will enable the largest appropriate number of cables for the conduit sizes to be drawn in without excessive bending.

(iv) Boxes will not be permitted in floors unless approved. Boxes cast-in situ must face downwards from the ceiling/ floor section.

(v) The circular boxes or equipment loop-in boxes shall be provided and securely fixed for all ceiling points. When the conduit is run on the surface, all circular boxes for ceiling points shall be fixed with screws.

(vi) Where ceiling boxes occur and the ceiling box is recessed below the finished level of the ceiling, suitable extension rings to accommodate the ceiling box must be provided.

(vii) Where ceiling boxes including extension rings are flush with the ceiling surface, break joint rings (biscuit rings) shall be provided to hide the joints.

(viii) In all the cases one ceiling box shall allowed per fitting except where fluorescent fittings are specified when two such boxes per fittings are desirable. When two such boxes per fitting are installed they shall be flush with ceiling and if necessary fitted with break joint rings or dome covers.

(ix) Where a non-metallic outlet box of thermoplastic material is used for the suspension of a lighting fitting care shall be taken to ensure that the temperature of the box does not exceed $60^{o}C$. The weight suspended from the box shall not exceed 3kg. Where it is intended to fix enclosed lighting fitting directly to a box or to suspend a fitting of weight in excess of 3kg, separate steel insert clips shall be used.

(x) All boxes intended for switches, socket outlets, lighting fittings or other outlets shall be fitted with brass ferrules to accommodate the fixing of screws. Ends of lengths of conduit shall be reamed and where they terminate at boxes, trunking and accessories not fitted with sprout entries shall be bushed to prevent damage to cables.

(xi) All draw boxes and inspection boxes shall be covered with appropriate box covers with screws of non-corrosive type.

1.5.1.3 Adaptable Boxes

Adaptable boxes shall be of PVC or mild steel (of not less than 12 SWG) and to be of black enamelled or steel galvanised finish according to location. They shall be square or oblong shape complete with lids secured by four 2BA brass rounded screws. No adaptable box shall be less than 75mm x 75mm x 50mm or larger than 300mm x 300mm x 75mm and shall be adequate in depth in relation to the size of conduit entering it. Conduits shall only enter boxes by means of couplers and bushes.

1.5.2 Steel Conduits and Steel Trucking

a) Where metal conduits and fittings are to be used they shall be of heavy gauge annealed mild steel Class "B" welded or solid drawn to standard specification KS-04-180: 1985 or BS 1387. In

no case will conduit smaller than 20mm diameter is to be used on the works. Conduits installed within buildings shall be black enamelled finish except where specified otherwise. Where installed externally or in damp conditions they shall be galvanized. Conduit fittings, accessories or equipment used in conjunction with galvanized conduits shall also be galvanized.

b) Metal conduit systems shall be electrically continuous and earthed in accordance to IEE regulations section D. All joints shall be made mechanically and electrically continuous by screwing to steel socket or by substantial mechanically clamps and ensuring the threaded joints do not corrode by applying a coat of paint of aluminium or iron oxide. Cables installed in steel conduits shall always be so bunched that the cables of all phases and the neutral conductor (if any) are contained in the same conduit.

c) Where vertical sections of steel conduit used exceed 5m in length staggered bends with draw-in boxes shall be provided at 5m interval to support the weight of the cables.

d) Metal trunking shall be fabricated from mild steel of not less than 18SWG. All sections of trunking shall be rigidly fixed together and attached to the framework of fabric of the building at intervals of not less than 1.2. Jointed trunking shall not have overhang-fixing points of more than 0.5m.

e) All metal trunking shall be made electrically continuous by means of 25x3mm copper links across each joint and where the joints are galvanised the links shall be made by galvanised flat iron strips.

f) All trunking fittings (i.e. bends, tees, etc.) shall leave the main trunking completely clear of obstructions, be continuously open except through walls and floors at which points suitable fire resisting barriers shall be provided as may be necessary. The inner edge of bends and tees shall be chamfered where cables large than $35mm^2$ are employed.

g) Where trunking passes through ceilings and walls it shall be properly secured and the cover solidly fixed. Screws and bolts securing covers to trunking or section of covers together shall be so arranged that damage to cables cannot occur either when fixing covers or when installing cables in the trough.

h) Where trunking is used to connect switchgear of fuseboards, such connections shall be made by trunking fittings manufactured for this purpose and not by multiple conduit couplings.

i) Where the wiring system incorporates galvanized conduit the trunking system shall also be galvanized and where the conduit system shall be painted, the trunking systems shall also be painted.

j) The number of cables to be installed in trunking shall be such as to permit easy drawing in without damage to the cables and shall in no circumstances be such that a space factor of 45% is exceeded. All cables shall be drawn or laid in trunking trough in parallel and untwisted.

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k) Where conduits terminate in fuse gear, distribution boards, adaptable boxes, non-sprouted switch boxes etc. they shall, unless otherwise stated, be by means of a socket and bare male brass bushes, compression washers or couplers and male brass bushes. All exposed threads and abrasions shall be painted using an oil paint for black enamelled tubing, aluminium paint or other approved corrosive resistant paints.

l) All bends and sets shall be made cold without altering the section of the conduit by means of approved pipe bending machine. The inner radius of the bend shall not be less than four (4) times the outside diameter of the conduit. Not more than two right angle bends will be permitted in a conduit run without draw-in box. No tee, elbows, sleeves either of inspection or solid type will be permitted as part of conduit installation. Where straight runs of conduit are installed, draw-in-boxes shall be provided at distances not exceeding 5metres.

m) Conduit shall be swabbed out prior to drawing in cables and they shall be laid so as to drain of all condensed moisture without injury to end connections.

n) All boxes shall conform to KS04-668: 1986, be malleable iron and black enamelled or galvanized according to the type of conduit specified. All conduit boxes shall have threaded brass inserts. Box covers where required shall be of heavy guage metal, secured by means of zinc plated or cadmium plated steel screws.

o) Boxes used on surface installation works shall be tapped or drilled to line up with the conduit fixed with spacer type saddles, allowing clearance between conduit and wall, without the need for setting the conduit.

p) Where used in conjunction with mineral insulated copper sheathed cable, galvanizes boxes shall be used and painted after erection.

q) Draw-in-boxes in the floors are generally to be avoided but where they are essential they must be grouped in positions approved by the Engineer and covered by a suitable floor traps, with non-ferrous trays and covers. The covers are to be recessed and fitted in with a material to match the floor surface.

r) Where buried in the ground outside the building the whole of the buried conduit is to be painted with two coats of approved bitumastic composition paint before covering up. Where run on the surface, unpainted fittings and joints shall be painted with two coats of oil bound enamel applied to dust and grease free metalwork.

s) Non-inspection bends shall only be used in special circumstances such as behind a lighting fitting or outer box.

t) When drawing cables into the conduit care must be taken to ensure that they are drawn in parallel throughout the conduit run with no cables twisted round each other.

u) Steel conduits must not be in contact with water pipes, gas pipes or alarm circuits, radio or telephone circuits or other metal works, and where this is unavoidable the conduits shall be bonded to the metalwork of this circuits. All conduits unless installed to be gas-tight must be self-ventilating and provided with means of drawing condensed moistures. Where conduit passes through a wall, ceiling or floor the hole must be made good to full thickness of the material of which the wall or partitions are build.

v) A square adaptable box shall be used where a number of conduits running together change direction. Proper mechanically and electrical continuity must be maintained when using such boxes.

w) Where extra low voltage cables such as telephone services, radio services alarm circuits, run in the same direction with low voltage cables for lighting or for power each category of the cables shall be segregated and run in different compartments or channel of the trunking.

1.5.3 Cable Ducts

The electrical contractor shall provide and lay pitch fibre or concrete cement ducts under roadways, concrete walkways etc., through which cables are to be routed. Where called upon the electrical contractor shall haunch or place concrete around the ducts to protect the ducts.

ii) The building contractor will supply and install ducts where required in footings of buildings but it will be the electrical contractor's responsibility to provide accurate details to the building

contractor of the required positions of these ducts and to ascertain that they are laid to the correct falls.

iii) After the installation of cable all ducts shall be adequately sealed to restrict the ingress of moisture. The number of cables to be installed in ducts shall be specified in the contract drawings but where not specified they shall be such as to permit easy drawing-in without damage to the cables and a space factor of 35% will not be exceeded.

1.5.4 Capacities of Non-Metallic and Steel Conduits

The cable shall be run in the conduits so as not to exceed the capacities as set in latest edition of IEE Regulations. For groups of cables, the numbers and sizes of cables installed shall be such that a space factor of 40% is not exceeded.

Conduits of sizes less than 19mm shall not be used without the written authority of the Engineer.

1.6 CABLES AND ASSOCIATED WORKS

3.6.1 PVC/XLPE Insulated Cables and Flexible Codes

All cables used in this contract shall be manufactured in accordance with the current appropriate Kenya Standard Specifications and British Standard. The standards are: -

- PVC insulated cables and Flexible Cords Ks 04-192:1988 or BS 6004
- PVC insulated Armoured Cables KS 04-194: 1990 or BS 6346
- Armouring of electrical cables KS 04-290: 1987

The electrical contractor will be required to submit samples of cables for the Engineer's approval; the Engineer reserves the right to take the samples to Kenya Bureau of Standard for testing at contractor's expense. If the supplied cables fail to meet the required standard the Engineer reserves the right to call for installation of cables of an alternative manufacture without any extra cost being incurred.

PVC installed cables shall be 100/1000 volt grade. No cable smaller than 1.5mm2 shall be used unless otherwise specified. The colour of cables shall conform to the details stated in the "cable markers and installation colours" Clause 1.14

3.6.2 Installation of Cables

(i) In wiring system where cables will be drawn in conduit, it is only after the conduit system has been completely installed, cleansed of bungs, burrs and building debris and moisture free, shall the cables be drawn into conduits.

(ii) The type of insulation protective cover, if any, shall be selected so as to allow compliance and precautions be taken against Mechanical damage, damage by heat, damage by fire or explosion, damage by dampness or corrosive atmosphere and electrical leakage.

(iii) For these general specifications unless otherwise specified all cables shall be of copper conductors and PVC insulated. All final sub-circuit cables shall be copper conductors with PVC insulation. Conductors for main and sub-mains distribution shall however be either copper or aluminium and PVC insulation as shown in the contract drawings.

(iv) Cable sizes shall be those specified in the contract drawings and Bills of Quantities but the lowest size of cable shall not be less than 1.5mm^2.

(v) All cables shall be suitable for operation at system voltage and be able to withstand currents equivalent to those specified for the current protective devices.

(vi) All cables connected in parallel circuit shall be of the same size and length to ensure proper division of the current.

(vii) Special care shall be exercised when terminating aluminium conductors. Such conductors shall not be placed in contact with terminal of brass or other metal having high copper content unless the terminal is suitably constructed to prevent electrolytic corrosion.

(viii) Conductors terminated in a pillar type terminal shall be mechanically swaged and fitted with a phosphor bronze sleeve whilst those to be terminated with lugs shall have these lugs fitted to them with a purpose made compression tool.

(ix) Cables shall be drawn into conduits by means of draw steel tape unless otherwise specified. However where there are numerous inspection boxes, it may not be necessary to employ draw wires or tapes. Where draw wires are to be used to draw cables into conduits, they shall be inserted during the erection of the conduit.

(x) All cables drawn must not twist round each other but must be parallel throughout the run. Care should be taken to ensure cable insulation is not mechanically damaged when drawing the cables. Cables whose insulation has been damaged in any part of the length shall not be taped or shrouded but the whole length shall be replaced in full. No cable joints shall be permitted along the length of the conduit but joints shall only be made at terminal boxes.

(xi) For these general specifications, wiring shall be carried out on the looping-in principal. All joints shall be made at the terminals of the main switches, distribution boards, ceiling roses, switches, sockets outlets and fixed apparatus only. No joint shall be permitted in inspection boxes, but jointing of cables shall be permitted at terminal boxes. No joints shall be made in any other boxes unless approved and no joints shall be drawn into conduit.

3.6.3 **Armoured PVC/XLPE Insulated and Sheathed Cables**

(i) Unless otherwise stated, armoured cables shall be of copper conductors of PVC SWA PVC type having a rating of 600/1000 volts and manufactured to KS 04-194: 1988 and KS 04-187/1988 with an overall extruded PVC insulation covering.

(ii) The Steel Wire Armour (SWA) of the cable shall be used wholly as an earth continuity conductor and the resistance of the wire armour shall not be more than twice of the largest current carrying conductor of the cable.

(iii) PVC/SWA/PVC cables shall be terminated using approved glands and a PVC tapered sleeve shall be provided to shroud each gland.

(iv) Where cables rise from floor level to switch gears etc. they shall be protected by PVC conduit to a height of 600mm from finished floor level, whether the cable is run on the surface or recessed into the wall.

(v) Where PVC/SWA/PVC cables are outside the building they shall be laid underground 750mm deep with protecting concrete interlocking cover tiles. The concrete tiles shall be 300mm by 150mm and with a minimum thickness of 25mm and of concrete mix of 1:2:4. The tiles shall be labelled 'HATARI'. The cables shall be laid on 50mm of sifted soil then covered with 50mm of sifted soil and interlocking tiles. The trench shall be carefully backfilled. As a caution cables

shall be snaked along their route to allow for ground subsidence or settlement and a 2% allowance shall be given on the measured route length before backfilling.

(vi) The electrical contractor will carry out all necessary excavations and reinstatement of ground. The cover tiles shall be continuous and without gaps between.

(vii) Where armoured cable is specified on the contract drawings, the electrical contractor shall ensure continuity of the armouring and it's cross bonding to other metal work and services.

(viii) All PVC/SWA/PVC cables run inside the building shall be fixed in rising ducts or on ceilings by means of die cast cables hooks or clamps, of appropriate size to suit cables, fixed by studs and back nuts to their channel sections support. The channel sections shall be fixed at an interval of 1500mm by means of rawlbolts for concrete ceiling, or wall and appropriate screws for wooden ceiling.

(ix) Where the cables are to be suspended from the concrete ceiling or wall, fixing shall be by BICC claw type cleating system with die-cast cleats and galvanised mild steel back straps or similar approved equal method. For one or two cables run together the cleats shall be fixed on a special channel section supports or backstraps which shall in turn be secured to walls or ceilings of ducts by rawlbolts.

(x) In excessively damp or corrosive atmospheric conditions special finishes may be required and the electrical contractor shall apply to the Engineer for further instructions before ordering cleats and channels for such areas. The above type of hooks and clamps and channels or cleats and back straps shall also be used for securing cables in vertical ducts.

(xi) Precaution should be taken when handling PVC insulated and / or sheathed cables during period of low temperatures to avoid mechanical damage as PVC insulation cracks due to very low temperatures.

(xii) Armoured cables, which might otherwise come into contact with fixed metal works, shall either be segregated or effectively bonded to prevent appreciable voltage difference at such possible points of contact.

(xiii) Where cable pass under roadways, ducts as specified on the contract drawings shall be provided. Cable route markers shall be provided to indicate the route of the underground cable as specified in the contract drawings or as required by the Engineer. After installation of armoured cables, they shall be tested in accordance with GES No. 2 and the result recorded.

(xiv) Single core steel armoured cables **shall not** be installed in cases where the current is alternating current. (NB: if copper cable is used then the armour should be aluminium otherwise use multicore cable for magnetic fields to cancel out)

3.6.4 **Flexible Codes**

i) Circular sheathed white twin TRS flex to BS: 6500:1989 shall be used for plain pendant fittings up to 100watts. For all other types of lighting fittings, the flexible cords shall be silicone rubber insulated. No polythene insulated flexible cord/cable shall be used in any lighting fittings or other appliance.

ii) The type of insulation of the flexible cord shall be such as to minimize risk of damage from high temperature, damp, corrosive situation and mechanical damages. Where flexible cords and cables are likely to be damaged by heat, heat resisting flexible cords shall be used, alternatively conductors shall be sleeved with heat resistant sleeves.

iii) The contractor shall ensure that exposed unsheathed flexible cables of the flexible cords shall be as a short as possible where unavoidable.

iv) Care shall be taken to ensure flexible cord does not support lighting fitting exceeding 3kg. The flexible cord size and rating shall be as described in the Bills of Quantities or contract drawing. Where the cord is not rated it shall be assumed to be capable of carrying 12Amps. Minimum size of flexible cable to be not less than 1.5mm^2.

v) The colour code for the flexible cord shall be brown for live, Blue for neutral or negative and Green and Yellow for earth

3.6.5 **Mineral Insulated Copper Sheathed Cable (MICSC)**

The wiring shall be carried out in single core or multi-core mineral insulated copper sheathed cable run on the surfaces of walls and ceilings, in the roof space or concealed in walls and floors.

3.6.6 **Cable Makers and Identification Colours**

(i) All cables ends connected in switchgear, Main Distribution Board, panels etc. shall have the insulation carefully cut back and the ends sealed with hellerman rubber slip as cable end markers. The markers shall be of appropriate phase colour. The insulation cable colours and cable end markers shall be in accordance with details stated below unless otherwise specified.

(ii) Every cable used for wiring shall be identified at its terminations throughout in length by colour of its insulation and / or cable end markers.

(iii) The method of identification shall be as below: -

Final Sub Circuit

Single phase	Cable end markers	Cable insulation Colour
a) Phase	red	red
b) Neutral	red	black
c) Earth	green	green

Three Phase & Neutral

a) Phase	red/yellow/blue	red
b) Neutral	black	blue

Main & Sub Main

Single phase

a) Phase	red	red
b) Neutral	black	black
c) Earth	green	green

Three Phase

Mains

a)	Phase	red	red
		Yellow	yellow
		Blue	blue
b)	Natural	black	black
c)	Earth	green	green

Three Phase & Neutral Multicore Cable

a)	Phase	red	red

		Yellow	yellow
		Blue	blue
b)	Neutral	black	black

iv) Where multicore armoured cables have the same insulation colours the cable shall be numbered with 1, 2, and 3 to signify live phase conductors and the number 0 shall be for the neutral cable. The cable end makers shall be insulation sleeves of appropriate colours or discs.

v) All cores of flexible cable including flexible cord shall be coloured throughout in accordance to the table below.

1.6.7 Cable Support

i) To ensure there is no appreciable mechanical strain on any cable termination adequate support shall be provided to conduits runs with cables drawn in them.

ii) Where conduits vertical runs exceed 5 metres there shall be a horizontal bend, which shall be supported as a precaution against undue compression of the insulation of the cable.

iii) Cables laid on trunking with vertical runs exceeding 5m in length shall also have adequately intermediate support. All PVC/SWA/PVC cables in horizontal runs in accessible trunking shall be supported by clips at spacing not exceeding the appropriate value stated in table B.2M of the IEE regulation.

iv) Where it is in an inaccessible position and unlikely to be disturbed support shall be provided at the top of the run by a clip and a rounded support of a radius not less than the appropriate value stated in table B.IM of IEE regulations.

3.6.8 Cable Lengths, Types Sizes Termination and Joints

(i) The cable type and sizes shall be as specified in contract drawings.

(ii) The length of the cable shall be as measured from supply point (meter board, distribution board, consumer unit etc.) to the intended terminal point (switches, lighting, fitting, apparatus etc.). No joint shall be allowed in between. The electrical contractor shall be deemed to have allowed for supply of sufficient cable lengths of each type and size to complete wiring system and for making allowances for any additional lengths due to cutting and waste.

(iii) All terminations of cable conductors and bare conductors shall be mechanically and electrically sound. Care should be taken to ensure there is no undue mechanical pressure applied to the conductor by over tightening of a clamping screw or others. The terminal point shall have anchors to secure all the wires. The electrical contractor shall allow sufficient length of cable inside the termination points to avoid undue strain of cables when terminating.

(iv) At every cable termination, the insulation shall be removed no further than is necessary. For braided, taped, sheathed or armoured cables the sheath shall be cut as far back from the end of the conductor insulation as may be necessary to prevent undue leakage from live parts of the braid, tape, sheath or armour.

(v) Where soldering is to be used for termination the type of solder fluxes shall be non-acidic or corrosive. Cores of sheathed cables from which the sheath has been removed and non-sheathed cables at the termination of the conduit duct or trunking shall be enclosed in a non-combustible material. In dump situation the enclosure shall be damp and dust proof and corrosive resistant.

(vi) In a flammable and/or explosive dust, flammable volatile liquid or vapours or gas situation termination shall be avoided but if necessary the terminations shall be enclosed in a flameproof fitting complying with **BS.229**.

(vii) Cable glands shall regularly retain the outer sheath or armour of the armoured cable without damage and shall incorporate adequate means of maintaining earth continuity between the armour and the threaded fixing component of the gland.

(viii) In termination point where high temperatures are to be encountered insulating sleeves or beads suitable for such temperatures shall be fitted over the individual cores of the cables or flexible cord in such a way that the normal insulation of the cores is not affected by the temperatures and are relied upon to prevent a short circuit between conductors and metallic part of termination enclosure or cause earth fault.

(ix) Terminations of mineral insulated cables shall be provided with sleeves having temperatures rating similar to that of the seals. Bare conductors in terminations of switches, bushes, consumer units etc. which are expected in normal service, shall be protected against accidental contact by screens or barriers or by adequate clearance. Special care shall be exercised when terminating Aluminium conductors. No overdue mechanical pressure should be applied on its conductor by over tightening of the clamping screw. Aluminium conductor shall not be placed in contact with a terminal of brass or other metal having a high copper content to avoid corrosion.

1.7 SUB-CIRCUITS

1.7.1 Sub-Mains

These shall be sub-circuits running from fuses or circuit breakers on the main switchboard or meter box to distribution boards or consumer units, and the cable sizes for these circuits shall be as to comply with IEE regulations and as shown in the contract drawings. No cables less than $4mm^2$ shall be used in these sub-mains circuits. Live, neutral, and earth continuity conductors, for these circuits shall all be drawn in the same conduit or enclosure.

3.7.2 Final Sub-Circuit-General

i) General or consumer circuit final sub-circuit from one distribution board will not serve outlets in an area served by another distribution board or consumer unit fed from the same meter.

ii) No fuse or circuit breakers shall be installed at any point other than on a distribution board, consumer unit, switch fuse or main switchboard except for fused spur boxes.

iii) Bell transformers shall be connected to separate way of a distribution board and form a separate final sub-circuit.

iv) Fire alarms systems shall also be from a separate final sub-circuit.

v) When the sub-main circuit protection comprises HRC fuses, final sub-circuit protection shall either be fuses or MCB's

vi) In all final sub circuits the neutral conductors shall be connected at the distribution board in the same order as that in which the live conductors are connected to the protective devices. All final sub-circuits for lighting points, sockets outlets points etc., wiring shall be carried out in the loop-in-system with no joints whatsoever along the run of cables.

vii) Each final sub-circuit shall be adequately protected against excess current and voltage at the beginning of the circuit. The size of the protective devices for each final sub-circuit shall be as shown in the drawings.

3.7.3 Lighting Final Sub-Circuits

i) All lighting points shall be wired with cables not less than 1.5mm^2 in size. Each final sub-circuit number for lighting points, in the drawing, indicate lighting points which shall be served or connected to the same final sub-circuit and protected by the same protective device.

ii) No lighting circuit shall comprise more than 20 points when protected by 10A MCB.

iii) All lighting fittings with metal enclosure shall be provided with an earth terminal, which shall be connected, to earth continuity conductor of the same size as the live conductor cable. The earth continuity conductor shall be looped to all such fittings in the same manner as the live and neutral conductor.

iv) All lighting fittings shown in the drawings as being switched by the same switches shall be so wired as to be switched and controlled by the same switch.

3.7.4 Ring Final Sub-Circuit for Socket Outlets

The ring sub-circuit shall run in the form of a ring commencing from a way in a distribution board or consumer unit etc. looping into the terminals of socket outlets and returning to the same way of the distribution board or consumer unit etc. The earth continuity conductors shall also run in the form of a ring having both ends connected to earth terminal at the distribution board or consumer unit etc.

The protective device for the final ring sub-circuit for socket outlet or any power points shall be as shown in the contract drawings.

1.8 EARTHING AND BONDING

1.8.1 Earthing

The Earthing of the installation shall comply with the following requirements: -

a) (i) it shall be carried out in accordance with the appropriate sections of the current edition of the regulations for Electrical Engineers of Britain.

(ii) Electricity Supply Authority bylaws.

b) (i) Every item of apparatus and every conductor operating at voltage exceeding extract low voltage shall be effectively protected from giving rise to dangerous earth leakage current.

(ii) All metal required to be earthed under statutory rules shall be effectively earthed.

c) (i) all consumer's units, Distribution Boards metal boards and switchgear shall have Earthing bus bar terminal. Throughout every circuit of such an installation an earth continuity conductor shall be provided and connected to the consumer's Earthing terminal.

(ii) All exposed metalwork of all apparatus in electrical installation shall be connected to the appropriate earth continuity conductors.

(iii) All metal works of wiring systems other than current carrying parts, including cable sheaths armour, conduit, ducts, trunking, boxes, and caternary wires shall be connected to the appropriate earth continuity conductors.

(iv) The Earthing terminal of every socket outlet shall be connected to the Earthing continuity conductor of the final sub-circuit. At every lighting point an Earthing terminal shall be provided and connected to the Earthing continuity conductor of the final sub-circuit unless the fitting is of all insulated enclosure.

(v) Metal works other than current carrying parts and one point of the secondary winding of any transformer shall be connected to the appropriate earth-continuity conductors unless otherwise specified.

d) (i) At all main distribution panels and main services position, a 25mm x 3mm minimum cross section area copper tape (earth bus-bar) shall be provided and all equipment including the lead sheath and armouring of cable distribution boards and metal frames shall be bonded thereto.

(ii) The earth tape (earth bus-bar) of the consumer Earthing terminal in Clause d(i) above shall be connected to the earth electrode by means of a copper tape or cable of suitable cross sectional area (earth lead). The minimum cross sectional area of the earth lead shall be 2.5mm and the maximum being 70mm^2. The connection of the Earthing lead to the earth electrode must be readily accessible and soundly made by soldered joint or clamp. The size of earth lead cable or tape shall be as specified in the contract drawings.

(iii) Where the earth electrode is located outside the building, a removable test link shall be provided inside the building as near as possible to the entry of the tape for isolating the electrode for testing purposes.

(iv) Where necessary, Earthing connection shall be protected against chemical damage and corrosion.

(v) All tapes to be soft high conductivity copper, untinned except in corrosive sites or where otherwise specified and where run underground, on or through walls, floors etc. it shall be served with corrosion resisting sleeve or coated with corrosion compound and braided

(vi) Where an earth rod is used for Earthing its earth resistance shall be tested in the manner described in the latest edition of the IEE regulation in the presence of the Engineer. The sub – contractor shall provide test equipment.

(vii) Where copper tape is fixed to the building structure it shall be by means of purpose made nonferrous saddles which space the conductor away from the structure at a minimum distance of 10mm. Fixings shall be made using purpose made plugs. No fixing requiring holes to be drilled through the tape will be accepted.

(viii) Joints in copper tape shall be tinned before assembly fitted with a minimum of two copper rivets and seated solid.

(ix) Where connections are made to the earth bus-bars connecting surface shall be tinned and bolts and nuts shall be of copper or brass. Cables to be bolted to the bus bars shall have appropriate termination non-ferrous lags.

(x) The earth rod shall be 1.5m long by 15mm diameter extensible type. The head of the earth rod shall be driven to 300mm below the surface of the ground and enclosed in a concrete box with concrete inspection covers, that is, Earth Inspection Chamber, as per contract drawings. The rod shall be fitted with hardened steel tip and driving caps and appropriate cable clamp of copper

(xi) In rocky soils conditions the electrical contractor shall obtain approval from the Engineer for an alternative Earthing system.

(xii) All Consumer Units, Distribution Boards and switchgear shall have Earthing bus-bars terminal.

(xii) Should the site condition be such that no effective Earthing can be achieved by means of earth electrode rod the Engineer shall instruct the electrical contractor the alternative Earthing system.

1.8.2 Bonding

(i) All metallic conduits, trunking, metal enclosure, the metallic sheathing of cables, the cases and enclosures of switchgear boxes fusegears and apparatus of an electrical nature, shall be so bonded as to be directly connected to the respective consumer's earth.

(ii) All Earthing terminals of every socket outlet and lighting point shall be connected to earth conductivity conductor of the final sub- circuit. Earthing assessments and the resistance of the earth continuity conductor shall comply with IEE regulations.

(iii) All lighting switches shall have Earthing terminal, which shall be connected to earth continuity conductor unless the switch plates themselves are of plastic moulded type.

(iv) All metallic work shall be bonded by earth continuity conductor expect where the metallic works is in isolation or is to be isolated.

(v) Isolated switches and incandescent lighting fittings using filament lamps installed above non-conducting ceiling need not be bonded.

(vi) The bonding connection to water and gas services (if any) shall be made as near as practicable to the point of entry of these services into the premises.

(vii) All consumer metal shall also be bonded. The minimum size of copper bonding lead to bond metalwork shall be 2.5mm2.

(viii) To avoid a situation where fortuitous faulty contact can occur between electrical apparatus and live conductors, metal works of the apparatus shall be bonded.

(ix) The bonding and connections to earth continuity conductor shall be such that no fault of negative impedance of earthed metal work shall be sustained so as to cause danger and electric shock or the risk.

(x) No bonding to metal works, water pipes, or members of structural metal works shall be done before the earth continuity conductor is connected to effective Earthing installation.

1.8.3 Protective Multiple Earthing

Where protective multiple Earthing (PME) is provided by the Supply Undertaker, the Earthing lead shall be connected to the consumer's Earthing terminal together with the neutral conductor of the installation and all shall be so arranged that connection to the neutral conductor of the incoming supply can be carried out linking the earth terminal of the consumer to the neutral terminal of the Supply Undertaker.

1.9 ELECTRIC POWER DISTRIBUTION

3.9.1 MV Main Switch Boards and Switchgear

The Main Switchboard is intended to ensure safety during operation, inspection, cleaning and maintenance of the entire electrical installation of the building protected by the board. The Board shall be so arranged as to minimise the risk of fire arising and spreading. It shall incorporate means of insulation, excess-current protection and earth leakage protection of the entire electrical installation.

1.9.1.1 Switchboard Construction

The switchboard shall be of free standing type manufactured in accordance with KS04-226, 1985(or BS 162), which coordinates the requirements for electrical power switchgear and associated apparatus. It is not intended that this K.S should cover the requirements for specified apparatus for which separate Kenyan Standard exist. All the other equipment and materials used in the switchboard shall be in accordance with appropriate Kenya Bureau Standard.

The switchboard shall comprise the equipment shown on the drawings together with all current transformers, auxiliary fuses, labels, small wiring, measuring instruments, if any, and interconnections necessary for the satisfactory operation of the switchboard.

The main switchboard shall be of modular construction type, of flush fronted, enclosed back, connected, all of steel construction and neat appearance, painted, with full front or rear access or both, as called for in the particular specifications. It shall be suitable for indoor use, sectionalized as necessary to facilities easy transportation and erection. The switchboard shall first be assembled at the factory, fully wired and checked before being installed on site in order to minimize installation work.

It shall be floor mounted with maximum height of the switchboard being approximately 2.0 metres. A suitable connection chamber containing all field terminals shall be provided at the top or bottom or special chamber of the switchboard as appropriate.

Before manufacturing the electrical contractor shall submit to the Engineer for approval of detailed drawings, showing the layout construction and connection of the switchboard.

Unless otherwise specified the switchboard shall be constructed from not less than **10guage** welded bright zinc plated mild steel for frame work and structural sections, and **12 gauge** zinc plated steel sheet for doors and panels which shall be adequately stiffened by folding or welded stiffeners. All doors shall be properly stiffened and fitted with heavy cadmium plated or any other non-corrosive concealed hinges and flush catches. Removable stiffened zinc plated steel sheets covers shall be provided elsewhere on the switchboard for full access. All doors and covers shall be fitted with cemented neoprene gasket seals to provide a dust proof enclosure. All hardware and fastening shall be heavily cadmium plated or any other non-corrosive fasteners.

No self-tapping screws shall be used. All steelwork shall be clean and free of burrs, scale and blemishes with all raw edges hidden and shall be finished with rust inhibiting treatment, one primer or undercoat and final coat of first quality zinc powder sprayed and baking enamel finish the colour of which shall be to approval.

The switchboard shall be arranged to provide the maximum of safety to personnel and equipment. All electrical wiring and bus-bars shall be completely enclosed, closure panel, isolating and insulating barriers, and interlocks shall be provided as required for maximum safety. All fuse switches or switch fuses shall be capable of being padlocked in “off” and the “on” positions.

The switchboard shall have provision of removable cross sections for easier cable installation and termination, adequate supports shall be provided for all bus-bars. Other terminations shall also be provided with adequate support.

All switches shall be operatable from floor level with maximum height of the switchboard not exceeding 2500mm from the floor level. The flush mounted indicating meters shall be within 1650mm height.

Mounting arrangements shall be such that individual complete fuse switches or switch fuse may be disconnected and withdrawn when necessary without extensive dismantling work. When switches are arranged in their formation all-necessary horizontal and vertical barriers shall be provided to ensure segregation from adjacent units.

Where spaces on the switchboard are provided for future circuit components to be installed, as shown on the drawings, all ancillary parts shall be provided and installed so that future components may be installed and connected in the least time possible. Full safety precautions shall be provided with all such spaces.

The mild zinc plated steel angle or channel forming the bottom rear edge (for rear access switchboard) or bottom front edge (for front access switchboard) shall be made up in sections and bolted into position such that any one section may be removed to facilitate installation of cables.

1.9.1.2 Bus-bars General

All bus-bars shall be of high conductivity copper and be provided in accordance with KS 04-226: 1985 (or BS 158 and BS 159). The bus-bars shall be clearly marked or painted with the appropriate phase and neutral colours, which should be red, yellow, blue for live phases and black for neutral. The switchboard shall be such that the bus-bars are so arranged that the extensions to the left and right may be made in the future with ease should this need arise.

The bus-bars, bus-bar connections and bare conductors forming part of the equipment of the switchboard shall be of current ratings as specified in the drawings, they shall also be able to withstand temperatures limits encountered during the normal operations of the switchboard and comply with BS. 159.

Each bus-bar shall be of adequate strength to withstand the electro-mechanical forces that may be set up by the designed prospective short circuit fault current and they shall be so installed that they are free to expand and contract as the temperature changes without any damage to themselves or to any other part of the installation.

The bus-bars shall be mounted fully enclosed within the main enclosure of the switchboard in separate chambers. They shall be fully separated from the incoming and outgoing cable areas. Except for instruments, potential or current connections to fuse switches, switch fuses etc., which shall be clamped in position and be of minimum length, no circuit wiring shall be within the bus-bar chamber.

Most parts of the bus-bars shall be sheathed in approved, insulating materials in their respective phase colours and secondary insulation shall be provided where they pass through supports to prevent tracing paths.

Interconnections between bus-bars and switchgears shall be of minimum length, properly insulated and rigidly supported. All contact areas of the bus-bars and the connection fastened to the bus-bars shall be either be of heavily silver-plated or solid copper bolts. Joints and connections shall be rigidly made with clamps and high tensile zinc plated steel bolts and nuts used with spring washers to maintain uniform pressure and flat washers to prevent cupping. Ready access to all joints and connection shall be provided. Bare aluminium conductors when terminated into copper bus-bars shall be suitably protected against corrosion.

The bus-bars and its interconnections shall be mounted and screened such that with fuse switch or swtichfuse door open it shall not be possible to make contact with live parts. All cables terminations shall have PVC deep moulded shrouds to prevent contact with live parts.

Small wiring emanating from bus-bars will be neatly arranged, cleated and shall be arranged in accordance with BS 158, the insulation of the wiring shall be coloured according to whether it is phase or neutral cable.

1.9.1.3 Phase Bus-bars

Termination of cables conductors on all phase bus-bars and all other bus-bars shall be through suitable manufactured technical clips. No holes shall be drilled on bus-bars for the purpose of terminating cables conductors. The clips shall be of cadmium plated, silver plated steel or pure copper suitable to match bus-bar materials to avoid corrosion in damp conditions.

1.9.1.4 Earth Bars

A high conductivity copper earth bars of adequate current rating for the anticipated earth fault current, shall be installed the full length of the switchboard in the outgoing cable area within the switchboard enclosure.

Connection to the earth bar shall be made with approved cable lugs and high tensile terminal clips with galvanised steel nuts and bolts with washers as specified for the phase bus-bars. No holes shall be drilled on the bus-bars for the purpose of terminating cables on the bus-bars.

1.9.1.5 Neutral Bars

A high conductivity copper neutral bar adequately rated and supported for normal and fault conditions shall be installed in the outgoing cable area in the switchboard enclosure. These bars shall be mounted on insulators and shall be divided into sections according to the design of the switchboard.

Copper links double bolted to each section shall connect the section.

Connection on the neutral bars shall be made as specified for the phase bus-bars. All points of contact on the neutral bars shall be silver-plated.

3.9.2 Labelling

3.9.2.1 Switchgear, Distribution Board, Consumers Units

All switchgear distribution boards consumer units etc. shall be clearly and properly labelled in accordance with IEE regulations. Fuse ways and circuit breakers feeding final sub-circuit shall be labelled to indicate power or lighting sub-circuit, the area served, or the equipment served, the circuit number etc., the details of which shall be as given in the contract drawings.

This shall be done by writing neatly on the label normally provided on the distribution boards consumer units etc., the area served and the circuit number etc., with a ball pen (not pencil or felt tip). If no label is provided the electrical contractor shall fix a special made label of the ''trifoliyte''type. (Dymotape will not be accepted)

The outside cover of all switchgear, distribution boards, consumer units etc shall be clearly labelled with a ''trifoliyte''type label (not dymotape) showing the service provided and any circuit reference number which may be given in the drawings current rating etc.

3.9.2.2 Switchgear, Switchfuse, Switches and Isolators

a) Switches or circuit breakers the purpose of which is not obvious shall be labelled to indicate equipment, appliances or apparatus it controls.

b) In labelling Switch fuse, fuse switches and isolators the information required shall include:-

i) Reference number of switch

ii) Special current rating

iii) Where circuit cables have been rated on the basis of close circuit protection the label shall include indication that the fusing factor must not exceed 1.5. in this case labelling shall be of ivorine engraved block on white plate screwed by R.H brass screws

iv) Where more than one phase of supply shall be brought into a multi gang switch box a label shall be fixed to show maximum voltage present and labelled "DANGER".

All labelling shall be completed before testing commences and the Engineer will accept no test certificates unless this has been done. Other labels shall be fixed where deemed fit and as instructed by the Engineer.

3.9.3 **Distribution Boards and Consumers Units**

All enclosures of distribution boards and consumer units shall be metallic with the case made of zinc metal clad steel sheet (galvanized), or zinc powder coated steel sheets. They shall be of surface or recessed mounting pattern. They shall have hinged lids fitted with foam rubber gasket, with enamelled finish. Where called for in the specification, the cases shall be provided with locks.

Removable undrilled gland plate shall be provided on the top and bottom of the cases for incoming cable terminations. Where the requirement for fuses is indicated on the contract drawings the distribution board shall be fitted with high quality porcelain fuse carriers and bases lined with heatproof material, and removable insulated shields or shrouds to provide adequate protection against accidental contacts with live metal. They shall also have circuit-indicating labels fixed inside the cover. Such Distribution board shall be complete with HRC fuses to B.586 1952 category 440 volts A.C.5

Where the requirement for Miniature Circuit Breakers (MCBs) is indicated in the contract drawings the Distribution Boards shall be fitted with moulded thermoplastic units of the combined thermal overload and magnetic short circuit tripping type to KS O4-311 Part 1 1987 or B.S 3871 part 1, having a minimum short circuit breaking capacity of 3000 Amps (3KA). The tripping mechanism shall be of inverse characteristics to prevent temporary overloads tripping and shall not be affected by normal variation in ambient temperature. The operating dolly shall be trip free with a positive movement in both make and break position. Clear indication of the position of the handle "ON and OFF" shall be incorporated.

In all the distribution Boards a complete list of circuits detailed on typed cartridge paper glued to stiff cardboards and covered with a sheet of Perspex and held in position with four suitable fixings, shall be fitted to the inner face of lids. The appropriate HRC fuse or MCB ratings shall be stated on the circuit chart against each circuit in use. Insulated barriers shall be fitted between phases and neutrals in all boards to shroud live parts. Neutral cables shall not be connected to fuses or MCB's. This shall also apply to earth bars.

All consumer units shall be metal clad steel sheet or zinc-coated sheet of steel enamelled with hinged covers. They shall be either flush or surface mounted. They shall be suitable to be fitted

with MCB's. All metallic cases of distribution boards and consumer units shall be effectively bonded to earth continuity conductor.

The Engineer has already carried out short circuit level calculations when preparing contract drawings but the electrical contractor is advised to check or calculate and assure himself that the prospective fault currents at each level does not exceed the short circuit protection capability of the switch or distribution gears he intends to install as it is his responsibility to sign the appropriate declaration in accordance with section E of the IEE regulations.

3.9.5 **Fused, Switchgear and Isolators**

All fused switchgear and isolators shall conform to the requirements of KS04-226 PART 1:1985, or KS IEC 61439 Part 1-5. All contacts are to be fully shrouded and are to have a breaking capacity on manual operations as required by KS-04-182: 1980.

i) Fuse links for fused switches are to be of high rupturing capacity cartridge type class 21 confirming to KS04-183: 1978 or BS 88.

a) The Isolators and fuse links shall be contained in metal clad, dust proof, gasket sealed individual enclosures. Isolators shall be load breaking/ fault breaking isolators without fuses. The fuse links shall be contained in metal clad, dust proof, gasket sealed individual enclosures. Mechanical interlocks are to be provided between the door and, main switch operating mechanism shall be so arranged that the door may not be opened with the switch in the "ON" position, similarly it shall not be possible to close the switch with the door open except that provision to defeat the mechanical interlock and close the switch with the door in the open position for test purposes. The "ON" and OFF positions of all switches and isolators shall be clearly indicated by a mechanical flag indicator or similar device.

ii) In T.P.N fused switch units, bolted neutral links are to be fitted.

iii) The fuse switch units shall have fault rating at least equal to the fault rating of the switchboard in which they are to be installed. It shall have fast make/break design suitable for on board operations.

v) The handles of the fuse switch shall be non-detachable steel handles capable of being locked in either the "on" or the "off" position. The switch contacts shall be separately and fully shrouded and shall be renewable.

vi) The fuses and miniature circuit breakers (MCBS) shall be the protective devices to the Electrical Installation.

vii) The fuses shall be fitted in Switchfuse, Distribution Boards etc. where they are readily accessible. They shall be so connected as to be in series with circuits they are designed to protect. The current rating of the fuse shall be as shown in Bills of Quantity or contract drawing. All fuses shall be inserted in live conductor only and shall offer class Q1 protection with the fusing factor not exceedingly 1.5 for close protection.

viii) The fuse shall make the circuit dead when the current exceeds 2.4 times the rating of the fuse. They shall be of High Rapture Capacity(HRC) type to **BS 88 or BS 1361** with silver strip as the breaking element and Quartz or Silver Sand filler in a ceramic tube with metal and caps and or/without fixing tags. They shall preferable have fuse blown indicators. The prospective short circuit current of the fuse shall generally be 80 KA for alternating current.

ix) Miniature Circuit breakers shall be used for excess current protection in single phase or triple pole, 240V or 415V finals sub-circuits or sub-mains with HRC fuses as backup in the mains switchboards. The MCBs shall easily be opened and closed by hand and open automatically

when overloaded. The MCB shall incorporate both thermal and magnetic overload tripping mechanism such that the bi-metal strip shall offer time – effect for load tripping, while high speed protection against short circuit is given by magnetic operation. The time response against overload and short circuit currents shall be as specified in particular specifications.

3.9.6 **Residual Current Circuit Breakers**

(i) The Residual Current Circuit Breakers or Earth Leakage Circuit Breakers shall be installed whenever indicated on the drawings and required by the regulation. However wherever a socket outlet is placed within 2 metres from a sink irrespective of the type of building, an Earth Leakage Circuit Breaker shall be installed to protect the ring main where the socket outlet forms part.

(ii) The current operated Earth leakage circuit breaker shall be installed if the product of its operating current in amperes and the earth loop impedance in ohms exceed 40. The operating current of the current operated Earth leakage circuit breaker in this specification shall not be more than 30mA and shall be of high sensitivity such that they shall trip in less than 30ms for a leakage current of 30mA(equal to the operating current). They shall be of the type not requiring a mains supply to operate the trip mechanism under fault conditions. The current operated Earth Leakage Circuit Breaker shall also be able to trip automatically when the neutral of the supply is absent, thus ensuring that there is no likely danger of a live-to earth fault being present on the neutral side of the load. The Earth Leakage Circuit Breaker shall incorporate a test button and shall also protect the installation against excess current and short circuit fault in addition to earth leakage faults.

iii) Where the installation involves current operated earth leakage circuit breaker the consumer Earthing terminal shall be connected to a suitable earth electrode.

iv) Where voltage operated earth leakage circuit breaker is specified for single phase installation the operating coil of the circuit shall be connected between the consumer earth terminal and an earth electrode through the earth lead. The earth electrode used with any voltage operated earth leakage circuit breaker shall be placed outside the resistance area of any parallel earth which may exist. The Earthing lead between the operating coil and the earth electrode shall be effectively insulated. The Voltage Operated Earth Leakage Circuit Breaker shall incorporate means of testing through a finger operated test button.

v) For three phase voltage Earth Leakage Circuit Breaker, connection to consumer earth terminal is not necessary. The Earth Leakage Circuit Breaker may be arranged to work in place of MCCB or MCB, or operate as a backup protection. The voltage operated Earth Leakage Circuit Breaker shall be necessary when the earth loop impedance exceeds the values applicable to fuses or MCBs. For example, for fuse of current Rate 100A the measured earth loop impedance is required to be 0.8Ohms. Value above that will necessitate installation of voltage operated Earth Leakage Circuit Breaker or improvement of Earthing installation.

1.9.8 **Electrical Fittings**

3.9.8.1 **Lighting Fittings**

i) The electrical contractor shall allow for the provision of handling charges, taking the delivery, safe storage, wiring (including internal wiring), assembling and erection of all lighting fittings shown on the drawings.

ii) All fittings and pendants shall be fixed to the conduit boxes with brass R/11 screws. These shall be in line with metal finish of fittings. The lighting fittings specified are detailed for the purpose

of establishing a high standard of finish, but equal and approved alternative fittings shall be accepted. The metallic parts of the fittings shall be bonded to earth continuity conductor.

iii) In case of rectangular shaped ceiling fittings, the extreme ends of the fittings shall be secured to suitable support in addition to the central conduit supply box. Supports shall be provided and fixed by the electrical contractor. Minimum size of internal wiring cables shall be 1.5mm^2. Where these cables are likely be exposed to risk of damage by heat generated in the fitting, especially for lamps rated 300W and above, silicone rubber sleeves shall be fitted to the cables.

iv) Where sub- circuit cables are not continued into the lighting fittings terminals, they shall be connected to the fittings wires through **Connectors** of approved type (see clause on Connectors.). The insulation of fittings cables employed shall be capable of withstanding the maximum temperature rise of the fittings enclosure.

v) Lighting fittings with chain or tube suspension shall be so mounted that they are in no way supported by the conductors and the whole weight of the fitting shall be borne by the chain.

vi) Lighting fittings should be installed at height indicated in the drawings.
Where not indicated these shall be mounted on the ceiling. Fluorescent fittings mounted on combustible material of the ceiling shall be spaced by 25mm minimum from the ceiling by space couplers or dome covers.

vii) It is very essential that the light fitting supplied by the electrical contractor are those specified in the drawings and particular specification for the fittings. However equivalent and approved type shall be accepted unless otherwise specified elsewhere.

viii) The type of lighting fitting supplied shall be as described in the Bill of Quantities and of a particular catalogue number and manufactured by the company indicated. Equal and approved equivalent fittings shall have similar architectural configuration as the one specified, have equal rated lighting lumens output , and of the same colour rendering as those specified and also with similar characteristics as the required fitting, such as dust proof, corrosive proof, etc. In case of LED fittings or discharge fittings, the starting mechanism of the equivalent lighting fittings must also be similar to the one specified. The electrical contractor must indicate the country of origin of all lighting fittings (in the Technical Schedule) which are deemed to be equivalent to those specified. The type of fitting provided shall be such that spares such as chokes, starters, capacitors etc. are available in the local market.

ix) The electrical contractor shall install the lighting fittings oriented as shown in the drawings. The electrical contractor shall not change the orientation without the approval of the Engineer.

x) Each lighting fitting shall be provided with number type and size of lamps as detailed in the drawings. The colour rendering of the lamps supplied shall be as required and specified in drawings or particular specifications.

3.9.8.1.1 **Ceiling Roses**

i) All ceiling roses shall either have three terminal connection plate or four terminal connection plates as specified in the contract drawings. All ceiling roses shall have inbuilt barriers between the terminal. They shall be semi-recessed for direct fixing to conduit boxes. They shall be plastic moulded type with shrouded live terminals. All terminals shall be such that conductors and flexible cords can be easily looped in.

ii) Not more than one flexible cord shall be attached to a ceiling rose unless otherwise specified. Each ceiling rose shall be fitted over a biscuit ring of similar colour. All ceiling roses shall have provision for cord grips.

iii) When specified, the ceiling rose shall have an earth terminal which shall be connected to earth continuity conductor of the final sub circuit. The rating of the ceiling rose shall be as specified in the contract drawings and Bills of Quantities. The ceiling rose shall be so wired that no terminal remains alive when the associated switch is off. All the terminals of the ceiling rose shall be of heavy brass, phosphor bronze or any other high conductive corrosive resistant material.

3.9.8.1.2 **Lighting Switches**

i) The lighting switch shall be of tumbler type. For direct current (DC) they shall be of quick break type, while for alternating current they shall be of the "Microgap" type. All switches shall be manufactured to KS04-247: 1988 standard. Where wiring systems is surface wiring, surface switches complete with boxes shall be installed and where conduits are concealed in the fabrics of buildings, flush type of switches shall be installed with boxes recessed.

ii) Single cord ceiling switches, where required, shall be of the type where one pull shall put the switch ON the next pull shall put the switch OFF. The switches shall be fitted with shock absorbing springs in the pull cords. All switches shall be mechanically robust able to withstand the constant operation, and the contacts shall be heavy brass and firm enough to carry the rated circuit current without overheating.

iii) Switches controlling discharge lighting fittings shall be so rated as to operate under likely inductive loads of the fittings. All switches shall be inserted on the live conductors of final sub-circuits only.

iv) The switch boxes shall either be plastic moulded or steel/alloy and the current rate of the switches shall be as described in the drawings or Bill of Quantities. All switches installed external to the building and exposed to the weather shall be of weatherproof type.

v) All switches shall be mounted at a height described in contract drawings and in any case they shall be at least at a height of 1.4m above floor level and in a readily accessible position, at least 220mm from the frames on the unhinged side of the door.

vi) Time delay switches where specified shall be able to operate on an "ON" position for at least two minutes and always on the "OFF" position unless operated. Where more than one flush switch is to be installed under one plate in a multigang assembly and where the live conductors are supplied from more than one phase the plate shall be marked "danger 415 Volts".

vii) The switch plates shall be either plastic moulded and coloured as specified or metal clad and coloured as specified. The contact parts shall be enclosed in plastic mould insulation material and be of pure copper hard drawn brass.

3.9.8.1.3 **Lamps and Tubes**

a) The electrical contractor shall supply and fit all lamps, LEDs lamps, etc., as required for installation.

b) The lamps and tubes shall be suitable for normal stated voltage and frequency and they shall have power rating as shown in the contract drawings and particular specification. For LED Lamps the power factor shall be as specified in particular specifications but not be below 0.8.

c) Colour rendering of LED lamps shall be specified in particular specifications or Bills of Quantities. However where not specified the LEDs shall be as assumed to be of "white" variety. Lumen output of the lamps and tubes shall also be specified but where not specified the sub – contractor shall notify the Engineer of the omission

3.9.8.1.4 **Lamp holders**

i) Lamp holders shall be of extra heavy gauge skirted type and shall be either be Bayonet Cap (B.C), Edison screw (ES), or Goliath screw (GS) variety, as specified in the drawings.

ii) All the lamp holders shall have heavy brass type electric solid plunge contacts separately sprung by rust proof steel plunger springs. All lamp holders shall be constructed of or shrouded in insulating materials to prevent contact with the live parts. They shall be so designed for quick removal and replacement of lamp and also be able to hold the lamp in firm metal electrical contact to prevent overheating.

iii) B.C type lamp holder shall comply with BS 52. Where lamp holders are supplied by flexible cord, the holders shall have "cord grip" arrangements and in the case of metal shades, Earthing screws shall be provided in each of the holders. The screwed cap of the ES and GS holders shall be connected to neutral. When wiring the lamp holders, care must be taken in bearing the flexible cord. The flexible wires must be well twisted together and should not be allowed to splay, as loose single strand may touch either the metal frame of the holder or the opposite terminal. The braiding should be neatly cut away to prevent cotton fibre touching the terminals.

iv) The current rating of the lamp holder shall be as specified in the contract drawings or Bills of Quantities. Lamps that are likely to draw more current than the current rating of lamp holder shall not be used or permitted to be connected to the lamp holder. Where not rated the lamp holder shall be assumed to be 5A, 240 Volts, 50Hz variety. BC lamp holders shall be used with tungsten lamps rated up to 150 W while for lamps up to 200W ES lamp holders are suitable and above 200W all lamp holders shall be GS variety.

v) Lamp holders shall be either insulated type of Bakelite, Plastic moulded type, or the brass type with porcelain interior, as specified.

3.9.8.2 **Sockets Outlets and Plugs**

i) Socket outlets and plugs shall be of the types appropriate to the system of wiring employed. They shall be rated 13Amps of 3Pin shuttered, and switched, manufactured to KS04-246: 1987 standard.

ii) For flush pattern the boxes shall either be steel or plastic moulded while for the surface installation the boxes shall be of steel, steel alloy galvanised or enamel painted with corrosive resistant paint, and also plastic moulded type. The number of gangs and type shall be as specified in the drawings.

iii) The socket base shall be of virtuous porcelain or tough insulation material and the contact tubes which must be self-adjusting to the pins shall either be of phosphor bronze or hard drawn brass with sound terminals. The exposed ends of the tubes shall be below the level of the base to prevent them from being touched accidentally.

iv) The shutter mechanism shall be such that the insertion of the earth pin of the plug shall allow the opening of the live and neutral tubes of the socket outlet.

v) All plugs shall be of substantial construction to clamp to the socket outlet tubes firmly. The plug cover shall be of tough rubber plastic non-combustible materials. All plugs shall have 13A cartridge fuse manufactured to BS1363.

vi) The socket outlet plates shall either be plastic mouldered and coloured or metalclad as specified. All outlets shall be installed at height of 300mm from the finished floor level or in special in cases, especially above benches, at 1.4m. All the earth contact tube shall be connected to earth continuity conductors. The insulation of the socket outlet shall be so constructed as to withstand temperatures likely to be encountered during normal operation and at rated current and voltage.

vii) The plug pins shall clearly be identified by "L" for live contact, "N" for neutral contact and "E" for earth contact. Both the plug and socket outlet shall be so constructed that it shall not be possible for any one pin of the plug to be in live contact with socket outlet while the other pin is exposed.

viii) Where two or more points are shown adjacent to each other on the drawings e.g. socket outlet and telephone outlet they shall be lined vertically or horizontally on the centre lines of the units.

3.9.8.2.1 **Fused Spur**

i) These shall be flush or surface mounted, metal clad or plastic moulded plate of single or double pole switched type, in steel/ plastic moulded box and type and make as specified in the drawings complete with pilot light to KSO4 –247:1988 standard.

ii) The fused spurs box shall be for connection and supply to permanent Electrical Appliances installed or likely to be installed. The rating of HRC fuse shall be as per contract drawings or Bills of Quantities but shall not exceed 13A. Where the fused spur is to be used to supply a hot water heater system in the bath or kitchen, it shall be positioned out of reach of a person using the bath or sink.

3.9.8.2.2 **Cooker Control Units or outlets**

i) These shall be flush mounted with 13A switched socket outlet and neon-indicators. The cooker control units shall be manufactured to KS O4-247: 1988. The construction of the cooker outlet shall be such that all terminals shall be easily accessed and shall be shrouded to avoid accidental contact.

ii) The current and voltage rating of the cooker outlet shall be equivalent to those of the cooker to be connected and the cooker outlet shall be capable of normal operations at ambient temperatures of 20^0 c to 45^0 c.

3.9.8.2.3 **Water Heaters**

a) Unless otherwise specified water heaters shall be of the self-contained type.

b) Where water heater cylinders are made up locally for immersion heaters, the plain cylinder shall be effectively lagged. Adequate thickness of thermal insulation shall be applied to the entire surface of the cylinder.

c) Each water heater shall be supplied by a separate final sub-circuit from the distribution board or consumer or where its rating equal or exceed 3kw, it shall separately metered by the Power Undertaker. In which case the Final sub-circuit shall be from a Double pole switchfuse (or Double Pole MCB) in the Meterboard. The wiring shall be complete from the distribution board, meterboard, or consumer unit to water heater switch without introduction of a plug and socket outlet. An approved heat resistant cable of butyl rubber insulated as CMA reference 610 butyl of voltage rating 600/1000 volts shall then connect the water heater switch to the immersion heater terminals.

d) All water heater switches shall be placed out of reach from a person using the bath or sink. The water heater shall be properly earthed from an earth terminal on the apparatus plate to the

general earth connection or earth continuity conductor. The pipe work of the hot water systems should not be relied upon as an earth continuity conductor, but shall be bonded.

e) The final sub-circuit of the water heater shall be protected by HRC fuse or MCB of appropriate current rating as shown in contract drawings.

3.9.8.2.4 **Telephone Outlets**

i) The electrical contractor shall install conduit for telephone wiring as shown in the drawings. The minimum conduit size shall be 25mm diameter PVC or steel conduit as specified

ii) Draw wires shall be left in all the conduits for telephone installation, in case telephone wiring shall be required to be installed later. The conduits shall be terminated to suitable Telephone outlet boxes of steel/alloy or Plastic moulded.

iii) Where telephone lines are to be installed along trunking they shall be installed in a separate channel or compartment of the trunking to ensure segregation from other cables of high voltage supply.

iv) Outlet plates shall be as specified in contract Drawing and Bills of Quantities and in any case shall be of the type complying to **KS 1588-3:2001.**

v) Where telephone points are to be wired the cables used shall conform to **KS 1588-3:2001.** The cables so installed shall be terminated in appropriate termination Block or Discase.

3.9.8.2.5 **Connectors**

(i) Where specified in Bills of Quantities and drawings, connectors shall be installed for the purpose of joining cables. When not specified, connectors shall be fitted for joining of looped PVC insulated cables with cables in lighting fittings or any other apparatus. The joint so formed shall be both mechanically and electrically sound.

(ii) The connector's insulation shall be as effective as that of cables forming the joint. Care shall be taken in the choice of connectors in joining conductors of dissimilar metal to avoid corrosion. In particular when joining aluminium and copper conductors, the connectors contacts shall be cadmium alloyed variety to prevent electrolytic corrosion.

(iii) The connector's screws shall be appropriately shrouded and the whole construction shall comply with KS IEC 60947 Part 1-7 2001 or B.S.196, BS1778 or B.S.4343.The terminals shall be of phosphor Bronze or hard drawn brass complete with screw.

(iv) The connector terminals shall be insulated with PVC or porcelain and be shrouded to prevent accidental contact of live parts.

(v) When the temperatures are not high Rubber insulated connectors may be used.

3.9.9 **Position of Electrical Plant and Apparatus**

The routes of cables and approximate positions of switchboards etc. as shown on the drawings shall be assumed to be correct for purpose of tendering but exact positions of all electrical equipment and routes of cables must be agreed on site with the Engineer before any work is carried out.

3.10 **PROSPECTIVE CURRENTS AND DISCRIMINATION**

3.10.1 **Prospective Currents**

Prospective current of the installation or Short Circuit Current Fault level is the RMS value of the alternating component of an Alternating Current (AC) that would flow in a circuit due to applied voltage, when a link is placed between the live and neutral conductors at any position of the circuit.

Thus when the live and the neutral conductor of a final sub-circuit is shorted through a link and voltage applied the RMS value of the short circuit current which shall flow shall be short circuit Current Fault level or the **prospectiv**e **current level of the final sub-circuit at the position of the shorted point**.

The value of the current is limited by the impedance of **Supply Transformer**, winding impedance, cable impedance, impedance of joints and equipment between the transformer and the fault position.

Generally the short Circuit Fault level at the Final sub-circuit is not expected to be higher than 3KA while at the Main Distribution Board the fault level may be as high or approximately 14KA. The Engineering design of the installation is such that all excess current protective device specified in Bills of Quantities and contract drawings are of specified prospective fault current level and any change in the installation with different protective devices introduced by the contractor could affect the design.

The contractor shall notify the Engineer of any changes he is likely to incorporate in the installation of protective device for approval before installation especially if the devices he intends to install are of different make from those specified. The installed fuses and MCBS must conform to the specified prospective fault current levels.

3.10.2 **Discrimination**

The installation shall be considered to offer effective discrimination when only the faulty final sub-circuit or a particular faulty apparatus is isolated.

Discrimination between two or more protective devices in series shall be proved to occur when, on the incidence of a short circuit or an over-current, only the device intended to operate does so.

Where HRC fuses are used as protective device in conjunction with MCBS the fuses shall provide backup protection to cut off high prospective currents rapidly thus reducing damage to the installation. The MCB shall offer rapid interruption of low prospective short circuit current in the Sub-main and Final sub-circuits. In general discrimination between two devices shall occur when **pre-arcing (1^2t)** of the major device, say HRC fuse-device of high current rating is greater than the total operational **(1^2t)** of the minor device of lower current rating, say an MCB, at its designed **prospective short circuit fault level current(I).**

The electrical contractor before installing the prospective devices shall ensure that the characteristics and specifications of such devices comply with the above criteria as well as the specifications drawn in particular specification for fuses and MCBS. **(1^2)** shall be the square of Ampere RMS value of **prospective short circuit fault level current** and **(t)** the time period in seconds.

3.11 **AS INSTALLED DRAWINGS**

The installation shall not be considered complete until test certificate and "As installed" drawings have been submitted and approved by the Engineer.

3.12 ON-SITE TESTING AND COMMISSIONING

The electrical contractor shall conduct, during and, at the completion of the installation and if required again at the expiration of the maintenance period, tests in accordance with the relevant section of IEE regulations and also to rule 3 of the Electrical Power Act, for additional test not covered by the regulations, and the Electricity Supply Authority by-laws.

The results of the tests shall be recorded on a test and commissioning certificate supplied by the Engineer or his representative. Two copies of each certificate shall be provided.

Additionally, in the case of underground cables, test shall be carried out to establish continuity, phase sequence and high voltage tests if required by the Engineer.

a) Tests shall be carried out to prove that all fuse and single pole switches are installed in the "Live" Conductor.

b) Tests shall be carried out to prove that all socket outlets and switched socket outlets are connected to the "Live " conductor in the terminal marked as such and that each Earth pin is effectively bonded to the earth continuity system.

c) Tests shall be carried out to verify the continuity of all conductors of each "Ring" circuit.

d) Phase tests shall be carried out on completion of the installation to ensure that correct phase sequence is maintained throughout the installation. Triplicate copies of the results of the above tests shall be provided within 14days of the witnessed tests and contractor will be required to issue to the Engineer the requisite certificate upon completion as required by the regulations referred above. In case of underground cables, tests shall be carried to establish the continuity, phase sequence and high voltage tests.

e) Inspection shall be carried out to ensure;

   i) No terminal in the Ceiling Rose is "LIVE" when the corresponding switch for that Ceiling Rose is in off position.

   ii) All conduit termination, conduit boxes, consumer unit, Distribution Boards, Adaptable boxes etc., shall not have rough edges and are bushed.

   iii) All fixed metal works close to Electrical installation are bonded to earth continuity conductor

f) Other tests may be conducted to test whether the arrangement of protective devices can afford Discrimination i.e., a fault in the furthest power point or lighting point does not blow or trip Fuses or MCBs respectively in the Meter Board, as an example, but blows or trips those that are in the consumer unit that are protecting the respective Final sub-circuits with the faults.

g) Other tests shall include;

   i) Installation Resistance Tests to various circuits and conductors and apparatus,

   ii) Earth-continuity conductor impedance tests,

   iii) Earth loop impendence tests,

   iv) Earth Electrode resistance tests.

h) Any apparent fault, defects or omission or faulty Workmanship, incorrectly positioned or installed parts of the installation found by such inspections or tests shall be rectified by the contractor at his own expense.

i) The electrical contractor shall provide accurate instruments and apparatus and all labour required to carry out the tests. The instruments and apparatus shall be made available to the services Engineer to enable him to carry out such tests as he may require. The contractor shall generally attend on other contractors employed on the project and carryout such electrical tests as may be necessary.

The Engineer and the contractor shall also participate in testing and commissioning of all other equipment plant and apparatus forming part of the works, in particular insulation tests, before connecting any power or other supply and setting to works such plant or apparatus.

Where such equipment etc. forms part of or is connected to a system whether primarily of an electric nature or otherwise (e.g. Air conditioning systems) the electrical contractor shall attend on and assist in balancing regulating, testing, and commissioning the systems to the service Engineer's approval.

3.12.1 **Space Factor and Bundling Of Cables**

Ensure not many Electrical cables are drawn in the same conduit and a space factor of 40% is maintained.

3.12.2 **Illumination Level**

The illumination level shall be as per design specification. A Lux meter may be used to test the illumination level of various rooms in the building.

3.12.3 **Manuals**

Obtain from the contractor all the maintenance manuals as required by the specifications.

3.12.4 **Earthing**

Inspect the Earthing Chamber to ensure the earth lead is enclosed in conduit up to the point of connection to the Earth rod Clamp. Ensure the earth lead cable termination at the earth rod clamp is be corrosive resistant.

3.12.5 **Radial Circuits**

Inspect and ensure that for all Appliances, Equipment, Apparatus etc. that are required to be supplied by radial circuits directly from Distribution boards, Consumer Units etc., without the circuit supplying any other equipment, this requirement is achieved.

PARTICULAR SPECIFICATIONS

2 PARTICULAR SPECIFICATIONS AND CONDITIONS

2.1 PARTICULAR CONDITIONS

2.1.1 Location of Site

The site of the proposed Sub-Contract works shall be at The Nairobi Hospital, along Argwings Kodhek Road.

2.1.2 Description of Project

The project comprises of the Fit-Outs and Reorganization for The Nairobi Hospital Labor Wards.

2.1.3 Commencement of Works

The Sub-Contractor in submitting his tender shall be deemed to have included for Commencing any necessary work on site at such a time as will comply with the Main Contractor's programme.

2.1.4 Scope of Works

The Sub-Contract Works shall comprise the supply, delivery, erection, testing, commissioning and setting to work of the Electrical Engineering Services as detailed in this Specification and the accompanying Contract Drawings.

The Sub-Contractor shall include for all apparatus and appliances not particularly called for in this Specification or on the Sub-Contract Drawings but which are necessary for the completion and satisfactory functioning of the Sub-Contract Works. No claims for extra payments shall be entertained from the Sub-Contractor due to his failure to adhere to the above requirements.

It is deemed that if in the opinion of the Sub-Contractor at the time of tendering, there existed a discrepancy between the Specification and the Contract Drawings, that the Sub-Contractor clarified this difference with the Engineer before tendering.

The work to be undertaken under this Sub-Contract shall comprise but not restricted to the following: -

(a) Supply and Installation of incoming electricity power supply system

(b) Supply and Installation of a New Distribution Board each area.

(c) Supply and Installation of distribution cables and sub-main cables.

(d) Supply and installation of small power system

(e) Supply & Installation of Lighting Fixtures.

(f) Small power wiring in new compartmentalised trunking.

(g) Supply & Installation of cable ducts, cable trays and trunking.

(h) Supply and installation of fire Detection and Alarm System

(i) Supply and installation of UPS Unit.

(j) Receiving, installing, commissioning of the client supplied items

2.1.5 Ordering of Materials

The Sub-Contractor shall order materials from the quantities taken from his own approved working drawings and not from the quantities shown on the Contract Drawings or in the Specification.

2.1.6 Environmental conditions

The installation shall be suitable for continuous operation under the following service conditions without both damage and performance de-rating:

Altitude: > 1000m

Temperature:

- Average temperature during 24hours: 35°C
- Max temp. +40°C
- Min temp. -5°C

Humidity:

- Max 50% at 40°C

2.2 INCOMING ELECTRICITY POWER SUPPLY AND DISTRIBUTION SYSTEM

The incoming electricity power supply for the Labour Ward shall be derived from the NHMP Low Voltage Switchgear located in the Power Centre.

The supply to the various sections of the Labour Ward works shall be through armoured electrical cables through overhead cable trays as shown on contract drawings.

From the respective Sub-Boards or Main Distribution Boards (DBs), power will then be distributed in the respective loads as shown on contract drawings.

2.2.1 Distribution Boards Consumer Units

The distribution boards and consumer units shall conform to the requirements of Clause 4.16 of this Specification and shall be as manufactured by M/S Schneider or equal and approved.

Distribution boards and consumer units shall be flush/surface mounted.

Residual Current Circuit Breakers [RCCB] where specified shall be incorporated in the distribution boards and consumer units' outgoing ways in place of MCBs for individual final circuit protection and shall be as ABB or equal and approved.

Schematic of individual distribution boards and consumer units have been prepared. The Sub-Contractor should note that power boards consist of single phase and three phases sub-circuit ways.

All neutral conductors in a single phase distribution boards and consumer units shall be connected in the same circuit sequence as its phase conductors, i.e. phase wire No.1 connected to No.1 terminal on the neutral bar.

In addition to this requirement for every distribution board each phase and neutral conductor shall have clipped to its sheath in the distribution board a clip-on numbered tag corresponding to its circuit number. The tags shall be of a type manufactured by M/S Critchley Brothers Limited. All circuit numbering shall commence from left to right.

2.2.2 L.V. Earthing

The Sub-Contractor shall provide a complete and effective system of Earthing for the L.V. electrical installation.

The system of Earthing shall comply with the IET wiring regulations and the recommendations stated in CP 1013, except where detailed otherwise in this Specification and the drawings. Where the IET wiring regulations and CP 1013 differ then the former shall take precedence.

Metallic services including gas mains, dry risers, etch, entering or leaving the building or structure shall be effectively bonded to the main Earthing terminal at their point of entry or exit. Connections shall be made to the services with purpose-made Earthing clamps to BS 951.

The lightning conductor system for the building or structure shall be effectively bonded to the main Earthing terminal in accordance with the requirements of CP 1013. The bonding conductors shall not be smaller than 25mm x 3mm. A suitable label shall be provided adjacent to this bonding connection at the main Earthing terminal.

Where the building is comprised of a steel framed structure or has metallic cladding then these shall be effectively bonded to the main Earthing terminal.

The cross-sectional area of all Earthing, bonding, and protective conductors shall comply with the requirements of the IET wiring regulations. Except where detailed otherwise in this specification or on the drawings all conductors for Earthing shall be copper manufactured in accordance with BS 1432, from strip and BS 4109, for cables.

Single-core cables forming part of the Earthing system shall be of stranded copper, insulated to 450/750V standards with green/yellow PVC. These cables shall comply with BS 6004, Table 1. Bare protective conductors in twin and three core cables included in BS 6004, Table 5 will be acceptable.

Mechanical joints between aluminium and copper shall have the joint faces lightly coated with a suitable compound to prevent corrosion, before the connection is made.

Where conduits or small glands for mineral insulated or armoured cables, terminate on switchgear, distribution boards, starter panels or other apparatus then brass compression washers shall be used to ensure an effective earth connection.

Where connections are made between sections of trunking then the manufacturer's earth continuity links shall be installed across the joint. Connections made between trunking sections crossing a building expansion joint shall be made with a flexible copper braid.

Sections of cable tray shall be thoroughly cleaned before overlapping and securing with a minimum of two screwed fixings. The remote ends of the cable tray shall be effectively bonded to the Earthing system.

The armouring of plastic sheathed cables terminate in a suitable compression glad fitted with a purpose-made earth tag. A suitable protective conductor shall connect the earth tag with the apparatus Earthing terminal. The earth tag shall be manufactured from a high conductivity material compatible with the cable gland.

The armouring of metal sheathed cables shall be securely clamped to the gland at the cable termination with a purpose-made bolted clamp. A protective conductor shall be installed to connect the armour clamp or gland fixing bolts to the apparatus Earthing terminal.

For an outdoor termination the armouring shall be suitably protected to prevent corrosion.

Metal sheaths and/or armouring of multi-core cables connected to a cubicle type switchboard shall be effectively connected to the switchboard earth bar as described in later clauses.

The earth terminal of all socket outlets shall be connected to the main protective conductor of the final sub-circuit. Where the protective conductor is formed by conduit, trunking or the metal sheath and/or armouring of cables then the earth terminal of the socket outlet shall be connected to an earth terminal in the box or enclosure associated with the conduit, trunking or cable.

Connections between earth bars, equipment frames, etc. and stranded copper cables shall be made with the appropriate lug, bolt, washers, nut and lock nut. The cable shall be seated into the lug and the contact surfaces shall be thoroughly cleaned and tinned prior to connection.

The washers shall be of sufficient size to prevent any distortion of the copper strip.

The diameter of fixing holes shall not exceed one-third the width of the earth bar or strip. Where a larger hole is required in an earth bar then connection shall be made to a suitable copper flag welded to the bar.

Copper strip joints shall be riveted and soldered using hard silver solder and suitable copper rivets, four to a joint and not less than 6mm from the edge of the copper strip. The amount of overlap of the two strips to the jointed shall not be less than the width of the larger conductor.

2.2.3 Test Requirements

Tests shall be made and recorded on the electrical installation Earthing system in accordance with chapter 6 and appendices 14, 15 and 16 of the IET wiring regulations and the results recorded on copies of the 'Schedules of Test Results' attached to this Specification. Tests shall be made both during and upon completion of the works.

The schedule shall be completed for each final sub-circuit and at each main and sub-main distribution point. Six typed copies of the completed schedules shall be available for inspection within fourteen days of the test completion.

These tests shall also be made on all plant and equipment supplied, installed and connected to the electrical installation under this sub-contract and/or existing plant and equipment connected to the electrical installation provided under this sub-contract.

The works Sub-Contractor shall re-set the Earthing system provided under this sub-contract thirty days prior to the end of the Defects Liability Period. The Works Package Sub-Contractor shall give seven days' written notice prior to visiting the site to make these tests. Tests shall be carried out as aforementioned on the following basis: -

(i) All socket outlets installed under this sub-contract shall be tested for earth fault loop impedance.

(ii) Two and a half per cent (2.5%) of all lighting points installed under this sub-contract with a minimum of five, shall be tested for earth fault loop impedance.

Should any point not comply with the test requirements then a further two and a half per cent (2.5%) shall be tested, when failure of any one will require testing of all lighting points.

(i) All miscellaneous plant machinery and equipment supplied and installed under this sub-contract shall be tested for earth fault loop impedance.

2.2.3.1 Schedule of Test Results for the Electrical Earthing Installation.

Job No: **Schedule No.**

Job Title:

Building:

Department:

Switchboard/Distribution Board Ref:

Method of Main Earth Connection:

cable or circuit ref.	**Circuit fuse or breaker rating (Amps)**	**Protective conductor resistance (Ohms)**	**earth fault loop impedance (Ohms)**

Sub-Contractor:

Date:

2.2.4 Moulded Case Circuit Breaker (MCCB):

2.2.4.1 General

The Circuit breakers shall be with thermal-magnetic or MICROLOGIC® electronic trip units as specified on the associated drawings. Circuit breakers shall have voltage and interrupting ratings that meet the application requirements. Interrupting rating shall be available up to 200 kAIR at 240Vac, 480Vac and up to 100 kAIR at 600Vac without fuses. Circuit breakers shall be available in frame sizes as follows: H-frame (150A), J-frame (250A) Q-frame (225A) L-frame 600A, M-frame (800A), P-frame (1200A) and R-frame (3000A).

2.2.4.2 References

Circuit breakers shall be constructed in accordance with the following:

a. CSA 22.2 No 5 / UL® 489 Low-voltage AC and DC circuit Breakers
d. [IEC 60947, "Low Voltage Switchgear and Control Gear – Part 2: Circuit Breakers]
e. [IEC 60947, "Low Voltage Switchgear and Control Gear – Part 3: Switches]

2.2.4.3 Equipment, Components and Accessories

2.2.4.3.1 Circuit Breaker:

Circuit breakers shall be constructed using glass reinforced insulating material. Current carrying components shall be completely isolated from the handle, and the accessory mounting area.

Circuit breakers shall have an over centre, trip free, toggle operating mechanism which shall provide quick-make, quick-break contact action. The circuit breaker shall have common tripping of all poles.

From 150 A to 600 A rating frame, MCCBs breaking unit shall be made with a double rotary contact to limit let through energy on the installation

MCCBs shall be designed to trip the circuit-breaker in the event of high-value short-circuit currents. This design shall be independent of the thermal-magnetic or electronic trip unit.

The circuit breaker handle shall reside in a tripped position between on and off to provide local trip indication. Circuit breaker escutcheon shall be clearly marked on and off in addition to providing international I/O markings. The maximum ampere rating and CSA, UL, IEC, or other certification standards with applicable voltage systems and corresponding interrupting ratings shall be clearly marked on face of circuit breaker.

Each circuit breaker shall be equipped with a push-to-trip button, located on the face of the circuit breaker to mechanically operate the circuit breaker tripping mechanism for maintenance and testing purposes.

Circuit breakers shall be factory-sealed with a hologram quality mark and shall have date code. MCCB's shall be able to receive a device for locking in the isolated position.

[Circuit breaker/circuit breaker] [Fuse/circuit breaker] combinations for series connected interrupting ratings shall be listed by UL as recognized for Canada component combinations. Electronic components shall withstand temperatures up to 221 °F (105 °C).

Circuit breakers shall be UL-listed to accept field installable/removable mechanical type lugs. Lugs shall be CSA/UL-listed to accept solid and/or stranded [copper and aluminum conductors] [copper conductors only]. Lugs shall be suitable for [140 °F (60 °C) rated wire on 125 ampere circuit breakers and below] [167 °F (75 °C) rated wire] [194 °F (90 °C) rated wire, sized according to the 167 °F (75 °C) temperature rating in the CEC/NEC].

Circuit breakers shall be capable of accepting bus connections. For rating frame higher than 250 A MCCBs shall be fitted with metallic filters to reduce effects perceptible from the outside during current interruption

For a MCCB rating frame given, MCCBs dimensions shall be the same whatever the AIR. H-, J-, L-, P-frame shall be available in manually operated version and electrically operated version

The P-frame electrically operated version shall be of the stored-energy type only and will be equipped with anti-pumping function

The P and R-frame circuit breakers shall be equipped with a safety interlock, which keeps the circuit breaker open if the trip unit is not installed.

2.2.4.3.2 Trip Unit

MCCB's with ratings up to 400 amperes shall be equipped with [thermal magnetic] [electronic] trip units.

MCCB's with ratings over 400 amperes shall be equipped with electronic trip units. Circuit breakers with permanent trip units shall be CSA/UL-listed for reverse connection without restrictive line, load markings, and be suitable for mounting in any position

MCCBs with field interchangeable trip units shall have trip units that are easily interchangeable and easily secured to the MCCB

The trip units shall not augment overall circuit breaker volume. Thermal Magnetic (400 Ampere Frame and Below):

Thermal trip elements shall be factory preset and sealed. Circuit breakers shall be true RMS sensing and thermally responsive to protect circuit conductor(s) in a 104 °F (40 °C) ambient temperature.

Circuit breaker frame sizes above 150 amperes shall have a single magnetic trip adjustment located on the front of the circuit breaker

Where indicated on drawings, Circuit breakers shall be equipped with a ground fault module (GFM) with 20 ampere to 200 ampere sensitivity level or earth leakage module (ELM) with sensitivity ranges between 30 mA and 3 amperes, or approved equal.

2.2.5 Miniature Circuit Breakers (MCB)

2.2.5.1 General.

Miniature Circuit Breakers (MCBs) shall be rated for uninterrupted duty at 240/415 volts and shall comply with BS 3871: part 1 and IEC 60947, plus any additional requirements of this specification.

MCBs shall be type tested by ABB or an equivalent approved coordination testing authority. All MCBs shall be of the same manufacture. Manufacturer's tripping characteristics shall be provided for each type of MCB specified.

Service and ultimate short-circuit capacities, impulse withstand voltages and insulation levels shall be suitable for the location to the MCB in the system and the backup protection provided.

MCBs shall be fitted with fixed, non-adjustable, direct-acting thermal and magnetic trips and shall trip instantaneously (within 0.1 seconds) at currents above 5 and up to 10 times normal current rating, (C-type in IEC 898), unless otherwise specified.

Energy limiting MCBs shall break the circuit within 5ms. The 1.2 energy let-through shall be stated for each energy limited MCB. In multi-pole MCBs, including 4-pole, all poles shall open, close and trip simultaneously.

Mechanisms shall be quick-make, quick-break, over-centre type which are trip-free. The contact position shall be positively indicated by coloured bands and/or entering to show whether the contacts are open or closed. If the rating or the incoming supply to an MCB board exceeds 200A on any phase, then moulded case circuit breakers shall be used in place of MCBs. As required by IEC 898 1987 plus amendments, the following information shall be provided for each MCB: -

1. Rated current
2. Rated operational voltage and rated insulation voltage
3. Number of poles
4. Rated services and ultimate short-circuit capacities.
5. Type according to tripping characteristic i.e., Type B, C or D.
6. Method of mounting
7. Method of connection
8. Protection against external influence.
9. On request, the I^2t tripping characteristic curve.

Each MCB shall be marked as follows: -

a) On the front of the MCB so that it is visible when mounted: Rated current, without the symbol 'A' preceded by the symbol of instantaneous tripping (B, C or D) e.g. B 16

b) Rated voltage

c) Manufacturer's name or trade mark

d) Type designation, catalogue number of serial number

e) Rated service short-circuit capacity in amperes

f) Reference ambient temperature if different from 30^0C.

2.2.6 L.V. Cable Distribution System

This section of the specification covers the supply, installation, testing and commissioning of the main and sub-main cables, distribution boards and consumer units in accordance with the contract drawings and specification.

The sub-main cables and methods of installation shall be as shown on the Schematic and Layout Drawings and/or specified of this Specification. The cables shall be from an approved manufacturer.

Distribution cables shall be run in trenches externally and on cable racks within the factory.

Types of cables

2.2.6.1 Power Cables

The most common cable conductor material used in building installations is copper. In some types of cables, the copper may be tinned to prevent the copper from reacting with the insulation material. Aluminium is often used for power cables, particularly by the electricity companies. These require different termination and jointing techniques.

Cables for specialist applications such as trace heating or underfloor warming may use materials such as copper-nickel or nickel-chromium alloys.

BS 6360 defines four classes of cable conductor:

- Class 1 has solid conductors
- Class 2 has stranded conductors
- Classes 5 & 6 are flexible cables and cords, with class 6 being more flexible than class 5.

The classes apply to both single core and multicore cables.

The British Standards for the various cable types cover which classes of conductor are allowable for the different cross sectional areas. The standards covering most of the cables used for fixed wiring can have either solid or stranded conductors up to 10 mm sq. CSA. However, in practice it will be found that these cables generally have solid conductors only for cables up to 1.5 mm sq. or 2.5 mm sq. and stranded conductors for the larger sizes.

Flexible conductors are commonly found in small sizes in multicore cable connections to luminaires and fixed equipment but are also used in large single core cables for the final connections to vibrating equipment such as generator.

2.2.6.2 Cable Insulation

The following cable insulation materials shall be used wherever specified.

1. Polyvinyl Chloride (PVC):

2. Thermosetting materials (XLPE & EPR):

3. Mineral Insulated (MI):

4. LSF & LSOH Insulation& Sheaths:

5. 'Fire-Resistant' Cables:

2.2.6.3 Contactors

Wherever possible, contactors shall be incorporated on the sub-main board, distribution boards or other switchgear.

Contact ratings, number of poles and coil ratings shall be as shown on the Contract Drawings. The Sub-Contractor shall ensure that the Contactors are adequately rated for the maximum prospective fault level in the particular part of the distribution system.

2.2.6.4 Isolators

Isolators shall conform with the requirements detailed in Clause 4.07 Part B of this Specification. Unless otherwise specified, isolators shall be designed for load making/load breaking duties.

2.2.6.5 Cable Schedule

The Sub-Contractor shall prepare a suitable cable route schedule for all major l.v. cables within the building. The schedules shall be submitted with working drawings after contracts have been exchanged. During the course of installation, each major cable shall be suitably identified along its route by traffolite cable markers, in accordance with the Sub-Contractor's Cable Schedule.

2.2.7 Electrical Services Associated with Mechanical Services

Work to be carried out under this section includes the supply, installation, wiring to and connection, testing and commissioning of the electrical services associated with the mechanical services and medical equipment. These shall include ventilation, water pumps, kitchen equipment, air conditioning units, medical equipment etc.

The Mechanical Services Sub-Contractor or medical equipment supplies will supply and install the equipment and the associated control panels as shown on the Contract Drawings. The Mechanical Services Sub-Contractor shall be responsible for the interconnection wiring between the power isolator and their equipment via the control panel in accordance with the requirements of the Mechanical Engineer.

2.3 LIGHTING AND SMALL POWER INSTALLATIONS

This section of the specification covers the supply, installation, connection, testing and commissioning of the lighting and single-phase power installation in accordance with the contract drawing and specifications.

2.3.1.1 Wiring System

Final sub-circuit wiring shall be carried out using PVC single core insulated copper cables enclosed in a system of high impact heavy gauge surface metallic conduits and embedded PVC in the fabric of the building. An insulated earth continuity conductor shall be enclosed in all non-metallic conduits.

Wiring in the factory and plant rooms shall be in surface mounted galvanised conduits, trunking or cable trays.

A system of three compartment PVC surface mounted trunking shall also be installed with office areas as shown on the contract drawings as part of the floor cable management system to distributed power, information, and communication and signal cables. Sub-contractor shall supply and install the necessary power outlets mounted on the trunking. The information, communication and signal outlets shall be by others.

All single phase 13 ampere power socket outlets shall be wired using 30 ampere ring main circuit system for raw power while all 'clean line' (UPS Supplied) 13A socket outlets shall be wired using 10A radial circuit system. No more than 4 No. twin socket outlets shall be wired in one radial circuit. All socket circuits shall be wired in 2.5mm^2 pvc insulated single core cables.

2.3.1.2 Accessories - General

Accessories shall comply with the relevant British Standards quoted in the later clauses referring to specific accessories. All accessories shall comply where applicable with the general requirements specified in BS 5733 and BS 6220.

Each type of accessory where applicable shall be of the same manufacture and where necessary of the same maker's catalogue number or description to provide consistent appearance and finish.

Flush mounting accessories shall be fitted into purpose made metal boxes, only and surface mounting accessories shall be fitted onto metal or all insulated moulded boxes as shown on the drawings or in the schedules.

All boxes or sections for use with accessories must incorporate a suitably marked earth terminal accessory plates shall be secured to boxes by not less than two fixing screws. Where these screws do not provide adequate earth continuity to metal plates or plates including parts to be earthed continuity to metal plates of plates including parts to be earthed bonding connection shall be provided from the earth terminal to insulated sleeve. The above requirement shall not apply to the earth terminal on a socket outlet when directly connected to protective conductor. Where more than one phase of a supply exists in a multigang box the following requirements shall apply:

A clearly visible label showing the maximum voltage present shall be arranged as a warning notice before access can be gained to live parts. Wiring and accessories connected to each phase shall be separated from each other by fixed screens or barriers.

2.3.1.3 Switches

All switches for lighting and associated circuits shall comply with B.S. 3676 and shall be quick make and break for use on d.c. supply, pole and rated not less than 20A, 240V for use only on a.c. BS 3676.

Switches for control of water heaters, radiators, and so forth shall be double pole and rated 20A, 240V for use only on a.c. systems and shall include neon pilot lamp.

Switches shall be one-way or two-way or intermediate as indicated on the drawings. Switches for lighting shall be of the metal grid switch system with rocker operation, and in single or multigang formation as detailed on the drawings or in the schedules. Architrave type switch units shall only be fitted if shown on the drawings or in the schedules.

Switches installed in damp areas or outside shall of non-tracking plastic, single pole, operated by external means. The switch enclosure shall be either weatherproof of galvanised metal construction or designed to protection level IP54 of BS 5490 or splash proof plastic to IP54 requirements.

Ceiling switches shall be of the all insulated pull cord type suitable for mounting on a British Standard conduit box and having an overlapping plate. Each unit shall be complete with 1.5m white cord terminating in a white/red accord. The unit shall be rated at 20A at 240V and suitable for inductive fluorescent or resistive loads to BS 3676.

Push buttons in single units or forming part of a multigang unit shall be rated at 20A at 240V. The switch shall be single/double-pole and arranged for push to make/to break the contacts. The bezel shall be marked by an appropriate symbol legend symbol and have a white finish.

The time delay switches shall comply where applicable with the general requirements for switches.

The switch shall be suitably rated to control tungsten filament lighting at 240V a.c. up to a load of 400 watts. The switch shall be of the push on type and returning automatically to off after the time delay. The time delay setting shall be internally adjustable over a time range up to 10 minutes.

Lighting switches shall be flush-mounted, single pole 10 or 15 ampere rating, rocker operated with wide rockers as MK Logic Plus white in door. Grid switches flush-mounted may also be necessary in certain situations.

Circuits on the uninterruptible power supply (UPS) shall comprise of non-standard 13-amp socket outlets complete with non-standard plug tops. The outlets shall be white as MK Logic and shall be indelibly engraved “CLEAN UPS SUPPLY”. The non-standard socket outlets ‘EARTH’ terminal shall not be bonded to the normal power metallic distribution system to facilitate ‘CLEAN EARTH’. A separate earth system shall be provided at the sub-circuit consumer unit and distribution boards specifically for the clean earth system which shall eventually be bonded to the general building externally.

2.3.1.4 Cable Management System

A system of two compartment metal trunking shall be installed as shown on the Contract Drawings in offices.

The system shall be used to distribute power, telephone services and computer data cables. The Sub-Contractor shall supply and install 13A non-standard and standard socket outlets and telephone outlet plates which shall be mounted on removable sections of the trunking cover plate.

Sizes, proposed fixing arrangements and routes of two compartment cable trunking have been detailed on the layout drawings. Proposed routes at each area, in relation to mechanical services, have been detailed but it is the Sub-Contractor’s responsibility to verify the routes of other services before submitting working drawings and commencing with the installation.

The Sub-Contractor shall tape together at 2 metre intervals all single core cable circuits which are enclosed within the cable trunking.

Surface high level and wall fixed metallic cable trays and ladders shall be employed for power distribution as indicated on drawings

The powder coating shall be of uniform thickness of about 180 microns throughout the entire system. Colour uniformity shall also be strictly maintained through the entire system. Where trunking will not be possible for installation, hence floor chasing and feeding from above using special chrome plated columns, in case furniture will not have cable management system.

The trunking we required shall have no sharp edges (edges shall be bend where possible) and shall be reinforced to ensure that it shall not buckle.

Particular attention shall be paid to those areas, where conduits enter the trunking to ensure a dirty and neat installation where power, voice and data cable ways are completely and neatly segregated. A sample section shall be prepared before installation commences.

The Sub-Contractor shall allow for all trunking inter-connecting conduits.

2.3.1.5 Luminaires (Lighting Fixtures)

Luminaires shall be of the type and manufacture as detailed in the schedule of Luminaires.
The luminaires have been itemized with a suggested manufacturer and the statement "equal and approved". "Equal and approved" shall mean equal in electrical characteristics, photometric data, size, cross-sectional area, finish and fixing details.

Luminaires in the factory shall be surface mounted on ceiling slabs. Where suspension is called for the pricing of the luminaire shall be complete with the suspension as specified.

All luminaires shall be supplied complete with gear, lamps and tubes of the voltage specified and shall be power-factor corrected (NPF) in the case of fluorescent luminaires.

All Luminaires will be complete with rated LED lamps (SMD technology only) with 50000 Lifetime L70 (hrs), SDCM ≤ 6.

2.3.1.6 Emergency Lighting

The emergency lighting system shall comprise of maintained luminaires containing one or more lamps, which operate from the internal emergency battery supply only upon failure of the normal mains supply. In addition emergency lighting shall also incorporate sustained (combined emergency luminaires) non-maintained and maintained 'EXIT' lights.

The system design shall conform to BS 5266 parts 1 and 7 1999.

2.3.1.7 Information, Communication and Signal System

Installation of conduit ways and trunking systems shall be installed by the Electrical Sub-contractor to facilitate installation of information, communication and signal system cables and accessories.

The installation of information, communication and signal cables and accessories shall be by others. The Electrical Sub-contractor shall offer these specialist due attendance and shall be deemed to have allowed for the same in his tender.

2.3.1.8 Socket outlets

Socket outlets for 240V a.c. supplies shall be of the 13A rectangular pin single pole switched type complete with shutters and shall comply with BS 1363. Each socket outlet shall be provided with a plug of the appropriate rating. Plugs for 13A socket outlets with sleeved insulated pins shall be made in hard plastic

complying with BS 1363 and shall be supplied compete with 13A or 3A fuse links to BS 1362 in accordance with the drawings. Plugs for ratings of 2A, 5A, or 15A shall comply with BS 546 and be made in hard plastic. Where detailed on the drawings or in the schedules plugs made of resilient material shall be supplied.

Weatherproof switch socket outlets and plugs for outside use shall be of all metal enclosure for surface mounting. The switch shall be singe pole/double pole having a substantial operating arm with ON/OFF positions clearly indicated. The outlet socket shall be protected when not in use with a screw-on metal cap attached to the unit by a chain/hinged spring closing flap incorporating a gasket. The metal enclosure shall have a hop dip galvanised finish and shall be protected by 30mA RCD devices.

2.3.1.9 Cable Outlet Units

Outlet plates for cables or flexible cords shall be similar to switch plates with 60.3mm fixing centres and complete with not less than two fixing screws. Terminals shall be provided to accommodate incoming wiring and outgoing cables or 1.5mm^2 flexible cord. The unit shall be unfused and shall incorporate an outgoing cable clamp or cord grip. The cover plate of white moulded plastic shall have a smooth aperture for the cable/flexible exit.

2.3.1.10 Earthing

The whole of the protective system shall have combined resistance to earth not exceeding 10 ohms. Should the values exceed 10 ohms, reduction in resistivity shall be achieved by linking earth electrodes below ground.

Each down conductor shall be provided with a testing joint in such a position that while not inviting unauthorised interference, is conveniently situated for testing.

Earth electrodes shall be situated at least 1m from foundations.

The Earthing network for the lightning protection system shall be bonded to the switchboard's Earthing system in the various blocks.

2.3.1.11 Continuity Tests

The entire networks shall be tested for continuity including the testing of each down conductor.

2.3.1.12 Testing of the Installation

After completion and before commissioning, the entire installation shall be subjected to the following tests and any faults found shall be rectified.

(a) **Polarity:**

All fuses and control devices shall be connected in live conductors only.

(b) **Insulation Resistance:**

When tested with a 500 V.dc. supply the insulation resistance between conductors of live lines, lines and neutral, line and earth, neutral and earth shall not be less than 1 megohm.

(c) **Earth Continuity Resistance:**

Resistance of earth continuity measured from a consumer unit to the farthest end of a circuit shall not exceed 0.5 ohm.

2.3.1.13 Testing and Commissioning

Testing and commissioning shall be carried out in accordance of this specification. All tests shall be carried out in the presence of and to the certification of the Engineer.

2.4 FIRE DETECTION AND ALARM SYSTEM

2.4.1 Type of System

The system shall be operable manually and automatically and shall be suitable for protection of life and property. It shall cover those parts of the building where there is a high risk to life in event of a fire anywhere in the building.

The system shall be of the Analogue Addressable type, with **Continuous** monitoring of analogue quantities and automatic adjustment of Alarm Threshold, designed in accordance with this Specification. The system shall allow continuous monitoring of data from the detectors by the control panel and shall be able to identify call points, detectors and interface units and pin-point sounders, repeat and mimic panels if any. The system shall be based on **the principle of central processing**.

Microprocessor systems shall be of modular design and consist of suitable standardized hardware and software packages. It shall thus be possible to expand and modify systems in future easily and without tampering with the existing working modules. In addition software routines shall be designed to provide automatic restart after power failure etc., so that the system will become fully operational without manual intervention. The main operating system, system configuration data and monitoring software shall be contained in battery-backed ROM, may be left in the ROM or automatically copies into the RAM area on booting up. Field-programming shall be carried out by means of fixed or plug-in keyboards or by hand held computers. The user data shall be safe-guarded by permanently fixed Lithium batteries or by storage in EPROM's.

The capacity of the data-processing system shall include 25% spare capacity.

2.4.2 Data Transmission

The communication faults shall be announced on both sides with transmission errors being indicated on the fire panel. Such faults shall not lead to deterioration of the Fire Panel Operation.

Transmission errors detected by a receiver shall deny acknowledgement of the message and request repetition by the sender. Receipt of three consecutive errors shall result in the fault message being displayed at the fire panel.

The system shall incorporate means for monitoring and circuit isolation complying with this specification.

2.4.3 Zoning

The zone divisions and associated circuiting shall comply with BS 5839. The complex shall be divided into zones as specified.

Where cable loops are specified, each leg of cable between the Control Panels and the first device enroute shall pass through different zones as soon as practicable after leaving the panel.

A single fault in any zone shall not prevent the operation of other zones and shall not remove protection from areas greater than permitted by this Specification.

Equally a single short or open circuit fault on any part of the loop shall not cause system malfunction, loss of operation, power or ability to report an alarm in the unaffected areas.

2.4.4 Training

The Tenderer shall allow for the training of two of the Client's Technicians to a level where they are sufficiently confident and proficient in managing, trouble-shooting and maintenance of the system including programming of the system and devices as desired.

2.4.5 Standards and Regulations

The design, manufacture, selection, installation, testing, commissioning and subsequent maintenance of all equipment and materials described in this Specification shall comply with the requirements of:

- The current editions of BS 5839, BS 5445 and BS 5446,
- The current editions of EN54,
- The current editions of BS 5266, BS 2560 and BS 5499.

All equipment, apparatus and devices shall be as Menvier, GE Security (Aritech) or equivalent and approved.

2.4.6 System Operation

2.4.6.1 Access Codes

The system shall be designed to operate at 4 security levels, as follows:

Level 1:	No access Code-operator
Level 2:	Access Code – Maintenance
Level 3:	Access Code – Commissioning
Level 4:	Access Code – Supervisor

Access codes shall be allocated and entered into the panel by the Supervisor, who shall have the ability to change codes at any time. Facilities must be provided for entering operator names against each access code.

2.4.6.2 Operation

The system shall be designed to operate with the minimum of operator training. Basic fire alarm functions shall be completely self – explanatory, and shall be understood by a person with no training.

The occurrence of a fire alarm shall indicate all relevant text and zone information without operator intervention.

The operation of a fire or fault signal, or a keyboard operation carried out by an operator, shall not inhibit or delay in any way the receipt of additional alarms.

Should any part of the system be isolated, disabled, or placed in a maintenance mode, then a lamp on the front of the panel must illuminate to indicate the systems abnormal status.

When the system is normal with no event to report, the main control panel LCD shall display time and date, the name of the site, make and model of the system control equipment.

2.4.6.3 Fire Operation

An alarm received from a fire sensor or other devise shall cause the following actions to occur immediately:

- Common Fire lamps to illuminate
- Zone/Super zone lamp to illuminate

- The LCD display shall indicate in text the following:

    - The zone
    - Device type
    - Actual location and address
    - Event number
    - Date
- Panel buzzer to sound continuously
- Common sounders to operate in a pre-determined manner.
- Zone sounders to operate (if applicable)
- Required control functions to operate
- Remote text or lamp displays to operate
- Graphics computers to indicate alarm status
- Fire Brigade signal to operate.

Pressing an appropriate key shall silence the alarms, except the panel buzzer, which must sound intermittently for 0.5 second, every 20 seconds.

Pressing the "Reset" button shall reset the system to normal. Should an alarm condition still exist, then the above sequence of events must re-occur.

2.4.6.4 Fault Operation

A fault signal received from a fire sensor or other device, or from the panel or battery charger, shall cause the following to occur immediately, where appropriate:

- Common Fault lamps to illuminate
- Zone/super zone lamp to illuminate
- Display to indicate in text:

    - Fault Description
    - Zone Number
    - Detector Number
    - Exact Location

- Panel buzzer to sound continuously
- Required control functions to operate
- Remote text or lamp displays to operate
- Graphics computers to indicate alarm status.

Pressing an appropriate key shall silence the alarms. The visual alarms are to remain. In the event of more than one fault signal occurring simultaneously, then the test display must rotate between the alarms.

Should a fire alarm occur while a fault is displayed, then the fire alarm must replace the fault signal, which must restore after the fire alarm has reset.

Pressing the "Reset" key must reset the system to normal. Should a fault condition still exist, then the above sequence of events must re-occur.

2.4.6.5 Key Features of the System:

- 2 Zone L.E.D. indication with facilities to expand display if required.
- Alphanumeric 8 line 40-character liquid crystal display.
- Integral printer.

- An Amber system common "fault" L.E.D. indicator with individual Amber L.E.D.'s for the following:

  a) Pre-alarm
  b) Disabled devices/loop/alarm lines.
  c) System test.

- Push button control of Sound Alarms, Silence Alarms, with L.E.D. indication and Reset.
- A manual evaluation (sound alarms) push button shall be provided to operate the external sounders without causing other panel control relays to be activated. However, should a true alarm occur, all functions would occur as programmed.
- The alarm activation of any initiation circuit shall not prevent the subsequent alarm operation of any other initiation circuit.
- System control access shall be limited by programmable 4-digit numeric security code.
- The system shall operate on 24 volts DC provided by power supply unit, which is transformer, fed by mains voltage. In the case of mains failure, the system shall switch automatically to the stand-by batteries. These shall have enough capacity to support the system for 24 hours with 30 minutes of general alarm ringing.

It shall be possible to increase this to 72 hours with 30 minutes of general alarm ringing if required.

The batteries shall be monitored for low batter condition/disconnection and shall be audible and visually indicated on the control panel.

- Each loop shall be capable of driving up to 120 addressable devices over a maximum loop distance of 2 km.
- The system shall be capable of providing alarm and relay extensions, which can be connected at any address on the loop thus eliminating the need to wire directly from the panel. All extensions should be fully programmable via the control panel software.
- All external circuits shall be monitored for open circuit, short circuit and fuse failure.
- Loop address locations shall be monitored for device type fitted and any deviations from programmed allocation visually and audibly indicated.
- Loop address locations shall be monitored for device removal.
- System shall have a minimum of 2 independently monitored alarm lines per loop.
- It shall be possible to disable/enable individual devices, zones, loops and alarm lines for maintenance purpose.
- Panel shall have the facility for 1 man test mode. In this mode, external alarms will sound for 3 seconds then reset and give 3-second alarm to indicate reset has taken place. Each device test shall be indicated on Control panel printout as a test activation.
- It shall be possible to view the Analogue level of each detector from the control panel without initiating an alarm.
- Panel shall have Dirty Detector and Pre-alarm facilities with adjustable pre-alarm and full alarm thresholds.
- The system shall have day/night facilities to provide an esensitized level of detection programmable to clients' requirements.
- The system shall be capable of onsite programming to accommodate system expansion and facilitate changes in operation.
- All software operations shall be stored in non-volatile programmable memory within the control panel.
- Loss of primary and secondary power shall not erase the instructions stored in memory.
- The system shall have the capability of recalling alarm and fault conditions in chronological order for the purpose of creating an event history.
- Should a fault condition be present an audible fault Buzzer will sound. If silenced; the buzzer will resound at pre-programmed time intervals to act as a reminder that the fire alarm system is not fully functional.

- The control panel shall have 2 x R.S. 232 ports to allow programming and connection to ancillary equipment.
- The Control panel shall have facilities to operate repeater/mimic panels from a dedicated output and also capable of supporting repeater panels wired directly on the loop.
- It shall be possible to network analogue panels to give configuration of 24 loops.
- All panels and peripheral devices shall be the standard produce of a single manufacturer.

2.4.6.6 History Recording and Reporting

The AACIE shall contain a history buffer that will be capable of storing input/control events. Each of these events will be stored and time and date stamped with the actual time of the activation. The contents of the History Buffer may be manually retrieved, one event at a time, on the LCD or the printer.

The History Buffer shall use non-volatile memory. System that uses volatile memory or battery-backed memory for history storage shall not be acceptable.

2.4.7 System Components

The system shall comprise of but not restricted to the components outlined below:

2.4.7.1 Annunciator and Control Panel

The Control Panel shall incorporate a QWERTY keyboard and printer, fire indicator, user instructions and controls, power indicator, warning indicator, fault indicator, function keys, liquid crystal display (LCD) with automatic backlighting and integral power supply system.

The fire alarm control panel shall be mounted on the wall. The cabinet shall be made of sheet steel, with lockable door, viewing panel and solid state microprocessor based electronics.

The main annunciator/control panel shall be located at the Ground floor entrance lobby.

2.4.7.2 Interface Units

These shall be used to interface the fire detection and alarm system with remote sites and devices such as the fire brigade, firefighting systems etc.

2.4.7.3 Printer

The control panel shall incorporate an inkjet printer with an audible signal for end of paper and fault.

The printer shall be the automatic type, printing time, date, location, device description, category and condition. The printer shall provide a hard copy print out of all changes in status of the system and shall time stamp such minutes with the current time of day and date. The printer shall be incorporated in the main analogue addressable control and indicating equipment (AACIE) housing.

2.4.7.4 Break Glass Unit

The break glass unit shall be mounted at a height of 1350mm from FFL and shall be suitable for flush mounting. The break glass unit shall be addressable with an LED indicator incorporated as standard to confirm that the unit has operated.

2.4.7.5 Heat Sensors

The heat detector shall be analogue intelligent addressable type capable of being configured by the control panel to operate as a rate of rise heat detector. The base shall be lockable and common with that of the

smoke detector. It shall also incorporate a fixed temperature element operating at a predetermined temperature.

2.4.7.6 Smoke Detector

The smoke detector shall be analogue addressable optical type with in-built processing capacity. The base shall be lockable type and common with that of the heat detectors.

2.4.7.7 Electronic Sounder

The sounder shall be weatherproof type, suitable for 24V DC, low current consumption with high output.

2.4.7.8 Visible Flash Light

The unit shall be weatherproof type, suitable for 24V DC, low current consumption with high visible flash light

2.4.7.9 Short Circuit Isolators

Short circuits isolators shall be provided to protect loop integrity in the event of a short circuit fault occurring on the loop. They shall latch out either side of the short circuit fault, effectively disconnecting the faulty cable.

The short circuit isolator shall have an indicator LED visible throughout the front cover, which will illuminate when latched out due to short circuit cable fault.

The loop should be divided into sections not greater than a conventional zone and each section of the loop separated by a short circuit isolator, to a maximum of 20 per loop.

2.4.8 Software Control

2.4.8.1 General

The System shall at all times be under software control. Two types of software shall be provided, the operating programme and the configuration programme.

2.4.8.2 Auto Configuration

Upon switch-on, the panel shall, automatically and without manual intervention, programme itself to operate as follows:

1. Be fully functional (Fire and Fault)
2. All device addresses present to be recorded in memory
3. All device types to be recorded in memory
4. Devices to be automatically calibrated.
5. Common fire lamps must operate
6. Common sounder outputs (2) must operate
7. Common fault output must operate
8. Display must operate

2.4.8.3 Manual Programming

Additional configuration data, to tailor the system to the individual application, must be able to be programmed into the system. This programming must be able to be done both via the panel keypad, and by means of an external computer. In both cases it must be possible to save the programme to disk.

2.4.8.4 Storage of Software

All software, both the operating programme and the configuration data, shall be held in solid state memories. In particular, software shall not be held on magnetic tapes or discs, or any device requiring mechanical moving parts.

2.4.8.5 Operating Programmes

The operating programme must be held in permanent, non-volatile, read-only, EPROM memory, which shall not be erasable or alterable. Each EPROM shall be permanently labelled with a part number, and a version and issue number, which shall be traceable to a software manual.

The operating programme shall provide all auto-start and self-programming features to provide an operational system, without any manual programming, as described above.

2.4.8.6 Configuration Data

All configuration data shall be stored in non-volatile, EEPROM read-only memory, which can be electrically erased for editing purposes. The EEPROM used must retain all programmed data, even when the system is completely powered down.

Printed circuit mounted batteries, such as lithium cells, for retaining memory contents, are not acceptable.

All configuration data must be able to be edited through the keyboard.

2.4.9 Control and Indicating Equipment

2.4.9.1 General

Equipment shall be provided for the reception, indication, control and relaying of signals originating from detectors or call points connected to it and for the activation of alarm sounders, signalling devices and transmission/receipt of signals to/from remote locations.

Control panels shall be of modular design employing plug-in cards allowing future expansion and tailoring of detection zones and outputs to meet the Engineer's requirements.

Where plug-in zone modules are used, these shall operate independently of other zone modules.

Operation of the control panel in case of alarm or fault shall be achieved by simple guided instructions with visual indicators on the control buttons.

It shall be possible to set any zone to test mode for testing of detectors and call points without raising an alarm condition. It shall also be possible to test sounder circuits, by operation for one second and off for 10 seconds, repeated for as long as required.

Monitoring of detection and alarm circuits shall be provided in accordance with BS 5839.

In all systems the electrical power for operation of detectors shall be provided through the loop circuit wiring.

2.4.9.2 Workmanship

The installation and method of fixing of all devices covered by this section of the Specification, shall be co-ordinated with the building fabrics and finishes to which they are fixed.

All devices covered by this section of the Specification, shall be fixed true and level to the surfaces on which they are mounted to a tolerance of ±5mm.

Under no circumstances shall Detectors and Alarms be fixed to temporary or movable parts of the building fabric, including doors and furniture.

2.4.10 Integration with Other Systems

2.4.10.1 General

The Fire Alarm system where required shall be integrated with associated and ancillary systems. These shall include lifts, Public Address, Security System, sprinkler system, HVAC System.

Ancillary equipment shall be equipped with means of isolation and disabling of Automatic operation so that servicing and maintenance can be carried out in complete safety.

Unless otherwise specified, power supplies for associated and ancillary equipment shall be provided by means completely independent of the Fire Alarm System Power Supply. These power supplies shall comply with this Specification where their operation is essential to the functions of the Fire Alarm System.

Indicators and detectors associated with ancillary equipment shall be taken into account in calculating the maximum load of the Fire Alarm System power supply.

Faults in equipment for other functions shall not affect the performance of the Fire Alarm System.

Extension and alterations to associated systems including the isolation and removal of parts, shall be possible without affecting the operation and performance of the Fire Alarm System.

2.4.10.2 Interface Units

Interface units shall be provided to send signals to and receive signals from associated and ancillary systems. Unless otherwise specified, all signals shall be via volt-free relay contacts.

The volt-free relay contacts shall be provided by means of addressable input and output modules of the fire alarm detection loop, each module representing a single address.

Addressable input and output modules shall be compatible with the system to which they are connected, and shall be of the type that draw their power supply from the detection loop.

Contacts shall have a minimum rating of 5 Amp inductive at 240V a.c.

The Sub-Contractor shall be responsible for the interface and all wiring and connections between interface units and the system to which they are being interfaced.

2.4.10.3 System Requirements

Fire alarms in integrated systems must always take priority over all other systems and must not be delayed in operation by any manual or automatic event.

The layout of control panels in integrated systems shall be arranged so that Fire Alarm controls cannot be confused with other controls.

Operation of other system controls shall have no effect on the operation of the Fire Alarm System.

2.4.10.4 System Monitoring

All wiring systems for communications, detection and alarms shall be monitored for open and short circuits, removal of detectors as well as Alarm/Healthy conditions.

All faults shall be registered by audible and visible fault alarms, the latter being yellow coloured LED's.

Alarms due to system fault as opposed to a fire condition shall be restricted to the panel buzzer only.

2.4.10.5 Wiring Systems

The Sub-Contractor shall be responsible for the supply, installation, testing and commissioning of all the wiring/cabling systems required to provide a complete and operable system.

All wiring shall be in highly durable fire resistant cables as Pirelli FD200 complying with IEC 331, BS 6387, IEC 1034, BS 7622, IEC 754 – 1, BS 6425 – 1, IEC 332 – 1, BS 4066 – 1, IEC 332 – 3 and BS 4066 – 3. Cables shall be drawn in high impact heavy gauge PVC conduit installed in ceiling spaces, chased into walls or cleated onto surfaces and shall be routed through areas of low fire risk.

Voltage drops in cables shall not exceed the limit which will prevent devices operating within their specified range at all times.

Cross-sectional area of any conductor shall be at least 1.5mm2.

Overhead lines shall not be used for any Fire Alarm System Interconnections.

The routing of cables shall be arranged so that damage to a cable in a single compartment does not affect the correct operation of devices in any other compartment.

Conductors carrying fire alarm power or signals should be separated from conductors used for other systems.

Cables should be installed in accordance with good practices recommended in the latest edition of the IET Wiring Regulations.

2.4.11 Power Supplies

2.4.11.1 General

Power supplies shall be obtained from the 415/240V 50Hz, single or three-phase mains supply with a backup from an automatic connected battery powered standby supply provided by the Sub-Contractor in case of mains supply failure.

The mains supply shall be obtained from the main distribution panel at the point of supply, via an acceptable switch/fuse, fuse/switch or circuit breaker dedicated for that purpose and which is lockable, coloured red and labelled `FIRE ALARM SUPPLY DO NOT SWITCH OFF'.

A fault alarm shall be raised if the battery voltage falls below 84% of the nominal specified voltage.

Upon restoration of the mains supply following an interruption, the power supply shall automatically revert to normal operation.

2.4.11.2 Batteries

Batteries shall have a guaranteed minimum life expectancy of 10 years, under the specified loading and environmental conditions.

The batteries used shall be of the sealed gas-tight lead-acid type specifically designed for emergency power sources and complying with the relevant standard. The outer container shall be made of acid resistant high impact strength ABS plastic. The electrodes shall be of high purity lead separated by a gel electrolyte enabling full recombination of gases evolved during charging. An automatic safety valve shall be provided.

Each battery shall have a storage capacity sufficient to maintain the system plus 20% spare capacity for 72 hours in the standby mode and to supply the full alarm load for one hour, without the terminal voltage falling below 84% of its nominal value.

2.4.11.3 Battery Chargers

Battery chargers shall comply with this Specification and be suitable for operation from 415/240V 50Hz, single or three phase systems as required.

The battery charge shall be of the automatic two-rate constant voltage type operating of the float charging principle. The charge shall be designed to compensate for variations in ambient temperature in accordance with this Specification.

Provision shall be made for a boost charge, under manual control, at a current sufficient to fully recharge a completely discharge battery in not more than 24 hours.

The battery charger shall have a monitoring system connected to the Fire Alarm panel which will raise an alarm in the event of a battery and/or charger fault or malfunction.

The monitoring system shall raise an alarm if the battery voltage falls to 84% of its nominal value and if the voltage falls to 80% of the nominal value the battery shall be automatically disconnected.

The transformer shall be double wound with an earthed metallic screen between primary and secondary windings, which shall be wound for the specified voltage, rating and supply system frequency.

2.4.11.4 Enclosures

Each battery and its charger shall be housed in a substantial steel cabinet or cubicle with the battery in a separate compartment.

Cabinets with a total installed weight not exceeding 25kg shall be wall mounted.

The Sub-Contractor shall ensure that the wall and/or floor supporting the cabinet or cubicle is adequate for the purpose.

Enclosures shall be rigidly constructed from zinc-coated sheet steel, stiffened by folding or reinforcement. The sheet shall not be less than 914mm thick for wall mounted enclosures. After thoroughly degreasing all enclosures shall be finished with an oven baked epoxy powder paint.

The interior surfaces of the battery compartment shall be treated with an acid and alkali resisting finish.

Access to the enclosures shall be via an easily accessible door with adequate space for replacement of batteries and any other parts of the charger. Doors shall be double hinged and stiffened to ensure adequate rigidity.

The batteries and charger components shall be arranged for ease of access and any maintenance required.

Warning labels shall be provided drawing attention to the presence of mains voltages. Incoming and outgoing cables shall be specially separated.

Enclosures shall be suitably ventilated to ensure proper ventilation of both the battery and charger compartments. The ventilation system shall be arranged to ensure that the concentration of Hydrogen within the enclosure shall not exceed 1% and that the internal temperature does not exceed 40°C.

2.4.11.5 Workmanship

The installation of power supply equipment, shall be fully co-ordinated with the Fire Alarm Control Panels, building fabrics and finishes provided by others, in an acceptable manner.

The method of fixing and the mounting height of flush and surface mounted power supply units, shall be properly coordinated with the fabrics and finishes.

Provision shall be made for the easy entry and termination of incoming and outgoing cables.

All power supply units shall be fixed true and level to the surfaces on which they are mounted with a tolerance of ±0.5mm.

2.5 SPECIALIST WORKS

2.5.1 Scope of Works

This section of the specification covers the supply and installation of conduits, cable trays, trunking systems, draw and adaptors boxes underground ducts and lead pipes necessary for the distribution cables in accordance with the contract drawings and specifications for the following specialist services:

- Structured Cabling Installations
- CCTV Surveillance and Access Control Systems
- Audio Visual facilities and Public Address systems
- *Mechanical Services* Installations
- etc.

All conduits shall be adequately sized to suit system and shall be complete with draw-wire. Conduits less than 25 mm dia shall not be acceptable.

2.5.2 Attendance

The Sub-Contractor shall allow for attendance to the respective specialist in the appropriate price schedule of the Bills of Quantities.

The equipment for the above systems shall be supplied by others under separate Sub-Contractors.

PRICE SCHEDULES

3 PRICE SCHEDULES

3.1 General Notes to Tenderers

1. The Bills of Quantities form part of the contract documents and are to be read in conjunction with the contract drawings and general specifications of materials and works.

2. The prices quoted shall be deemed to include for all obligations under the sub-contract including but not limited to supply of materials, labour, delivery to site, storage on site, installation, testing, commissioning (**excluding 14% VAT**).

3. All prices omitted from any item, section or part of the Bills of Quantities shall be deemed to have been included to another item, section or part thereof.

4. The brief description of the items given in the Bills of Quantities are for the purpose of establishing a standard to which the sub-contractor shall adhere. Otherwise alternative brands of **equal** and **approved** quality will be accepted.

5. Should the sub-contractor install any material not specified here in before receiving **written approva**l from the Project Manager, the sub-contractor shall remove the material in question and, **at his own cost**, install the proper material.

6. The grand total of prices in the price summary page must be carried forward to the **volume 1**.

7. The Bills of Quantities are divided generally into three sections:-

   a. Contractual Requirement – Bill 1

   The sub-contractor shall study the conditions and make provision to cover their cost in this Bill. The number of contractual items to be priced by the Tenderer have been limited to tangible items such as site office, temporary works and others. However the Tenderer is free to include and price any other items he deems necessary taking into consideration conditions he is likely to encounter on site.

   b. Installation Items – Other Bills

   The brief description of the items in these Bills of Quantities should in no way modify or supersede the detailed descriptions in the contract Drawings, conditions of contract in volume 1 and specifications. The unit of measurements and observations are as per those described in the contract documents.

   c. Summary

   The summary contains tabulation of the separate parts of the Bills of Quantities carried forward with provisional sum, and any prime cost sums included. The sub-contract shall insert his totals and enter his grand total tender sum in the space provided below the summary.

   The grand total tender sum shall be carried forward to form of Tender

3.2 Bills of Quantities

(Continue to the next page)

PROPOSED FIT OUTS AND RE-ORGANIZATIONS FOR THE LABOR WARDS IN NAIROBI HOSPITAL

GENERAL ELECTRICAL INSTALLATIONS

PRICED BILL OF MATERIALS

SECTION D.W. 1.0 TITLE: PRELIMINARIES AND CONTRACTUAL REQUIREMENTS

Item	Description		Qty	Rate (Kshs)	Total (Kshs)
D.W.1	**CONTRACTUAL REQUIREMENTS**	-			
A	Preparation of 'Working Drawings", printing and distribution as specified. Drawings to include:	Sum	1		-
B.	Preparation of 'As Built Drawings", printing and distribution as specified. Drawings to include:				
	(a) Blue Prints - 4 sets of each.	Sum	1		-
	(b) AutoCAD on CD – 2 No.	Sum	1		-
	(c) Operational Instructions, Manuals and Test Certificates	Sum	1		-
C.	Provision of Performance Bond as stated under clause 5 of the published conditions of sub-contract.	Sum	1		-
D.	Allow for removal of existing equipment/items and handing over to the client.				-
E.	Any other item necessary to complete the installations in this section (please state)				
Total Carried to Main Summary of Prices					**-**

	SECTION DW 2; Power Distribution System				
S/N	**Description**	**Unit**	**QTY**	**Rate (Kshs)**	**Total (Kshs)**
A.	35mm² XLPE/PVC Four (4) Core Copper cable from the NHMP Power Centre to the Proposed Labour Ward Main Power DB	M	150		-
C.	12 way 125A TPN Raw Distribution Board Complete with Outgoing Breakers, Spareways and Blanking Plates as shown on the Contract Drawings.	No.	1		-
D.	8 way 63A SPN UPS Distribution Boards Complete with Outgoing Breakers, Spareways and Blanking Plates as shown on the Contract Drawings.	No.	1		-
E.	16mm² XLPE/PVC Four (4) Core Copper cable from the Raw Power DBs to Clean Power DBsVia UPS BYPASS & UPS	M	100		-
F.	Any Other item (s) needed to complete the installation in this section (Please state)				
	Sub - Total Carried Forward to the Main Summary Page				-

SECTION D.W. 3.0: ARTIFICIAL LIGHTING					
S/N	Description		Qty	Rate (Kshs)	Total (Kshs)
	ARTIFICIAL LIGHTING	-			
	Lighting points wired in 1.5mm2 pvc/sc copper cables drawn in 20mm diameter pvc heavy gauge conduits complete with switching accessories, Switches, etc as shown on drawings.	No	112		-
	The following luminaires complete with rated LED lamps (SMD technology only) with 50000 Lifetime L70 (hrs), SDCM ≤ 6 as specified:				
A.	TYPE (J4) - IP43 38W, 600 x 600mm Backlit LED Light Panel Luminaire as Specifications and Approved by Engineer	No	2		-
B.	TYPE (J4E) - IP43 38W, 600 x 600mm Backlit LED Light Panel Luminaire as Specifications and Approved by Engineer	No	1		-
C.	TYPE (J2) - IP43 38W, 300 X 1200 mm LED Backlite Skyblue Panel Luminaire as Specifications and Approved by Engineer	No	2		-
D.	TYPE (J2E) - IP43 38W, 300 X 1200 mm LED Backlite Skyblue Panel Luminaire as Specifications and Approved by Engineer	No	7		-
E.	TYPE (N) - IP65 18W, 240V Low Profile Surface Mounted luminaire fitted with microwave sensor and Emergency Kit	No	8		-
F.	TYPE (D) - IP65 20W, 240V, 120mm Backlit Surface/ceiling Mounted LED Donlight Light Luminaire	No	40		-
F.	TYPE (DE) - IP65 20W, 240V, 120mm Backlit Surface/ceiling Mounted LED Donlight Light Luminaire	No	6		-
G.	TYPE (S)-15W LED, IP65 Polycarbonate Triple Ant-corrosive luminaire	No	8		-
H.	TYPE (L) 9W, IP20 LED Downlighter luminaire to Specification.	No	12		-
I.	TYPE (EL) - 8W Dual Sided Ceiling Mounted LED Exit Light to specifications.	No	2		-
J.	TYPE (EL) - 8W One Sided Ceiling Mounted LED Exit Light to specifications.	No	1		-
K	Light Motion sensor (occupancy sensor).	No	15		-
L	Wiring to Bed Head Luminaire and room light switching compete with two way switching (separate circuits).	No	8		-

Total Carried Forward to Next Page -

SECTION D.W. 4.0 TITLE: POWER INSTALLATIONS					
S/N	**Description**		**Qty**	**Rate (Kshs)**	**Total (Kshs)**
	The following power outlets complete with 25mm diameter PVC Heavy gauge conduits, all accessories and wiring as specified:	No.	109		-
A.	13A Twin Water Tight Metal Glad Socket outlet	No	2		-
B.	13A Twin Standard Socket outlet in "White" Color for Normal power	No	25		-
C.	Work Station 1 comprising with Twin Socket Outlet for Raw Power, Twin Socket Outlet for Clean Power and Twin Data Point Outlet.	No	6		-
D	Work Station 3 comprising with 2NO. Twin Socket Outlet for Clean Power and 1NO.Dual Data Point Outlet.	No	10		-
E	Work Station 6 comprising with 1NO. Twin Socket Outlet for Clean Power and 1NO.Data Point Outlet for TV	No	8		-
F	15A Unswitched Spur Socket outlet	No	4		-
G	32A SPN Isolator complete with 2x4.0 Sq mm pvc/swa/pvc CU Cable (cable approx. 45metres) and associated accessories	No	2		-
H	20A D.P. Switch complete with 3x2.5 sq mm SC CU Cables and associated accessories	No	25		-
I	Wiring to Bed Head Luminaire and room light switching compete with two way switching (separate circuits).	No	8		-
J	13A Single Standard Socket outlet for X-Ray Viewer	No	7		-
K	Allow for wiring with 3x2.5sq mm PVC SC CU cables drawn in 25mm dia. pvc conduits to the Bed head unit - Critical Power Supply line (Workstation 2)	No	12		-
L	Wireless Point Outlet complete with Conduit only & Draw wire.	No	2		-
M	TV outlet complete with Conduit only & Draw wire	No	7		-
N	CCTV Camera point Outlet complete with Conduit only & draw wire.	No	2		-
O	Access Control point Outlet complete with Conduit only & draw wire.	No	2		-
P	Nurse Call point Outlet complete with Conduit only & draw wire.	No	9		-
Total Carried Forward to Collection Page					-

SECTION D.W. 5.0 TITLE: CABLE MANAGEMENT SYSTEM					
S/N	**Description**		**Qty**		**Total (Kshs)**
5	**CABLE MANAGEMENT SYSTEM**	-			
	Supply, installation, testing & commissioning of the following complete as specified: -				
A	300x50mm Heavy Gauge Cable Tray complete with angles, bends etc as shown on contract drawings	M	50		-
B	250x50mm 2-Compartment uPVC Trunking complete with external/internal angles, covers, bends etc as shown on contract drawings	M	30		-
C	250x50mm 2-Compartment uPVC Below Worktop Trunking complete with covers as shown on contract drawings	M	10		-
D	32mm Heavy gauge PVC Conduits in Floor Screed	M	150		-
E	Any other item necessary to complete the installation in this section (Please state).	Sum			
Total Carried to Main Summary Page					-

6	SECTION DW 6; FIRE DETECTION AND ALARM SYSTEM				
S/N	**Description**	**Unit**	**Qty**	**Rate (Kshs)**	**Total (Kshs)**
	For the supply and installation of the following complete with associated accessories to complete the installation as specified and shown on the contract drawings:				
	2 Zones, 1 Loops Analogue Addressable fire detection and alarm panel complete with printer and with associated accessories.	No.	1		-
	Combined Ionization and Photoelectric type Analogue Addressable smoke detector mounted on ceiling or on wall complete with 25mm diameter HG PVC conduit work and LSZH fire resistant cabling as specified and shown on the contract drawings as follows;	No.	16		-
	Analogue addressable Fire alarm combination bell/visual strobe complete with 25mm diameter HG PVC conduit work and LSZH fire resistant cabling as specified and shown on the contract drawings as follows;	No.	9		-
	Analogue Addressable Fire alarm combination bell/visual strobe complete with 25mm diameter HG PVC conduit work and LSZH fire resistant cabling as specified and shown on the contract drawings as follows;	No.	2		-
	Allow for programming of the alarm system as described in the fire alarm sequence of operation	Sum	1		-
	Allow for programming of the alarm system as described in the fire alarm sequence of operation to work with the existing Fire Alarm Panel for other floors	Sum	1		-
	Sub - Total Carried to the Main Summary Page				-

7	SECTION DW 7; UPS POWER SUPPLY SYSTEM				
S/N	**Description**	**Unit**	**QTY**	**Rate (Kshs)**	**Total (Kshs)**
	Uninterruptible Power Supply (UPS) Supply & Installation of the following complete as specified:				
A.	20 kVA 3 Phase in 3 phase out True-on-line double conversion uninterruptible Power Supply unit (UPS) complete with 10 Minutes Autonomy, dual power supply unit, Electronic Voltage Booster, Li-on Batteries and accessories as specified and shown on the drawings. The Approved brands are APC, ABB, Eaton or approved equivalent.	No.	1		-
B.	Allow for 40A Change Over Switch for the UPS to allow for Isolation during maintenance.	No.	1		-
C.	Installation, testing & commissioning of the above UPSs	Sum	3		-
D.	Labeling, Documentation, 1year Warranties, associated Training and certification.	Lot	1		-
E.	Allow for interfacing with other System like Fire Detection & Alarm System and BMS as call for and approved by Engineer and shown on the drawings.	Sum.	1		-
F.	Any other item necessary to complete installation in this section (Please state)	Sum			
	Sub - Total Carried to the Main Summary Page				-

PROPOSED FIT OUTS AND RE-ORGANIZATIONS FOR THE LABOR WARDS IN NAIROBI HOSPITAL		
GENERAL ELECTRICAL INSTALLATIONS		
PRICED BILL OF MATERIALS		
Item	**Description**	**Total (Kshs)**
1	**SECTION 1** Preliminaries and Contractual Requirements	-
2	**SECTION 2** Power Distribution	-
3	**SECTION 3** Artificial Lighting	-
4	**SECTION 4** Power Installations	-
5	**SECTION 5** Cable Management	-
6	**SECTION 6** Fire Detection and Alarm	-
7	**SECTION 7** UPS Installations	-
	Sub Total	-
	Rates are Inclusive of VAT	
Summary Carried Forward to Main Collection Page		-

3.3 Schedule of Unit Rates

The tenderers shall provide a schedule of unit rates (under Tables (a) and (b) below) that shall be used to build up rates for variation items not specified in the bill of quantity.

This section, and the terms filled herein shall form part of the contract, and shall be considered locked for the duration of the project.

Rates filled herein shall be evaluated as part of the tender evaluation process. Attention is drawn to the tender evaluation criteria included in this tender package.

The sub-contractor shall disclose the cost of the material offered by the supplier, including or manufacturer or any other sources to the Engineer used to build up the rates in respect to schedule of table (a) and table (b) below. The engineer can reject the disclosed sources where the conflict of interest seems to prevail.

Table (a) and Table (b) shall be deemed to be exhaustive in capturing all cost components and the percentages filled herein shall be considered to be locked for the duration of the contract.

3.3.1 Locally Available Items

Unit rates for items that can be procured locally shall be generated according to table (a) below. Table (a) consists of the below items:

- Material cost – This is the supplier's unit cost for the item, i.e. the cost at the shop/supplier.
- Labour – This is to include all transportation, security, hoisting, installation, tools and consumables, testing, commissioning, costs, etc. The tenderer is to provide his/her labour cost as a percentage of material cost.
- Overheads and Profit – This is to capture all Sub-contractor's overheads, margins, profit, etc. The tenderer is to provide his/her overheads and profit as a percentage of material cost.
- Further to this, tenderers are expected to list all other cost carriers not deemed to have been captured in the table below, as a percentage of material cost.

3.3.1.1 Table (a): Locally Available Items.

Material Cost Kshs. (a)	Labour (as a percentage of material cost) (b)	Overheads and Profit (as a percentage of material cost) (c)	List any other component as necessary (as a percentage of material cost) (d)	Total Installed Cost of item shall Kshs. a + (axb%) + (axc%) + (axd%) (VAT exclusive)
	……..%	……..%	……..%	

3.3.2 Imported Items

Unit rates for items that will require importation shall be generated according to table (b) below. Table (b) consists of the below items:

- Material cost – This is the supplier's unit cost for the item as landed and cleared in Kenya. It includes FOB price, Carriage Insurance & Freight, Inspection Charges, Duty, Port Levies, Clearance Charges and VAT.
- Labour – This is to include cost for transportation from port to site, security, hoisting, installation, tools and consumables, testing, commissioning and associated costs, etc. The tenderer is to provide his/her labour cost as a percentage of material cost.

- Overheads and Profit – This is to capture all Sub-contractor's overheads, margins, profit, etc. The tenderer is to provide his/her overheads and profit as a percentage of material cost.
- Further to this, tenderers are expected to list all other cost carriers not deemed to have been captured in the table below, as a percentage of material cost.

3.3.2.1 Table (b): Imported Items.

Material Cost Kshs. (a)	Labour (as a percentage of material cost) (b)	Overheads and Profit (as a percentage of material cost) (c)	List any other component as necessary (as a percentage of material cost) (d)	Total Installed Cost of item shall Kshs. a + (axb%) + (axc%) + (axd%) (VAT exclusive)
	……..%	……..%	……..%	

…….. **(Signed)**

…….. **(Date)**

…….. **(Official Stamp)**

3.4 Day Work Terms for Labour

(To Be Completed By Tenderer)

Description of Artisan	**Cost Per Hour**
Supervisor	……
Grade A Electrician	……
Grade B Electrician	……
Grade C Electrician	……
Labour	……
Apprentices	……

…… **(Signed)**

…… **(Date)**

…… **(Official Stamp)**

4 TECHNICAL SCHEDULE

4.1 Switchgears Technical Data Sheet

4.1.1 Environmental Conditions

Site location		Nairobi, Kenya
Altitude above sea level	**m**	1795
Highest recorded temperature	**°C**	35
Average recorded temperature	**°C**	19
Lowest recorded temperature	**°C**	4.4
Highest recorded Humidity	**%**	80
Average Recorded Humidity	**%**	65
Lowest recorded Humidity	**%**	30
Corrosion conditions		Normal

4.1.2 Number of units and name tags

Drawing No.	Name tag	Assembly designation / Description

4.2 Testing Requirements

Routine Test – Inspection of the assembly including inspection of wiring	YES
Routine Test – Functional and electrical operation test	YES
Routine Test – Dielectric test	YES
Routine Test – All relevant temperatures, press ures, flows, speeds	YES
Routine Test – Checking of protective measures and of the electrical continuity of the protective circuits	YES
Routine Test – Insulation resistance	YES
Type Test – Verification of the temperature rise limits	YES
Type Test – Verification of the dielectric properties	YES
Type Test – Verification of the short-circuit withstand strength	YES
Type Test – Verification of the effectiveness of the protective circuit (Earthing and bonding)	YES
Type Test – Verification of clearances and creepage distances	YES
Type Test – Verification of the mechanical operation	YES
Type Test – Verification of the degree of protection (IP rating)	YES
Site Test – Functional and electrical operation test	YES
Site Test – Checking of protective measures and of the electrical continuity of the protective circuits	YES
Site Test – Insulation resistance	YES
Special Test – Temperature-rise test	yes
Special Test – Dielectric properties	Yes
Special Test – Short-circuit withstand strength	Yes

4.3 Documentation Requirements

Document	With Bid	Before Manufacture	During FAT	Upon Delivery
Preliminary general arrangement drawing (with dimensions)	YES			
QA / QC Plan in accordance with ISO 9001:2008		YES		
General arrangement drawing (with dimensions)		YES		
Schematics/Line diagrams for construction	N/A	YES	N/A	N/A
Recommended Spares List	N/A	N/A	N/A	YES
Routine Test Reports / Certificates			YES	
Type Test Reports / Certificates	N/A	N/A	YES	N/A
Commissioning Procedure	N/A	N/A	N/A	YES
As-built General arrangement drawing			YES	
As-built Schematics			YES	
Site Test Reports / Certificates				YES
Special Test Reports / Certificates	N/A	N/A	YES	NO

4.4 Technical Schedule

The tenderer **MUST SUBMIT** comprehensive manufacturer's technical brochures and performance details for all items listed in this schedule (fill forms attached).

ITEM No.	Description	Remarks
A	Copper cables	
B	Distribution Board	
C	Consumer Units	
D	Conduits	
E	Isolators	
F	Light fittings	
G	Power Sockets	
H	Lighting switches	
I	DP switches	
J	Data/Voice outlets	
K	TV outlets	
L	Trunking	
M	Cable tray/cable ladder	
N	Fire detection system	
O	UPS Unit	
P	Fire Cables	

5 APPENDICES

5.1 Appendix I; Statement of Compliance

Technical Schedules shall be submitted by tenderers to facilitate and enable the Engineer to evaluate tenders but only when the fittings and accessories upon which the tenderer has based his tender sum differs in manufacture, type or performance from the description contained within this specification.

Tenderers shall submit separate leaflets and catalogues giving technical and physical details for all fittings and accessories described in the Technical Schedule at the time of tendering.

Completion of Technical Schedule shall not relieve the Sub-Contractor from complying with the requirements of the Specification except as may be approved by the Engineer.

…….. **(Signed)**

…….. **(Date)**

5.2 Appendix II; Exchange Rate Fluctuations

Adjustment will be made to the price of imported materials to compensate for variations in the foreign exchange rate. For this purpose, the tenderer is required to state the exchange rate in Kenya Shillings for the currency of the Country of origin of imported materials as applied to the actual remittance effecting payment to manufacturers of the materials.

Exchange Rate: ……..

Signed (as in Tender) ……..

Date ……

5.3 Appendix III; System Warranties

The tenderer shall outline the warranties for all systems installed on this site as specified elsewhere.

These shall include but not limited, to the following:

- Copper cables
- Distribution Board
- Consumer Units
- Conduits
- Isolators
- Light fittings
- Power Sockets
- Lighting switches
- DP switches
- TV outlets
- Trunking
- Cable tray/cable ladder
- Fire detection system
- UPS Unit
- Sounders
- Fire Cables
- etc.

5.4 Appendix VI; Technical Schedule

TECHNICAL SCHEDULE

The tenderer must complete in full the technical schedule. Apart from the information required in the technical schedule, the tenderer **MUST SUBMIT** comprehensive manufacturer's technical schedules details for all items listed in this schedule (fill forms attached).

Description	Manufacturer	Country of origin	Remarks (Catalogue No. etc.)
• Copper cables • Distribution Board • Consumer Units • Conduits • Isolators • Light fittings • Power Sockets • Lighting switches • DP switches • TV outlets • Trunking • Cable tray/cable ladder • Fire detection system • UPS Unit • Sounders • Fire Cables • Photocell etc.			

GENERAL SPECIFICATION

1 GENERAL SPECIFICATION

1.1 General:

The site of the proposed Sub-Contract works shall be at The Nairobi Hospital, along Argwings Kodhek Road.

1.2 Reference Sites:

The offered equipment shall have been sold in Kenya in sufficient quantities to provide good proof of a Tenderer's capability of handling similar projects. Tenderers shall supply a detailed record of similar equipment that have been installed by them.

In addition to ensure continued support of the proposed equipment from the manufacturer, the Tenderer must submit documentary evidence that they are indeed authorised and accredited distributor/reseller of the manufacturer.

1.3 Cable Management:

The necessary infrastructure for the Proposed Systems shall be done by the Electrical Sub-Contractor, however additional requirements should be necessary the Sub-Contractor shall provide all the working drawings showing all the necessary conduit/trunking cable ways.

1.4 Systems Requirements:

The systems shall comprise but not limited to the following:

- Structured Cabling

1.5 Commencement of Works:

The Tenderer in submitting his bid shall be deemed to have allowed for commencing the works on site immediately upon appointment.

1.6 Scope of the Sub-Contract Works:

The Sub-Contract Works shall comprise the supply, delivery, erection, testing, commissioning and setting to work of the complete **systems** as detailed in this Specification and accompanying Sub-Contract Drawings.

The Tenderer shall include for all apparatus and appliances not particularly called for in this Specification or on the Sub-Contract Drawings but which are necessary for the successful completion and satisfactory functioning of the Sub-Contract Works.

It is deemed that if, in the opinion of the Sub-Contractor at the time of tendering there exists a discrepancy in the Specification, Drawing or both, that the Sub-Contractor clarifies this difference with the Engineer before tendering.

The Tenderer shall provide as an integral part of his bid a statement of compliance in which he shall clearly declare any items of the Specifications to which his offer does not comply and an alternative which is included in the offer.

The Sub-Contractor shall be obliged to liaise with other parties involved in the project and to provide any necessary information as and when required.

No claims for extra payment shall be accepted from the Sub-Contractor due to his failure to adhere to the above requirements.

The work to be installed under the Sub-Contract shall comprise but not restricted to the supply and installation of the following complete as specified elsewhere in this Specification:

1. Data cabinets
2. Patch cords
3. Cables UTP and fiber
4. Termination modules
5. Active equipment
6. Patch panels
7. Routers
8. Wireless devices
9. IP Telephony Devices
10. Etc.

All equipment as far as is practicable shall be designed and manufactured by a single preferred manufacturer. In any case equipment shall be of uniform standards compatible in operation and spare parts trained support and maintenance facilities being available. In this regard the Tenderer shall produce a letter of guarantee and commitment from the equipment manufacturer for production at tender opening. Any tender without such a commitment letter shall be rejected.

1.7 Ordering of Materials:

The Sub-Contractor shall order materials from quantities taken from his own approved working drawings and not from the quantities shown on the Sub-Contract Drawings or in the Specification.

1.8 Builder's Work Requirements:

All chasing, cutting away and making good of walls and slabs shall be by the Main-Contractor.

1.9 Tender Return Items:

Drawings and publications illustrating the systems and equipment being offered against the schedules shall be returned with the Tender, together with a comprehensive description of the systems being offered to meet the requirements detailed elsewhere in the Specification.

1.10 Standards and Regulations:

The design, manufacture, selection, installation, testing, commissioning and subsequent maintenance of all equipment and materials described in this Specification shall comply with internationally recognised standards.

1.11 Documentation:

Record Drawings, Operating instructions, log book and certificates of installation and commissioning shall be provided adjacent to the control and indicating equipment at the end of the Sub-Contract.

Operating and Maintenance Instructions shall be provided before the system is accepted. The instructions shall describe the system operation, zoning, routine care and maintenance, fault finding procedures and the function and settings of all controls.

The instructions shall include a full set of drawings, other manufacturer's handbooks and proprietary items and a complete list of spare parts provided and which are available. Full details shall be provided of all manufacturers and Sub-Contractors.

1.12 Defects Liability and Spares:

The Sub-Contractor shall provide a comprehensive routine and emergency call out service for the defects liability period, and shall confirm the response time to be provided. This service shall include routine examination and any adjustments, cleaning, replacement of parts as required to keep the system in full working order.

All equipment shall have a minimum 1 year warranty period from the manufacturer.

The Tenderer shall include details of a proposed Maintenance Sub-Contract to provide regular maintenance from the start of the defects liability period, in accordance with this specification. The Client is not bound to accept the offer from the Sub-Contractor.

An appropriate set of spares shall be provided, including consumable and modular items, which can be replaced by on-site maintenance staff. A list of the proposed spare parts shall be provided with the Tender.

1.13 Inspection, Testing and Commissioning:

The Sub-Contractor shall inspect, test and commission the works in accordance with the equipment manufacturer's recommendations. The results of all tests shall be recorded on the standard test forms unless otherwise specified.

Before completion of the installation the Sub-Contractor shall submit to the Engineer for acceptance, a method statement of the procedure to be used for testing and commissioning, which has been agreed with the equipment manufacturers.

Before cables are terminated each cable shall be tested for continuity, insulation resistance, polarity and markings. Following satisfactory testing, cables shall be terminated in the equipment only by the manufacturer's appointed representative.

Power supplies shall be tested prior to making connections to the control equipment. The Sub-Contractor shall allow for all necessary attendance during the testing and commissioning of any ancillary systems interconnected with the security system.

PARTICULAR SPECIFICATIONS

2 PARTICULAR CONDITIONS

2.1 Location of Site

The site of the proposed Sub-Contract works shall be at The Nairobi Hospital, along Argwings Kodhek Road.

2.2 Commencement of the Works

The Tenderer in submitting his bid shall be deemed to have allowed for commencing the works on site immediately upon appointment.

2.3 Scope of Sub-Contract Works

The Sub-Contract shall comprise the supply, delivery, installation, testing, commissioning and setting to work of the complete voice, data and image /video system as detailed in this Specification and accompanying Contract Drawings.

The Tenderer shall include for all apparatus appliances and accessories not particularly called for in this Specification or on the Contract Drawings but which are necessary for the successful completion and satisfactory functioning of the Contract Works.

It is deemed that if, in the opinion of the Sub-contractor at the time of tendering there existed a discrepancy in the Specification, Drawing or both, that the Sub-contractor clarifies this difference with the Engineer before tendering.

The tenderer shall provide as an integral part of his bid, a statement of compliance in which he shall clearly declare any items of the Specification to which his offer does not comply and an alternative which is included in the offer.

The Sub-contractor shall be obliged to liase with other parties involved in the project and to provide any necessary information as and when required.

The Sub-contractor shall, where applicable mark the details of structural, duct or conduit provisions for the installation of their cables or equipment.

No claims for extra payment shall be accepted from the Sub-contractor due to his failure to adhere to the above requirements.

The work to be installed under the Sub-contract shall comprise but not restricted to the supply and installation of the following:

- Structured cabling
- Active equipment
- Unified communication

- IP Telephony Devices

All equipment as far as is practicable shall be designed and manufactured by a single preferred manufacturer.

In any case equipment shall be of uniform standards compatible in operation and spare parts, trained support and maintenance facilities. In this regard the Tenderer shall produce the necessary letter of **Product and Applications Assurance Warranty.**

2.4 Ordering of Materials

The Sub-contractor shall order materials from quantities taken from his own approved working drawings and not from the quantities shown on the Contract Drawings or in the Specification. The tenderer shall ensure that all correct parts are ordered and installed.

2.5 Builder's Work Requirements

All chasing, cutting away and making good of walls and slabs will be by the Main Contractor.

The Sub-Contractor shall however be responsible for ensuring that the Builder's work has been carried out accurately and in accordance with his requirements.

2.6 Orientation

The Tenderer shall allow for the orientation of the Client's representatives to a level where they are sufficiently confident and proficient in managing, trouble- shooting and maintenance of the systems.

The orientation shall be carried out immediately after installation and shall be taken into consideration in assessing the completion of the project and release of payments.

The Sub-contractor shall be deemed to allow for any costs associated with the orientation.

2.7 Tender Return Items

The tenderer shall submit the following together with the tender:

- Drawings and publications illustrating the systems being offered against the schedules.
- A comprehensive description of the control systems being offered to meet the requirements detailed elsewhere in the Specification.

- The Manufacturers Catalogues showing such details as dimensions, colours and configurations.

- Other documents referred elsewhere in this specification.

2.8 Standards and Regulations

The design, manufacture, selection, installation, testing, commissioning and subsequent maintenance of all equipment and materials described in this Specification shall comply where applicable with the requirements of:

[i] Institute of Electrical and Electronic Engineers [IEEE]

[ii] Communication Authority of Kenya (CAK).

[iii] Kenya Bureau of Standards (KBS).

[iv] CENELEC.

[v] International Standards Organisation/International Electro technical Commission [ISO/IEC] IS 11801.

[vi] The following Electronic Industries Association/Telecommunications Industry Association [EIA/TIA] Standards:

(a) 568B – Commercial Building Telecommunications wiring standards.

(b) 569 – Commercial Building Standard for Telecommunications pathways and spaces

(c) TSB-67 – Transmission Performance Specifications for Field Testing of Unshielded, Twisted Pair Cabling Systems.

(d) 72 - Centralised Optical Fibre Cabling Guidelines.

(e) 75 – Cabling Practices for Open Offices.

[vii] Underwriter's Laboratories [UL] Cable Certification and follow up Programme.

2.9 Site Visit

The Tenderer must visit the site and shall be deemed to have satisfied himself with regard to conditions under which the Sub-Contract Works shall have to be carried out.

2.10 Defects Liability, Spares and Maintenance Contract.

The Sub-Contractor shall provide a comprehensive routine and emergency call out service for the defects liability period, and shall confirm the response time to be provided. This service shall include routine examination and any adjustments, cleaning, replacement of parts as required to keep the system in full working order.

The tenderer shall include details of a Maintenance Contract to provide regular maintenance from the start of the defects liability period, in accordance with this specification. The Sub-contractor should note that the Client may wish to enter into a negotiation with him/her and is therefore not bound to accept the charges proposed.

2.11 Warranty

The Sub-Contractor shall submit an extended Product Warranty and Applications Assurance of at least 15 years for the installation where applicable.

The Extended Product Warranty from the Manufacturer shall include but not restricted to the following conditions:

(a) That the registered cabling installation shall be free from manufactured defects in material or workmanship under normal and proper use.

(b) That all approved passive cabling products of the registered installation meet or exceed the (Near End Cross Talk) NEXT, PSNEXT, ELFEXT, PSELFEXT, return loss, bandwidth and attenuation/loss specifications of the ISO/IEC IS 11801 (1995), CENELEC EN 50173 1995 and TIA/EIA 568-B and their approved amendments.

(c) That the installation will meet or exceed the PSNEXT, ELFEXT, PSELFEXT, return loss, attenuation and NEXT requirements of ISO/IEC 11801(1995), CENELEC EN 50173 (1995) and TIA/EIA 568-B and their approved amendments for copper cabling.

(d) That the installation will meet or exceed the attenuation/loss and bandwidth requirements of ISO/IEC is 11801 (1995), CENELEC EN 50173 (1995) and TIA/EIA 568-B and their approved amendments for fibre cabling.

The Applications Assurance shall cover but not restricted to the following conditions:

(a) That the registered structured cabling system will be free from failures, which prevent operations of the specific application(s) for which it was originally designed. This shall not include failures due to electronic hardware and/or software.

(b) Applications specified in the current and future versions of the manufactures structured cabling system performance specifications.

(c) Any application introduced in the future by standards or user forums that use the ISO/IEC IS 11801 or TIA/EIA 568-B UTP or fibre components and UTP or fibre link/channel specifications for cabling.

2.12 Workmanship

The installation and method of fixing of all device covered by this specification shall be co-ordinated with building fabrics and finishes to which they are fixed.

Work shall be done to the highest standards of care within the industry and shall be subject to inspection and acceptance by the Engineer.

Inspection by the Engineer shall not relieve the Sub-Contractor from any responsibility for the proper supervision and execution of the work described in this specification.

All components of the installation shall be installed in a neat manner. Wiring colour codes shall be strictly observed and terminations shall be uniform throughout the system. Identification markings and systems shall be uniform. TIA/EIA 606 administration guidelines shall be used as standard for all structured cabling system wiring.

2.13 Documentation

The Sub-contractor shall provide a theoretical and practical orientation prior to the final commissioning covering the following subjects:

- The generic cabling system [general description, technical specifications, standardizations etc.]
- Link performance measurements (what, how, test equipment etc.).
- Network administration (purpose, needs etc.).
- Maintenance of the generic cabling system (trouble shooting, spare parts etc.).
- Training manuals for all the above installations.
- Troubleshooting manual for all the installed systems.
- Any other documents necessary for the above installation.
- Any other training found indispensable, desirable by the Sub-contractor to recommend by the manufacturers.

The Sub-Contractor shall also provide a complete, organised and uniform documentation. Each document shall be technically correct and shall refer to the quoted equipment only. The contents shall be structured in a logical way. Computer based documentation shall be preferred.

The documentation shall contain but not restricted to:

- General description of the installation and product specification. It shall contain general layouts per floor with locations of outlets, floor distributors and horizontal

cabling. Backbone details, detailed layout of each distributor and its patch panel shall be included.

- Test and measuring reports.
- Connectivity diagrams.
- Network Administration documents.
- Operation manuals.

2.14 Inspection, Testing and Commissioning

The Sub-contractor shall inspect, test and commission the Structured Cabling System works in accordance but not limited to relevant IEEE, TIA/EIA, ISO/IEC, CENELEC, ASTM and Communication Commission of Kenya [CCK] and Telkom Kenya [TKK], the inspection, Testing and Commissioning section of the Main Contract and the equipment manufacturer's recommendations. The results of all tests shall be recorded on the standard test forms unless otherwise specified.

Before completion of the installation the Sub-contractor shall submit to the Engineer for acceptance, a method statement of the procedure to be used for testing and commissioning, which has been agreed with the equipment manufacturers.

Before cables are terminated each cable shall be tested for continuity, insulation resistance, polarity and markings. Following satisfactory testing, cables shall be terminated in the equipment only by the manufacturer's appointed representative.

The Sub-contractor will provide a cabling management system for system administration. This will enable the Client to accurately identify and keep a record of all the components that comprise the cabling system as well as pathways, telecommunication closets and other spaces in which it is installed.

The Sub-contractor shall provide the following to assist the Client in network administration:

- Ensure consistent colour coding per telecommunication outlet, patch panel etc.
- A unique identifier assigned to every part of the cabling system (cables, outlets distributors etc.).
- A label at each telecommunication outlet the numbering of outlets based on floor and work area numbers.
- A label at each cable end to indicate corresponding telecommunication outlet.
- A cable schedule for each distributor indicating the cable number, its source and destination, its type and current use. This schedule shall be ordered both by cable number and destination.

- A complete patch list for all cross-connections.
- A full set of "as built" drawings.(printed and on CD)

The tenderer shall submit a list of equipment/tools for carrying out the installation and testing of the system.

2.15 Structured Cabling

The structured cabling shall consist of the following:

- Incoming services provisions (ISP)
- Backbone installations
- Horizontal cabling installations
- Active equipment (switches, Wi-Fi Access points)
- Protection system

2.16 Incoming Connection (ISP)

Two reliable internet providers shall be engaged to allow for 100% redundancy. The contractor shall allow for attendance to follow up with connection with the ISP.

The ISP's will be configured for the following;

Load Sharing: Use the two links with a distributed load of connections going out from the Security Gateway. Connections coming in are alternated. The bandwidth monitor will have the ability to configure the best relative link for the current load.

Primary/Backup: One link will be used for incoming and outgoing connection one as the Primary and the other as a backup. If one ISP is in use then the other is shut down

2.17 Cabling General

a) All cables must pass through conduits or trunking.
b) All cables and connectors shall be labelled.
c) No distortion due to kinks, sharp bends or excessive hauling tension shall be allowed.
d) Cables shall be run in a manner eliminating any possibility of strain on the cable itself or on the terminations.
e) Cables shall have no joints or splices.
f) Cables shall be kept at a minimum distance of 150mm from items liable to become hot or cold.
g) Bending radii shall be not less than eight times the overall cable diameter.
h) The manufacturers hauling tension shall not be exceeded.

i) All cable ties and fixings shall be tightened to support the cable loom without distortion of the cable sheath.
j) The fibre optic cable shall be multi-mode optimal speed and with graded index, and of nominal size 62.5/125 micron.
k) Fibre optic cable shall have a core/cladding diameter on nominal 850nm and 1300nm optical wavelength.
l) The optic cable shall be of appropriate core with each core terminated on both ends.
m) The enhanced UTP 4 pair shall be of cat 6 grade and exceed ANSI/TIA/EIA-568-Aj and ISO/IEC 11001standards. Cat 6 structured cabling shall be used throughout the entire installation.

2.18 Backbone Installations

2.18.1 Fibre Cable

This shall originate from the **Core Switches** located in the communication room and terminate in the **Access Switches** within the floors.

The Sub-Contractor shall supply and install 8 core multimode armoured fibre optic cable. It shall support all the applications outlined in the system overview. It shall have the following characteristics.

- Wavelength 62.5/125 micron
- 8 core loose tube
- Corrugated armour

The tenderer shall observe the bending radius and pulling strength requirements of all backbone cables during handling and installations. The cable shall run in suitably sized ducts provided by others.

2.18.2 Cabinet/Closets

The new distribution enclosure shall consist of Standard Cabinets with lockable transparent front door and a cooling fan. These shall be located as shown on the contract drawings.

The distribution unit will contain the patch panels with fibre optic and RJ 45 connectors, distribution frames with insulation displacement connection [IDC] modules and the auxiliary equipment (cable organizers, power distribution bar, earthing, fans, etc.)

Cabinets shall be able to contain each type of active equipment for possible future development. The tenderer shall take into consideration the active equipment at the Administration point and shall allow space for this.

The Sub-contractor shall connect the trunk cross-connect and the distribution cross-connect the common equipment such as IPBX or Server computer in the equipment rooms.

The mounting hardware must provide vertical and horizontal wire ways for cross-connect wires.

2.18.3 Modular RJ45 Patch Panel

The patch panel will have standard dimensions (19") in order to guarantee the fitting in a standard rack, box or cabinet. To avoid installation errors the Insulation Displacement Connection [IDC] contacts shall be marked with the same colour code as the cables and the outlets.

Patch panels shall be full CAT 6 with more than 40 dB NEXT measured at 200MHz between every pair combination thus capable of supporting applications of up to 200 MHz as specified in the ISO/IEC JTCI/SC25 IS 11801.

The patch cords will be arranged in a patch guide (cord organizer) to achieve a well-ordered network management.

The RJ45 patch panel shall have RJ45 jack termination in front and Insulation Displacement Connector (IDC) at the rear of the module.

The panels shall be available in different standard port configurations. The modular jack panel will have an insertion life of 750 cycles minimum. When configured in worst case 100 meter channels with full cross-connects and consolidation points with other products proposed in this tender, the connecting block shall be capable of delivering the minimum Guaranteed Channel Performance.

2.18.4 Patch Cords & Work Areas/Cables

Modular Patch Cords shall be provided:

- Between the patch panels and the applications such as IPBX patch panel.
- Between the patch panel and the active LAN equipment.
- Between the patch panel and the video /controllers.

Inspection Displacement Connection patch cords provided shall have built-in exclusion features to prevent accidental polarity reversals and split hairs.

Work area cables shall also be provided for interconnecting the telecommunication outlet and the terminal equipment.

Generic patch cords shall have transmission characteristics specified up to 1200 MHz and have the same nominal characteristics as the cable used in the horizontal cabling to ensure a homogeneous cabling system.

The patch cords and the work area cables shall be of the same type to limit the number of spare parts.

They shall be available in stranded screened version and in different lengths of 3m and 1m. Generic patch cords and work area cables shall consist of 4 pair's flexible cable with fully populated 8 pin module connectors at both ends and equipped with a moulded strain relief. The total length of patch cord, an equipment cable and a work area cable of the same link will not exceed 10m.

All cords shall conform to the requirements of TIA/EIA568-B, IS1180-1 and EN50173, Horizontal cabling Section and be part of the Underwriters Laboratories [UL] LAN Certification and Follow-up programme.

2.19 Horizontal Cabling Installations

2.19.1 Copper Cable

Horizontal cabling shall be run in a star topology format and will not exceed 90 metres from the patch panel to the outlet.

All horizontal cables used for each outlet shall be 4-pair CAT 6 unshielded twisted pair (UTP) unless otherwise stated.

During handling and installation the Sub-contractor shall observe the bending radius and pulling strength requirement of the 4-pair unshielded twisted pair (UTP) cable.

The cable run between the telecommunication outlet and the patch panel shall be continuous without any joints or splices.

In raised floors or suspended ceilings without cable trays/conduits, the Sub-contractor shall bundle the wiring with plastic cable ties at appropriate distances. Where appropriate 'J' hooks shall be used to support the cables.

All communication cabling used throughout this project shall comply with the requirements as outlined in the appropriate local codes. All cabling shall meet the relevant fire performance standards for the environment in which they are installed.

All cables shall be terminated testing and labeled in an alphanumeric sequence at all terminations. All copper cable terminations shall comply with and be tested to TIA/EIA 568-B, TSB-67 standards and TIA/EIA 606 respectively.

Cables shall terminate on the wall or trunking plates as shown on the Contract Drawings.

All cables used shall meet or exceed Guaranteed Class E Channel Performance values when configured as a worst-case channel.

Cables shall be tested for the following parameters:

- Characteristics impedance
- Cross talk attenuation
- DC loop resistance
- Attenuation
- Propagation time
- Immunity to EMI
- EM radiation

2.19.2 Telecommunication Outlets

Voice and data communication outlets shall consist of two gang utility outlet boxes/plates equipped with 8-Pin modular [RJ 45] jacks. All horizontal cabling shall terminate on termination blocks at their associated wiring closet.

All telecommunication outlets for 24 AWG (American Wire Gauge) copper cable shall be modular 8-position/8-conductor outlets. The outlets shall be able to support universal applications in a multi-vendor environment accepting modular RJ 45 plugs.

All unused module locations shall be provided with blank module inserts.

All telecommunications outlets shall conform to TIA/EIA 568-B, IS11801 and EN50173 requirements. Where an outlet is configured in worst-case of 100-metre channel, the telecommunication outlet shall be capable of delivering a minimum Guaranteed Channel Performance of Class E.

Telecommunication outlets shall be compatible with CAT 6 – when the outlet is mated with a CAT 6 plug, the connection performance shall be CAT 6 or better

The Sub-contractor shall supply the wiring and/or cords, connectors and extension cords.

2.19.3 Administration Centres

The administration system shall consist of RJ 45 modular stackable patch frames for termination of copper cables and /or IU combination on shelf for the termination of optical fibre as indicated in the Bills of Quantities.

2.20 Edge/Access Switches

- 10/100/1000BASE-T auto-sensing Gigabit Ethernet switching ports
- Power over Ethernet: Up to 30 watts per port
- SFP+ (10Gb/1Gb) ports
- Switch Fabric Capacity 176.0 Gbps

- VLAN support for tagging and port-based as per IEEE 802.1Q; protocol-
- based VLANs
- Quality Of Service, Multicast, Access Control Lists
- iSCSI optimization and monitoring
- Industry-standard CLI accessible via Telnet, SSH, or local console (RJ45 Yost) and Robust HTTP GUI Management
- Redundant Power Supply
- Lifetime Warranty

2.21 Distribution Switch specifications:

- 10/100/1000BASE-T auto-sensing Gigabit Ethernet switching ports
- SFP+ (10Gb/1Gb) ports
- 2 Stacking Ports
- Switch Fabric Capacity 128.0 Gbps
- VLAN support for tagging and port-based as per IEEE 802.1Q; protocol-based VLANs
- Quality Of Service, Multicast, Access Control Lists
- iSCSI optimization and monitoring
- Industry-standard CLI accessible via Telnet, SSH, or local console (RJ45 Yost) and Robust HTTP GUI Management
- Redundant Power Supply

2.22 Core Switch:

Performance and capabilities shall but not limited to the following minimum requirements;

- Up to 928 Gbps wired switching capacity with 250 Mpps of throughput
- Up to 20 Gbps of wireless termination capacity. Support for up to 100 access points and 2000 wireless clients on each switching entity
- Up to two 40 Gigabit Ethernet uplinks (Quad Small Form-Factor Pluggable Plus [QSFP+])
- Up to 4 no blocking 10 Gigabit Ethernet uplinks (Small Form-Factor Pluggable Plus [SFP+])
- SFP support on uplinks to offer flexibility for up to 4 Gigabit Ethernet ports
- 384 ports of no blocking 10/100/1000
- PoE+ (30W) capabilities on all ports in a line card simultaneously
- Cisco UPOE (60W) capabilities on all line card slots
- Energy Efficient Ethernet (IEEE 802.3az)
- 196 ports of no blocking Gigabit Ethernet SFP (4 uplink ports plus 192 line card ports)
- 100 ports of 10 Gigabit Ethernet SFP+ (4 uplink ports plus 96 line card ports)
- Up to 128,000 FNF entries in hardware
- SD card support for flexible storage options

- 256,000 routing entries for high-end campus access and aggregation deployments
- IPv6 support in hardware, providing wire-rate forwarding for IPv6 networks
- Dual stack support for IPv4/IPv6 and dynamic hardware forwarding-table allocations for ease of IPv4-to-IPv6 migration
- Scalable routing (IPv4, IPv6, and multicast) tables and Layer 2 tables
- Scalable and dynamic allocation of Access Control List (ACL) and Quality of Service (QoS) entries to use 8 queues per port and comprehensive security policies per port
- SD-Access: The Supervisor Engine 9-E forms the foundational building block for SD-Access – Cisco's leading enterprise architecture, which includes:
- Policy-based automation from edge to cloud
- Segmentation and micro-segmentation made easy, with predictable performance and scalability
- Automation through the Cisco Application Policy Infrastructure Controller – Enterprise Module (APIC-EM)
- Policy through the Cisco Identity Services Engine (ISE)

2.23 Protection System - Earthing

The Sub-contractor shall provide adequate earthing (grounding) for both electrical safety and Electromagnetic Compatibility (EMC) Performance, which are subject to national and local regulations.

It is the responsibility of the Sub-contractor to ensure that the cable raceways i.e. trunking, metal ducts are properly earthed to reduce EMI. The Sub-contractor is expected to earth all the cabinets, closure and racks.

It is the Sub-contractor obligation to liaise with the Electrical Sub-contractor to establish the type of earthing used for this particular project.

2.24 IP Telephony System

The Voice over Internet Protocol (IP) PBX System shall be a complete telephony system that will provide telephone calls over IP data networks. All conversations shall be sent as data packets over the network. The technology shall include advanced communication features but will also provide significant scalability and robustness.

The system shall consist but not limited to the following:

- Incoming services connection (ISP)
- IPBX (router ISDN, VioP)
- Telephony Devices

2.25 Incoming Connection (ISP)

The contractor shall allow two or more reliable services providers to be engaged to allow for 100% redundancy. The contractor shall allow for attendance to follow up with connection with the ISP.

The sub-contractor shall allow all necessary accessories not included in the bills of quantities to make the system complete of the provision of the services to clients satisfactorily and to Engineers' approval.

The following is the description of the major components of the IP PBX system.

2.26 Enterprise Call Manager Communication Server Software

The Sub-Contractor shall supply a complete switchboard and Call Manager Communication Software as part of the system capable of delivering the expected feature set. As a minimum the system shall be able to support the following features and services.

2.27 Features

Calling line ID including customization, Call Routing, Least Cost Routing, Call Forwarding on Busy and on No Answer, Call Transfer, Data Network Integration and Click to Dial, Advanced Music on Hold with an option to program music of minimum 2 minutes and capability to have external music on hold interface, Call Waiting, Call Transfer when not online, Call Conferencing with support for multiple 3 party conference and support for meet-me conference (Min. 6 users), Do Not Disturb, Find Me/Follow Me, On the Fly Recording Call Return and Voicemail Call back

2.28 Primary Services

a) Centralized Call Processing
b) The IP PBX system shall be able to support initially 400 IP users with expansion capacity of up to 1,000.
c) The IP PBX system shall be able to support 20 trunk lines.
d) The system shall be able to support full outlook and e-mail integration including voice mail to Email.
e) The system shall have support for business critical applications and unified communication applications which shall include IP Contact Centre/Call Centre, unified messaging.
f) The system shall have support for integrated services such as conferencing, one number follow me, personal call directory, recorded announcement, network-wide attendant and messaging.
g) The system shall have an IP PBX based unified communication security solutions that offer comprehensive threat protection, strict policy enforcement, robust access control, and privacy of confidential data.
h) As the Sub-Contractor plans for the security of the system, they should bear in mind the current security software used at AFA i.e. antivirus, firewall etc.

i) The Sub-Contractor shall indicate the licensing regime applicable to the IP PBX system. AFA shall prefer cost effective licensing which will allow for grow-as you-want - Licensed per extension one-off payment.
j) The system shall be able to interoperate with IP Phones, PSTN Gateways, SIP Trunks, IP Trunks, Analogue Trunks and Microsoft products such as Exchange 2016 or lower versions. The system shall have a CTI server to be able to provide call management on every desktop. The system shall make it possible for the following feature to be integrated:

    a. Pop-up of incoming calls with caller ID on ISDN line, List of incoming/outgoing and answered/unanswered calls.
    b. Click to dial.
    c. Integration with MS outlook to dial from Outlook contacts.
    d. Support in future, unified messaging to have Voicemail as .wav (or equivalent) file in email client.
    e. Support in future, supervision feature to have status Free/Busy/forwarded etc.) of all users.

k) The system shall have multi-party conference with clock to conference and multiparty video conferencing.
l) The system shall be flexible enough to allow AFA configure any preferred numbering plan, including capability to support all extension on Direct Inward Dialing (DID) numbering.

2.29 Secondary Services

- Cell Phone Integration
- Extension Groups
- Time of Day Routing
- Extension Call Recording
- Voice call recording for help desk purposes.
- Extension Range Flexibility
- Voicemail Bypass
- Intuitive VoIP Ready
- Announcement Interface

2.30 Phone Sets

The system shall be able to support extensive user equipment including cordless, soft phones, IP, digital and analogue phone set support to meet diverse end-user requirement. Specifically the system shall be able to support the following; Digital Sets, Analogue Sets, IP phones (IP Key phones / Soft phones), SIP Phones (SIP desk phones / soft phones), DECT Phones and V-WLAN WIFI Sets.

a) The Digital/IP sets shall have large display and permanently-labeled feature buttons: e.g. Speaker, Mute, Volume, Headset, Contacts, Home, History, Message, Phone. Executive phones will have a feature for video calls.

b) The Sub-Contractor shall supply IP Phone sets capable of being powered through Power over Ethernet (PoE).
c) The Sub-Contractor shall supply client software for IP soft phones to be installed on desktop and laptop computers. The Sub-Contractor shall also supply all associated accessories for each IP soft phones that is: - mouth pieces, mikes, earpieces, headphones and holders.

2.31 Operations and Management Console Software

a) The system shall have a secure Web based IP PBX management system for easy system administration. It shall also be password protected and accessible over the network.
b) Multiple Country number selection.
c) Talk Time Management
d) Call Account Management
e) Call Detail Records - Call Logs

2.32 Automated Call Distributor

The system shall be able to support an automated call distributor with the following features;

- Automatic call attendant
- Call menu
- Call forwarding
- Call transfer
- Managing extensions
- Call parking
- Support auto attendant (16 ports) with the option to upgrade it to multiple trees, by way of software upgrade only with no additional hardware.

2.33 GSM Gateway

The system shall have a GSM Gateway which shall be used to route call straight to mobile networks.

2.34 Unified Messaging Gateway

The system shall have a Unified Messaging Gateway which shall be used to link with Microsoft Exchange 2013, higher or lower versions

2.35 Interactive Voice Response System (IVRS)

The system should be supplied with an Interactive Voice Response system to give callers automated support or guide them on accessing various services offered by the Authority.

2.36 Redundancy Requirements

In order to meet availability that is commensurate to world best practices, AFFA proposes a redundancy arrangement as indicated in the high level configuration attached at annex of this document.

2.37 Training Requirements

The Sub-Contractor shall provide a professional certification on Certification Partners Convergence Technologies Professional (CTP) or an equivalent certification relevant to Unified communication systems for five (5) technical staff members before the actual implementation of the Unified communication system.

The training so provided shall be of highest standard, preferably conducted at the manufacturers training facility for the communication system. The training shall be coupled with tours of sites where similar solutions have been implemented.

In additional to this training the Sub-Contractor shall provide on-the-job training to all AFFA technical staff to be assigned to the Unified Communication System project during the implementation of the system.

2.38 Documentation

The Sub-Contractor shall supply, together with the equipment, a set of documentation to be used for purposes of operation and maintenance of the IP PBX systems.

BILLS OF QUANTITIES

3 BILLS OF QUANTITIES

3.1 General Notes to Tenderers

1. The Bills of Quantities form part of the contract documents and are to be read in conjunction with the contract drawings and general specifications of materials and works.

2. The prices quoted shall be deemed to include for all obligations under the sub-contract including but not limited to supply of materials, labour, delivery to site, storage on site, installation, testing, commissioning (**excluding 16% VAT**).

3. All prices omitted from any item, section or part of the Bills of Quantities shall be deemed to have been included to another item, section or part thereof.

4. The brief description of the items given in the Bills of Quantities are for the purpose of establishing a standard to which the sub-contractor shall adhere. Otherwise alternative brands of **equal** and **approved** quality will be accepted.

5. Should the sub-contractor install any material not specified here in before receiving **written approva**l from the Project Manager, the sub-contractor shall remove the material in question and, **at his own cost**, install the proper material.

6. The grand total of prices in the price summary page must be carried forward to the **Form of Tender for the tender to be deemed valid**.

7. The Bills of Quantities are divided generally into three sections:-

a. Contractual Requirements – Bill 1

Sub-contractors contractual requirements as called for the bill of quantities shall be priced and included in the tender. However the Tenderer is free to include and price any other items he deems necessary taking into consideration conditions he is likely to encounter on site.

b. Installation Items – Other Bills

The brief description of the items in these Bills of Quantities should in no way modify or supersede the detailed descriptions in the contract Drawings, conditions of contract and specifications. The unit of measurements and observations are as per Volume 1 or as indicated in the Bills of Quantities.

c. Summary

The summary contains tabulation of the separate parts of the Bills of Quantities carried forward with provisional sum, contingencies and any prime cost sums included. The sub-contract shall insert his totals and enter his grand total tender sum in the space provided below the summary.

3.2 Bills of Quantities

SECTION D.W. 1.0 TITLE: PRELIMINARIES & CONTRACTUAL REQUIREMENTS

Item	Description	Unit	Qty	Rate	KShs.
D.W. 1	**CONTRACTUAL REQUIREMENTS**				
A.	Preparation of working drawings, printing and distribution.	Sum	1		-
B.	Preparation of 'As Installed Drawings", printing and distribution as specified. Drawings to include:				
	(a) Blue Prints - 4 sets of each.	Sum	1		-
	(b) AutoCAD on CD – 2 No.	Sum	1		-
	(c) Operational Instructions, manuals and test certificates	Sum	1		-
C	Allow for Necessary Insurances (WIBA, etc) for the Works execution	Sum	1		-
D	Provision of Performance Bond as stated under clause 5 of the published conditions of sub-contract.	Sum	1		-
E	Allow for removal of existing equipment/items and handing over to the client.				-
F	Any other item necessary to complete the installations in this section (please state)	Sum			
					-

SECTION D.W. 2 TITLE: BACKBONE CABLING

Item	Description	Unit	Qty	Rate	KShs.
D.W. 2.1	**BACK BONE CABLING**				
A.	8 Core Outdoor singlemode fibre optic cable from Existing Data Centre to 9U Cabinet located in Linen Store	M	250		-
B.	Pulling and termination of the above cables.	Sum	1		-
C.	Labelling, Documentation and Certification of the above works.	Sum	1		-
D.	Testing & Commissioning of the above works.	Sum	1		-
E.	Fibre consumables (connectors, adapters, termination kit etc) for the above cables.	Item	1		-
F.	Any other item to complete the installation in this section [Please state].	Sum			
Total Carried Forward to Main Summary of Prices					-

SECTION D.W. 3.0 TITLE: HORIZONTAL CABLING

Item	Description	Unit	Qty		KShs.
D.W. 3.0	**Horizontal Cabling**				
A.	CAT 6A UTP cable:				
	• Data Points	Rolls	12		-
	• WAP	Rolls	1		-
	• Public Address	Rolls	1		-
	• CCTV Points & Access Control & Video Intercom	Rolls	2		-
	• Nurse Call Points	Rolls	4		-
B.	Data Cabinet as Giganet or approved equivalent: 9 U c/w with fan and 3 No 13A power outlets as ANSI for server room	No.	1		-
C.	CAT 6A UTP Copper 1 M patch cords for data cabinets	No.	67		-
D.	CAT 6 UTP Copper 3 M patch cords for work stations	No.	56		-
E.	Cable Managers:	No.	4		-
F	Sieomon Z6as -pnl-24k ZMAX 24 Port CAT 6 Shielded Patch Panel or equal and Approved	No.	4		-
G.	Twin outlet CAT 6 CT coupler shuttered with blue and red icons complete with gang horizontal plastic face plate:	No.	32		-
H.	RJ45 point wired to Nurse Call points complete with necessary termination kits (wiring already included in item A above):	No.	11		-
I.	RJ45 point wired to CCTV points complete with necessary termination kits (wiring already included in item A above):	No.	6		-

I.	RJ45 point wired to PA points complete with necessary termination kits (wiring already included in item A above):	No.	5		-
J.	Pulling of above Cables.	Sum	1		-
K.	Termination and testing of above cables.	Sum	1		-
L.	Labelling both patch cords and outlets.	Sum	1		-
M.	Documentation and certification.	Sum			
N.	Any other item to complete the installation in this section [Please state].	Sum			

Total Carried Forward to Main Summary of Prices	-

SECTION D.W. 4.0 TITLE: ACTIVE EQUIPMENT

Item	Description	Unit	Qty		KShs.
D.W. 4.0	**Active Equipment**				
A.	Supply and Installation of Either 24Port auto sensing POE switch compatible with CAT6A systems complete as CISCO 9200L - 24P - 4G - A or CISCO 9200 - 48T - 4X - E Series with copper cable connectors; ♠ 24P and 48P 10/100/1000 mbps data poE + Models ♠ Five optional uplink modules with 4XGE, 1 X 10GE, 4X10GE, 8X10GE or 2X40GE QSFP + ports ♠ Cisco Stackpower technology ♠ Dual Redudant modular power supplies and thre modular fans ♠ Fiber Input Ports and UTP Outputs				
A.1	Network Points Switch	No.	3		-
B.	WI - FI Access Point 5GHz Support, 4G LT Coexistence 802.11ac Wi-Fi Access Point as Cisco 3800i Access Point or equal and equivalent.	No.	1		-
C.	Any other item necessary to complete the Installation (Please state). All Active equipment shall carry minimum 2 year warrant on parts and labour.	Sum			
Total carried forward to Main Summary of Prices					-

SECTION D. W. 5.0 - DIGITAL TELEVISION

Item	Description	Unit	Qty	Rate	KShs.
D.W. 5.0	**DIGITAL TELEVISION** Allow for supply, Installation, testing, configuration & Commisioning of the following items complete as specified:				
A.	RG 11 Pure Copper Cable in Roll of 300M	Roll	4		-
B.	Amplifier	No.	3		-
C.	8 Splitter Channel	No.	1		-
D.	2 Splitter Channel	No.	1		-
E.	F Connectors	No.	7		-
F.	Single Television Outlet complete woth Back Box	No	7		-
F.	TV brackets	No	7		-
H.	Termination and testing of above system.	No.	1		-
I.	Labelling of the above system.	No.	1		-
J.	Documentation and certification.	No.	1		-
K.	Any other item necessary to complete the installation in this section	sum			
					-

PROPOSED FIT OUTS AND RE-ORGANIZATIONS FOR THE LABOR WARDS IN NAIROBI HOSPITAL

DATA & VOICE SYSTEMS INSTALLATION
MAIN SUMMARY OF PRICES

Item	Description	Unit	Qty	Rate	KShs.
D.W.1	**SECTION 1** Preliminaries & Contractual Requirements				-
D.W.2	**SECTION 2** Backbone Cabling.				-
D.W.3	**SECTION 3** Horizontal/Internal Cabling				-
D.W.4	**SECTION 4** Active Equipment				-
D.W.5	**SECTION 5** Digital Television				-
	Sub - Total				

Total Carried Forward to Main Summary of Volume I **-**

TECHNICAL SCHEDULE

4 TECHNICAL SCHEDULE

4.1 Documentation Requirements

Document	With Bid	Before Manufacture	During FAT	Upon Delivery
Preliminary general arrangement drawing (with dimensions)	YES			
QA / QC Plan in accordance with ISO 9001:2008		YES		
General arrangement drawing (with dimensions)		YES		
Schematics/Line diagrams for construction	N/A	YES	N/A	N/A
Recommended Spares List	N/A	N/A	N/A	YES
Routine Test Reports / Certificates			YES	
Type Test Reports / Certificates	N/A	N/A	YES	N/A
Commissioning Procedure	N/A	N/A	N/A	YES
As-built General arrangement drawing			YES	
As-built Schematics			YES	
Site Test Reports / Certificates				YES
Special Test Reports / Certificates	N/A	N/A	YES	NO

4.2 Technical Schedule

The tenderer **MUST SUBMIT** comprehensive manufacturer's technical brochures and performance details for all items listed in this schedule (fill forms attached).

ITEM No.	Description	Remarks
A	Access Data Switch	
B	Telecommunication outlet	
C	Fibre Cables	
D	Patch panel	
E	Data cabinet	
F	ODF	
G	UTP cables	

APPENDICES

5 APPENDICES

5.1 Appendix I; Statement of Compliance

Technical Schedules shall be submitted by tenderers to facilitate and enable the Engineer to evaluate tenders but only when the fittings and accessories upon which the tenderer has based his tender sum differs in manufacture, type or performance from the description contained within this specification.

Tenderers shall submit separate leaflets and catalogues giving technical and physical details for all fittings and accessories described in the Technical Schedule at the time of tendering.

Completion of Technical Schedule shall not relieve the Contractor from complying with the requirements of the Specification except as may be approved by the Engineer.

…….. **(Signed)**

…….. **(Date)**

5.2 Appendix II; Exchange Rate Fluctuations

Adjustment will be made to the price of imported materials to compensate for variations in the foreign exchange rate. For this purpose, the tenderer is required to state the exchange rate in Kenya Shillings for the currency of the Country of origin of imported materials as applied to the actual remittance effecting payment to manufacturers of the materials.

Exchange Rate: ……..

Signed (as in Tender) ……

Date ……

5.3 Appendix III; Declaration

We …….. (Name of Tenderer) do declare as follows:

(i) That we shall adhere to the Specifications or any alternatives as may be approved by the Engineer.

(ii) That we have visited the site and fully understand and appreciate the prevailing site conditions and the terms and conditions under which the works detailed in the Specifications and drawings shall be carried out.

(iii) That we have studied the relevant drawings to the project and understand them fully and any discrepancies have been clarified.

(iv) That we have enclosed a Letter of Bond from an approved and recognized Surety (Reputable Insurance Firm or Bank) willing to be bound to (Name of the Project) in an amount equal to 10% of the contract amount.

Name of Surety ……..

Amount Bound to Employer:

Kshs. ……

In Words ……..

…….. (Signed by Surety).

…… (Date).

…… (Official Stamp of Surety).

(v) That we understand the tender validity period to be **90 days** from the date of submission of tenders.

5.4 Appendix IV; System Warranties

The tenderer shall outline the warranties for all systems installed on this site as specified elsewhere.

These shall include but not limited, to the following:

- Structured Cabling
- Data Switches
- Cables

Etc.

5.5 Appendix V; Schedule of Unit Rates

The sub-contractor shall provide a schedule used to build up rates for items (randomly selected in preceding pages) listed in the table (a) below.

5.5.1 Table (a): Randomly selected items listed in the preceding pages.

Item	Material Cost Kshs. (a)	Labour (as a percentage of material cost) (b)	Overheads (as a percentage of material cost) (c)	Inflation (as a percentage of material cost) (d)	Total Cost of item Kshs. (VAT exclusive) (a+b+c+d)	Signature
IP Based 91dB, 9W RMS, 5" ceiling						
Cisco C9500-24T data switch						
42U Data Cabinet						
4 core Singlemode Outdoor fibre optic cable						

The sub-contractor shall provide a breakdown schedule to be used to build up rates for any other item not listed in the preceding pages as outlined in the table (b) below. **Sub-contractor shall disclose the cost of the material offered by the supplier or manufacturer or any other sources to the Engineer used to build up the rates in respect to schedule of table (b) below. The engineer can reject the disclosed sources where the conflict of interest seems to prevail.**

5.5.2 Table (b): any other item not listed on the preceding pages.

Material Cost Kshs. (a)	Labour (as a percentage of material cost) (b)	Overheads (as a percentage of material cost) (c)	Inflation (as a percentage of material cost) (d)	Total Cost of item Kshs. (VAT exclusive) (a+b+c+d)	Signature

5.6 Appendix VI; Day Work Terms for Labour

(To Be Completed By Tenderer)

Description of Artisan	**Cost Per Hour**
Supervisor	……..
Grade A Electrician	……..
Grade B Electrician	……..
Grade C Electrician	……..
Labour	……..
Apprentices	……..

GENERAL REQUIREMENTS

1 GENERAL REQUIREMENTS

1.1 General:

The Security systems shall be controlled and maintained at the Security Control Room. The system and equipment used will be the state-of-the-art technology available today, reliable and robust and of open protocol for integration with other vendor's systems.

1.2 Reference Sites:

The offered equipment shall have been sold in sufficient quantities to provide good proof of a Tenderer's capability of handling similar projects. Tenderers shall supply a detailed record of similar equipment's that have been installed by them.

The Sub-contractor shall in the preliminary section of the pricing allow for the following;

- Factory inspection/Training of the system (SMS) to allow the Engineer and Client Staff familiarize themselves with the systems functions and installations procedures.
- Site inspection of at least two sites where the proposed systems has been installed.

In addition to ensure continued support of the proposed equipment from the manufacturer, the Tenderer must submit documentary evidence that they are indeed authorised and accredited distributor/reseller of the manufacturer.

1.3 Cable Management:

The necessary infrastructure i.e. cables, accessories, devices (excluding conduit work and raceways) for the Security System shall be done by the Security Sub-Contractor.

1.4 The Security Systems Requirements:

- CCTV Camera Installations.
- Access Control Systems Installations.

1.5 Commencement of Works:

The Tenderer in submitting his bid shall be deemed to have allowed for commencing the works on site immediately upon appointment.

1.6 Scope of the Contract Works:

The Contract Works shall comprise the supply, delivery, erection, testing, commissioning and setting to work of the complete **integrated security management system** as detailed in this Specification and accompanying Contract Drawings.

The Tenderer shall include for all apparatus and appliances not particularly called for in this Specification or on the Contract Drawings but which are necessary for the successful completion and satisfactory functioning of the Contract Works.

It is deemed that if, in the opinion of the Sub-Contractor at the time of tendering there exists a discrepancy in the Specification, Drawing or both, that the Contractor clarifies this difference with the Engineer before tendering.

The Tenderer shall provide as an integral part of his bid a statement of compliance in which he shall clearly declare any items of the Specifications to which his offer does not comply and an alternative which is included in the offer.

The Sub-Contractor shall be obliged to liaise with other parties involved in the project and to provide any necessary information as and when required.

No claims for extra payment shall be accepted from the Sub-Contractor due to his failure to adhere to the above requirements.

The work to be installed under the Contract shall comprise but not restricted to the supply and installation of the following complete as specified elsewhere in this Specification:

1. Access control zonal counter.
2. Access control readers.
3. Access control cards.
4. CCTV Camera Installations.
5. CCTV surveillance system integration.
6. Associated Structured Cabling.

All equipment as far as is practicable shall be designed and manufactured by a single preferred manufacturer. In any case equipment shall be of uniform standards compatible in operation and spare parts trained support and maintenance facilities being available. In this regard the Tenderer shall produce a letter of guarantee and commitment from the equipment manufacturer for production at tender opening. Any tender without such a commitment letter will be rejected.

1.7 Ordering of Materials:

The Sub-Contractor shall order materials from quantities taken from his own approved working drawings and not from the quantities shown on the Contract Drawings or in the Specification.

1.8 Builder's Work Requirements:

All chasing, cutting away and making good of walls and slabs will be by the Security Sub-Contractor to the satisfaction of the Interior Designer & Engineer.

1.9 Tender Return Items:

Drawings and publications illustrating the systems and equipment being offered against the schedules shall be returned with the Tender, together with a comprehensive description of the systems being offered to meet the requirements detailed elsewhere in the Specification.

1.10 Standards and Regulations:

The design, manufacture, selection, installation, testing, commissioning and subsequent maintenance of all equipment and materials described in this Specification shall comply with internationally recognised standards.

1.11 Documentation:

Record Drawings, operating instructions, logbook and certificates of installation and commissioning shall be provided adjacent to the control and indicating equipment at the end of the Contract.

Operating and Maintenance Instructions shall be provided before the system is accepted. The instructions shall describe the system operation, zoning, routine care and maintenance, fault finding procedures and the function and settings of all controls.

The instructions shall include a full set of drawings, other manufacturer's handbooks and proprietary items and a complete list of spare parts provided and which are available. Full details shall be provided of all manufacturers and suppliers.

1.12 Defects Liability and Spares:

The Sub-Contractor shall provide a comprehensive routine and emergency call out service for the defects liability period, and shall confirm the response time to be provided. This service shall include routine examination and any adjustments, cleaning, replacement of parts as required to keep the system in full working order.

All equipment shall have a minimum 1-year warranty period from the manufacturer.

The Tenderer shall include details of a proposed Maintenance Contract to provide regular maintenance from the start of the defects liability period, in accordance with this specification. The Client is not bound to accept the offer from the Sub-Contractor.

An appropriate set of spares shall be provided, including consumable and modular items, which can be replaced by on-site maintenance staff. A list of the proposed spare parts shall be provided with the Tender.

1.13 Inspection, Testing and Commissioning:

The Sub-Contractor shall inspect, test and commission the works in accordance with the equipment manufacturer's recommendations. The results of all tests shall be recorded on the standard test forms unless otherwise specified.

Before completion of the installation the Sub-Contractor shall submit to the Engineer for acceptance, a method statement of the procedure to be used for testing and commissioning, which has been agreed with the equipment manufacturers.

Before cables are terminated each cable shall be tested for continuity, insulation resistance, polarity and markings. Following satisfactory testing, cables shall be terminated in the equipment only by the manufacturer's appointed representative.

Power supplies shall be tested prior to making connections to the control equipment. The Sub-Contractor shall allow for all necessary attendance during the testing and commissioning of any ancillary systems interconnected with the security system.

PARTICULAR SPECIFICATIONS

2 PARTICULAR SPECIFICATIONS

2.1 Location of Site

The site of the proposed Sub-Contract works shall be at The Nairobi Hospital, along Argwings Kodhek Road.

2.2 Description of Project

The project comprises of the Fit-Outs and Reorganization for The Nairobi Hospital Labor Wards.

2.3 Integrated Security Management System

General

The System must be designed to perform a wide variety of feature rich functions as part of a Total Security Management Solution. These System functions are categorized into System modules which will be integrated with the overall platform. The various features and modules include:

A. Access Control
B. IP CCTV Camera Installations
C. CCTV Integration
D. Data Integration Services
E. Alarm & Event Monitoring
F. Time & Attendance
G. Third Party Integration
    a. Fire Detection System
    b. Building Management System
    c. Intercom Systems
    d. Wireless Locks
    e. Elevators
H. Licenses

2.3.1 Seamless Integration

All System application modules, features, and functions shall be generated from a single source code set. The access control, alarm monitoring, asset management, digital video management, intrusion detection, remote access level management, and visitor management, and credential management modules of the software shall be created from this single source code set.

One or All **systems** shall be from **ONE** manufacturer.

All System modules shall be seamlessly integrated to feature a single System, single code base, single graphical user interface, and single database.

The system shall allow for ease of maintenance and allow for the ease of future upgrades and enhancements. All System features and functionality listed in the specifications shall ship with each System. Features and functionality available to the client shall be determined through licensing and shall be controlled by a hardware/software license key – the license should be a onetime buy and should not.

All System data shall reside in a single database on the network and be instantly accessible from every/any client workstation connected to the network that is licensed to do so. This shall

provide automatic change propagation to all client workstations on the System as well as a common database to consolidate all information and allow for better disaster recovery. As such, any modifications made to cardholders, time zones, assets, or access levels shall be downloaded in real-time to all related Intelligent System Controllers.

2.4 IP CCTV Surveillance System

General

The Closed Circuit Television system shall cover the following areas:

- Entrance/Exit doors.
- Electrical and Server Rooms.
- Reception.
- Lobbies.
- Corridors.

All the systems shall be monitored and controlled at the Control Room.

CCTV System shall be integrated with other system like Access Control, Music System, Voice Evacuation, BMS etc.

2.4.1 Network Video Recorder (NVR):

- Optimized for Megapixel Video Recording
- Hardware RAID Subsystem
- Data Protection, RAID 5, 6
- Real-time network camera discovery
- Versatile views of various screen divisions
- HTML and image overlays
- Multiple views supported
- View patrolling for single or multiple views
- Real time video/event alarm display
- Instant playback
- Behaviours smart features like unattended items zoning
- Video clip bookmarking
- ANPR features
- Drag-n-drop camera manipulation
- Directional camera display
- Hierarchical map structure
- Real time event alert
- Instant live video of camera
- Multiple maps supported
- Pan, tilt, zoom operations (dependent of camera)
- Built-in, floating PTZ control panel
- Pre-set position (dependent of camera)
- Scheduled or continuous camera patrolling
- Event-driven camera patrolling
- On Screen PTZ control
- Up to 16 monitors
- Supports live view, playback, eMap functions
- Direct display to secondary monitor(s)
- Search by date, time, camera

- Search by pre-defined recent time
- Search by VI event combinations
- Search over multiple days
- Search over multiple cameras
- Video clip bookmarking and commenting
- Search via built-in VI analyser
- Customizable bookmark
- Intuitive, video thumbnail search results
- Cue-in, cue-out and repeat
- Quick playback by video thumbnail
- 1/8, 1/4, 1/2, 1x, 2x, 4x, 8x,16x play, pause, stop
- AVI-formatted video clip export
- 4-channel synchronized playback
- Supported in video alarm, event alarm, view functions
- Pre-defined playback durations
- Video clip bookmarking
- General motion detection
- Missing object detection
- Foreign object detection
- Intrusion detection
- Forbidden area detection
- Tampering detection
- Virtual fence
- Object counting

Full functional operation & management via standalone VMS Client should support web clients and storage

- Video codec: H.264, MPEG4, MJPEG
- Image enhancement
- Video privacy mask
- Digital zoom in, zoom out
- Log viewer
- Windows lockup
- Client auto login
- Digital I/O management
- Automatic storage recycling
- Client-server architecture
- Guaranteed performance of long period recording
- Customizable appearance of Surgeon logo
- Configurable video retention period
- Digital watermark proofing
- Support DDNS Function
- Support CH Products USB joystick
- Support Ethernet I/O device
- Support NTP Server synchronized

2.4.2 Cables:

All cables used for the installation shall be 4 – pair CAT 6 unshielded twisted pair (UTP) unless otherwise stated installed by other however, sub-contractor shall allow for all necessary accessories to make system functional.

2.4.3 Intelligent Camera and Lenses:

Cameras offered shall have an image sensor of 1/2.7" 3-megapixel progressive scan. All lenses used must be automatic iris with a variable local length of 3.3 – 12mm.

Min. Illumination - 0.01 Lux @ F1.2 (B/W) 0.1 Lux @ F1.2 (Colour)

Camera Angle Adjustment - Pan 0° ~340°, Tilt 30°~90°

Video Compression - H.264/MPEG-4/MJPEG

Resolution - Up to 2048 x 1536 Video Resolution

Video Stream - Dual stream at H.264, MPEG-4, and MJPEG simultaneously

Video Control- AGC (Auto Gain Control), AWB (Auto White Balance), AES (Auto Electronic Shutter), BLC (Back Light Compensation), image adjustment

Intelligent Video - Motion detection, tampering detection (blocked, redirected, defocused, or spray-painted)

Supported Protocols - IPv4, ARP, TCP, UDP, ICMP, DHCP, NTP, DDNS, SMTP, FTP, HTTP, CIFS, PPPoE, UPnP, RTP, RTSP, RTCP, 3GPP

Ethernet -10/100 Base-T / RJ45

Power Consumption - Max. 7.5W IP66 rated for indoor/outdoor use

2.4.4 Industrial Network Poe Switch-for IP Cameras

Features:

PoE Injectors, which complies with 802.3af

Embedded 200W AC power supply

10/100/1000TX support auto MDI/MDI-X function with 2 Gigabit combo interfaces

PD parametric information and power testing

QoS/CoS support

VLAN tagging (up to 4K)

802.3ad LACP

GVRP (256 groups)

Port mirroring / Port security

IGMP Snooping and Query mode

IGMP multicast groups

DHCP Client

802.1X RADIUS

SNTP support

Ingress / Egress packet filtering

User access authorization

Login IP source authorization

SNMP v1, v2

Remote upgrade support

2.4.5 Software Specification:

Monitors suitable for commercial applications shall be suitably installed in the areas as earlier mentioned. They shall have an impedance switch in the 75 ohms or in the 'High Impedance' position.

Management	SNMP/ Telnet/ web-browser/ CLI management
SNMP MIB	RFC 1157 SNMP, RFC 1213 MIB II, RFC 1643 Ethernet like, RFC 1493 Bridge MIB, RFC 2674 VLAN MIB, private MIB, RFC 1628 UPS MIB, RFC3621 Power Ethernet MIB
RFC standard	RFC 2030 SNTP, RFC 2821 SMTP (option), RFC 1215 Trap, RFC 1757 RMON 1
Type of Trap	Cold start, link down, link up, authorization fail, Trap station up to 3. Private trap for power supply device.
Software Upgrade	TFTP and console firmware upgradeable.
Port Trunk	Support IEEE802.3ad with LACP function. Up to 7 trunk groups and group member up to 4. The trunk port within 24-port 10/100TX and extension module.
Spanning Tree	Support IEEE802.1d spanning tree, IEEE802.1w RSTP
VLAN	Port based VLAN IEEE802.1Q Tag VLAN VLAN groups up to 256
Class of Service	Per system supports high and low queues. The priority service rule: first come first service, all High before Low, WRR for High or low weight.
Port-based Priority	Support 3 settings: "Disable, Low or High priority". When set to "Disable", the income packet will follow QOS policy; Otherwise, the packet will follow port priority setting to "High/Low" queue.
IGMP	It supports IGMP snooping for multimedia application and supports 256 groups.
Port Security	It supports ingress and egress MAC address filter and static source MAC address lock.
Port Mirror	Global system supports 3 mirroring types: "RX, TX and Both packet". The maximum of port mirror entries is up to 25.
Bandwidth Control	Per port supports bandwidth control. Per level 100Kbps.
802.1x Authentication	Supports IEEE802.1x User -Authentication and can report to RADIUS server. Reject / Accept / Authorize / Disable.
DHCP	DHCP client

Packet filter	Broadcast storm filter
Port configuration control	Port Disable / Enable. PD detect control (enable/disable), Classification detect control (enable/disable)
Fault status detect	Null: no PD present Overload: current support over 475mA @ DC 48V and over 50 milliseconds DR fail: PD discovery resistor is not in the limited range
Mode status	System detects status, it will show I –sample, V-sample and R-detect.
Parametric information	It will show current PD parameters, it includes Discover-resistor detected value, current, voltage, power consumption, classification current and determined class
SNTP	Supports RFC 2030 Simple Network Time Protocol
System log	System Log record up to 1000 entries.
Power monitor	Support power supply monitoring function for AC power, DC power, fan status Additional power supply can be installed with POE switch and POE-UPWM.
Power testing	Support test function to testing power supply.
PoE Management	PoE Enable/Disable, Power limit by Classification; Power limit by management, Power feeding priority Detect Legacy Signature

2.5 Access Control & Intruder Alarm System

General

The System must be designed to perform a wide variety of feature rich functions as part of a Total Security Management Solution. These System functions are categorized into System modules which shall include:

A. Access Control
B. Alarm Monitoring
C. Credential Management
D. Digital Video Management
E. Intrusion Detection Management
F. Asset Management
G. Visitor Management
H. Remote Access Level Management
I. Third Party Interfaces
J. System Administration
K. Mobile Enterprise Solutions
L. Badge Layout Creation
M. Screen/Forms Creation
N. Graphical Map Creation
O. Application Programming Interfaces
P. Data Import
Q. Bi-Directional Data Exchange
R. API Development Toolkit
S. Server Redundancy

2.5.1 Seamless Integration

All System application modules, features, and functions shall be generated from a single source code set. The access control, alarm monitoring, asset management, digital video management, intrusion detection, remote access level management, and visitor management, and credential management modules of the software shall be created from this single source code set.

All systems shall be from **ONE** manufacturer.

All System modules shall be seamlessly integrated to feature a single System, single code base, single graphical user interface, and single database.

The system shall allow for ease of maintenance and allow for the ease of future upgrades and enhancements. All System features and functionality listed in the specifications shall ship with each System. Features and functionality available to the client shall be determined through licensing and shall be controlled by a hardware/software license key.

All System data shall reside in a single database on the network and be instantly accessible from every/any client workstation connected to the network that is licensed to do so. This shall provide automatic change propagation to all client workstations on the System as well as a common database to consolidate all information and allow for better disaster recovery. As such, any modifications made to cardholders, time zones, assets, or access levels shall be downloaded in real-time to all related Intelligent System Controllers.

2.5.2 System Capacity

The System shall support an unlimited number of card readers, input points, video cameras, intrusion detection points, and relay outputs.

The System database server shall support an unlimited number of cardholders, visitors, and assets limited only by the memory located in the Intelligent System Controllers in which cardholder information shall be downloaded.

The database server shall also support an unlimited number of System events and System Operator transactions in the history file. The System shall support an unlimited number of client workstations.

A fully loaded System shall guarantee a one half-second response time for access granted/denied decisions from the time that a cardholder swipes his/her badge.

2.5.3 ID Management System

The System shall include a seamlessly integrated credential management module. The credential management functionality must allow the enrolment of cardholders into the database, capturing of images, biometric data, and signatures, as well as the import/export of employee data. This functionality shall also allow the System Operator to assign and/or modify the access rights of a cardholder.

The System shall include a seamlessly integrated state-of-the-art, 32-bit, credential creation and production System. This shall allow for the creation of different badge types based on a database field, the linking of that field to a badge type to automate the process of credential production, and the use of security colours, chromakey, and ghosting, to allow officers to quickly identify personnel access authority.

The System shall have capabilities for biometric verification. Through the enrolment and comparison of hand geometry (the size and shape of an individual's hand and fingers), or fingerprints, the identity of an individual shall be verified.

The System shall have the ability to crop and rotate an image automatically based on the orientation of the eyes found in the image. This shall include photographs captured from digital cameras, live cameras, scanned images and imported images.

2.5.4 Visitor Management Module

The System shall include a seamlessly integrated visitor management module. The visitor management module shall be a desktop-based application utilizing technology that allows the client to enrol and track visitors of the organization.

It shall allow the client to enrol visitors, sign them in or out, assign them to an employee, capture a photo, capture a signature, and track the visitors as they move throughout the facilities. It shall allow System Operators to enter and pre-schedule visits. It shall allow System Operators to print visitor badges and shall incorporate complete audit trail and reporting capabilities.

2.5.5 Browser-based Visit Host Application

The System shall provide a browser-based visit host application. The browser-based visit host application shall utilize n-tier architecture. The browser-based visit host application shall support single sign-on.

The browser-based visit host application shall allow for the registration of new visitors by the System User. The System User shall be able to create a new visitor and enter demographic information about the visitor, including first name, last name, address, and phone number. The System shall allow for the System User to add additional user defined fields to the list of demographics fields. The visitor and the visitor's information shall be saved on the System database and shall be able to be utilized by other components of the System.

2.5.6 Bi-Directional Data Exchange

The System shall support a real time, bi directional data interface to external databases such as Human Resources, Time and Attendance, Food Service Systems. The interface shall allow data to be imported into or exported out of the System in real time or in a batch mode basis. Data used for import shall be retrieved directly from an external database or through an import file. Data provided for export shall be applied directly to an external database or through an export file. Any data shall be imported or exported including image data. The file used for import or created by export shall have the ability to be structured in a wide variety of ways, but shall always be in ASCII text format.

The System shall also support a one-step download and distribution process of cardholder and security information from the external database to the System database, all the way down to the Intelligent Field Controller (ISC) database. This shall be a guaranteed process, even if the communication path between the System database server and the ISC is broken. If the communication path is broken, the data shall be stored in a temporary queue and shall be automatically downloaded once the communication path is restored.

2.5.7 Client/Server Relational Database Management Systems

The System shall support industry standard Open Database Connectivity (ODBC) compliant relational database management Systems. This shall include relational database management Systems such as Microsoft SQL Server 2005 and Microsoft SQL Server 2008 and Oracle Server 10g, and 11g.

These databases, through ODBC, shall be true client/server, high performance, and ANSI standard capable of handling high transaction rates and multiple users concurrently accessing and modifying the database.

2.5.8 Destination Assurance

The System shall provide an advanced destination assurance feature that reports instances of cardholders not going directly to their required locations after entering a specified card reader checkpoint. Once a cardholder passes through a checkpoint reader, that cardholder shall have a predefined amount of time to reach his or her destination card reader. Destination Assurance proves beneficial for entry and exit readers at hazardous locations, for example, where an alarm can be generated if a cardholder has not exited the hazardous location within a given length of time.

2.5.9 Network Account Management

The System shall support a Network Account Management module. The System's Network Account Management Module shall integrate System cardholders with external user network accounts. Through linked accounts, System Administrators shall be able to perform a set of administrative tasks in Windows domains from the System Administration Module. The Network Account Management functionality shall also enable System Administrators to create a link between physical access control and logical domains. The System shall additionally be combined with the management of cardholders' digital certificates stored on a smart card.

The integration shall provide a number of benefits, including the ability to do the following:

1. Perform administrative functions on Windows user accounts from within the System Administration Module.

2. Enable interaction between Physical Access Control Cardholders and Windows logical domains. For example, if badge is lost, a designated Windows account shall disable.

3. Control access to Computer Anti-Pass Back Areas

2.5.10 Access Control

2.5.10.1 Time Zones

The System must be capable of creating and storing up to two hundred fifty (250) time zones. Each time zone must have a minimum of six (6) intervals. Each interval shall be assignable to any day of the week and capable of being restricted on a minimum of eight (8) types of holidays.

2.5.10.2 Access Levels

All users shall have access based on facility, reader, time, and day. These time zones for each day are to be pre-defined by the client and must be able to be modified quickly by the System Administrator without vendor intervention.

2.5.10.3 Holidays

The System must allow the System Administrator to designate certain dates as holidays. As well, the dates for Daylight Saving Time shall be definable and shall automatically take effect without System Administrators/System Operators intervention.

2.5.10.4 First Card Unlock

The System shall support a First Card Unlock feature. When configuring the default attributes of a card reader in System Administration, a first card unlock setting shall be selectable. First Card Unlock requires that a valid access grant shall be received at a card reader (by an authorized cardholder) after the time zone change has occurred before placing the reader into an unsecured mode.

2.5.10.5 Database Segmentation

The System shall employ advanced database segmentation functionality. Each segment shall be allowed to have its own unique set of cardholders, hardware, and system parameters including access control field hardware, time zones, access levels, etc., which shall allow System Administrators to expand upon current hardware constraints. For example, each segment shall have its own 32,000 access levels, 250 time zones, and 250 holidays. As such, only credentials

that are assigned access levels to card readers in a segment need to be downloaded to the Intelligent System Controllers in that segment.

Cardholders shall be allowed to belong to one segment, many segments, or all segments.

2.5.10.6 Field Hardware Communications

The System shall communicate with the Intelligent System Controllers (ISC) by either RS-485 or RS-232 EIA standard. The System shall have the ability to communicate with ISCs by LAN/WAN connections utilizing TCP/IP communications protocol. The System shall also have the ability to communicate with the ISCs through remote dial up capabilities.

2.5.10.7 Dual Path Field Hardware Communications

The System shall support dual path communications between the database server and the Intelligent System Controllers. This shall allow for two paths of communication: a primary and secondary path. The primary path shall communicate between the database server and the Intelligent System Controllers (ISC) by either RS-485 or RS-232 EIA standard, LAN/WAN connections utilizing TCP/IP communications protocol, or through remote dial up capabilities using modems. The secondary path shall communicate via RS-485 or RS-232 EIA standard (dial-up shall not be the primary connection using this method), LAN/WAN connections utilizing TCP/IP communications protocol or remote dial up capabilities using modems.

Upon sensing a loss of communications via the primary communication path, the ISC shall automatically initiate the switching of communications to the secondary communications path. Once communications are switched from the primary path to the secondary path, the host shall periodically check and determine if the primary communications path has been restored. Upon restoration of the primary communications path, the host shall restore communications back to the primary communications path. Alarms shall be posted to alarm monitoring client workstations when the primary communications path is lost and/or restored. The currently active path shall be displayed with the Intelligent System Controller status in the System Hardware Status Tree.

2.5.10.8 Area Control

The System shall provide five (5) area control features: Global Hard Anti-pass back, Global Soft Anti-pass back, Timed Anti-pass back, Two Person Control, and Occupancy Limit. Area control shall be a security method of preventing a person from passing their badge to another person for dual entry into a single location utilizing one card.

2.5.10.9 Two Person Control

Two Person Rule shall be provided to restrict access to certain areas unless there are two (2) cardholders present. This restricts individuals from being alone in restricted or highly secure areas.

2.5.10.10 Designated One-Person Control

The System shall allow for a special One-Person Mode. This mode shall require that a designated cardholder is present before anyone else is allowed to access a certain area. This restricts individuals from accessing a restricted or highly secure area when not accompanied by the designated cardholder.

2.5.10.11 Occupancy Limit

Occupancy Limit shall restrict the number of cardholders that shall be present in an area at any given time. The Occupancy Limit area shall be able to be defined by the System Administrator to limit up to 65,000 users to be in that area at any given time. Once the occupancy limit has been reached, a cardholder must swipe out of the exit card reader before the next cardholder may enter. Each area for which Occupancy Limit is enabled shall be definable with up to 64 entry/exit card readers. Multiple Occupancy Limit Areas shall be definable.

2.5.10.12 Mustering

The System shall support advanced Mustering functionality. The Mustering function shall provide an automatic capability for registering cardholders that are on site during an incident. Designated exit and entry card readers shall be used to enter and leave hazardous locations and safe locations. When an incident occurs, a Muster Report shall be generated that consists of a listing of all personnel that are within the hazardous locations as well as all personnel that have registered in a safe location.

Safe Locations
A Safe Location shall be defined using entry and exit readers associated with the location. Safe Locations shall have both entry and exit card readers at all portals. Safe Locations shall require that a reader be used to enter and exit an area. Entry and exit readers shall be able to span across multiple ISCs.

ii) Muster Mode Operation
A Muster Mode shall mean that an incident has occurred and an evacuation is required of one or more Locations. A location shall enter into Muster Mode either automatically via an occurrence of a given hardware event transaction (such as an Alarm Input going active) or manually via a System Operator placing the Location into Muster Mode.

When a Location goes into Muster Mode, all associated Alarm Monitoring Workstations shall be notified with a breakthrough notification and Muster Reporting shall begin.

2.5.10.13 Global Input/output/Event Linkage

The System shall support a global linkage feature whereby any input/output/event shall be linked to any other input/output/event in the System. Input/output Linkages shall be able to span across Intelligent System Controllers.

System Administrators shall be able to create global I/O function lists, each consisting of a sequence of actions to be performed, such as changing card reader modes, activating outputs, and opening or closing anti-pass back areas. Each function list may include up to six actions.

System Administrators shall then be able to link events to the aforementioned global I/O function lists such that a particular device change will execute a function.

The System shall allow for the creation of correlation logic to execute a function only when two or more events occur within a specified time window. This correlation logic shall support both mandatory correlation of ALL members of a user specified a set of inputs (AND), and correlation of ANY members of a user specified set of inputs (OR). This correlation function must accommodate events that occur in close proximity but not necessarily overlapping. Simple Boolean logic does not satisfy this requirement.

2.5.10.14 Guard Tour

The System shall support advanced Guard Tour functionality. A tour shall consist of one or more checkpoints defined as card readers or alarm inputs that a guard shall check during a guard tour.

Security Clearance Levels

Security clearance levels shall optionally be created and assigned a name. Security clearance levels shall be assigned to one or more guard tours.

A Security Clearance Level is a means of limiting the number of 'tour guards' when a tour is launched. Particular Security Clearance Levels shall be assigned only to guards who will need access where the tour will take them. When a tour is launched, only those guards with the security clearance levels shall be listed.

2.5.10.15 Scheduling Utility

The System shall support an advanced Scheduling Utility. The Scheduling Utility shall allow System Administrators to schedule actions to occur on a one-time or a recurring basis. Recurring schedules shall be configured to begin immediately, last indefinitely, or have optional start and end dates.

2.5.10.16 Multiple Card Formats

The System shall support an unlimited number of card formats. Magnetic stripe and Wiegand card formats shall be supported. Each ISC shall support a minimum of eight (8) access control card formats and if applicable, eight (8) asset formats. As such, each card reader shall also be able to support a minimum of eight (8) access control card formats. If applicable, asset readers shall be able to support a minimum of eight (8) access control card formats and eight (8) asset management card formats. The System shall support any magnetic stripe format that uses card number, facility code, and issue code combinations with a maximum of a nine-digit card number and two-digit issue code. The System shall support any industry standard Wiegand card format.

2.5.11 Hardware Specifications

Biometric Reader
CPU: 400MHz DSP
Memory: 8MB flash + 16MB RAM
Fingerprint Sensor: Minimum 500 dpi optical sensor
Identification Speed: Minimum 2,000 matches in 1 second
Fingerprint Capacity: 5,000 fingerprints (10,000 templates)
Log Capacity: 50,000 events
RF Card Options: EM, Mifare / Desfire
Authentication: Finger / PIN / Card
Network Interface: TCP/IP
Wiegand: 1 channel (input/output switchable)
Environmental Rating: IP65
Credential Specification:
Dimensions: 2.127" x 3.375" x 0.033" max. (5.40 x 8.57 x 0.084 cm)
Weight: 0.20oz (5.7 g)
Card Construction: Thin, flexible polyvinyl chloride (PVC) laminate.
Operating Temperature: -40° to 158° F (-40° to 70° C)
Operating Humidity: 5-95% non-condensing
Operating Frequency: 13.56 MHz
Memory Type: EEPROM, read/write
Multi-application Memory: 2k bit (256 Byte) card

Endurance: Min. 100,000 cycles

2.5.12 System Controller Specifications

2.5.12.1 Communications:

On-board Ethernet 10/100Base-T. DHCP and fixed IP addressing supported. DNS device naming through DHCP extended commands additional RS-232 9600 to 115.2 Kbps async RS-485 (2-wire) 9600 to 38.4 Kbps a sync

2.5.12.2 Memory:

6 MB of available on-board, non-volatile flash memory. Battery-backed, non-volatile storage of 50,000 events.

2.5.12.3 Firmware Management:

Firmware stored in flash memory, background download of firmware updates supported.

Number of Simultaneous Card Formats Supported
Up to 16 different formats (8 card formats and 8 asset formats)
Access levels, Time zone and reader support
Up to 32,000 access level permissions
250 holidays with grouping
250 time zones, each with 6 intervals
Individual extended held open and strike times
Up to 9-digit user PIN codes

Other features:

. 2 dedicated inputs for tamper and power failure status
. . Advanced Encryption Standard (AES) 128-bit algorithm for communications

BILLS OF QUANTITIES

3 BILLS OF QUANTITIES

3.1 General Notes to Tenderers

1. The Bills of Quantities form part of the contract documents and are to be read in conjunction with the contract drawings and general specifications of materials and works.

2. The prices quoted shall be deemed to include for all obligations under the sub-contract including but not limited to supply of materials, labour, delivery to site, storage on site, installation, testing, commissioning (**excluding 14% VAT**).

3. All prices omitted from any item, section or part of the Bills of Quantities shall be deemed to have been included to another item, section or part thereof.

4. The brief description of the items given in the Bills of Quantities are for the purpose of establishing a standard to which the sub-contractor shall adhere. Otherwise alternative brands of **equal** and **approved** quality will be accepted.

5. Should the sub-contractor install any material not specified here in before receiving **written approva**l from the Project Manager, the sub-contractor shall remove the material in question and, **at his own cost**, install the proper material.

6. The grand total of prices in the price summary page must be carried forward to the **Form of Tender for the tender to be deemed valid**.

7. The Bills of Quantities are divided generally into three sections: -

a. Contractual Requirements – Bill 1

Sub-contractor's contractual requirements as called for the bill of quantities shall be priced and included in the tender. However, the Tenderer is free to include and price any other items he deems necessary taking into consideration conditions he is likely to encounter on site.

b. Installation Items – Other Bills

The brief description of the items in these Bills of Quantities should in no way modify or supersede the detailed descriptions in the contract Drawings, conditions of contract and specifications. The unit of measurements and observations are as indicated in the Bills of Quantities.

c. Summary

The summary contains tabulation of the separate parts of the Bills of Quantities carried forward with provisional sum, summary volume included. The sub-contract shall insert his totals and enter his grand total tender sum summary of prices.

3.2 Bills of Quantities

(Continue to next page)

SECTION D.W. 1.0 TITLE: PRELIMINARIES & CONTRACTUAL REQUIREMENTS

Item	Description	Unit	Qty	Rate	KShs.
D.W. 1	**CONTRACTUAL REQUIREMENTS**				
A.	Preparation of working drawings, printing and distribution.	Sum	1		-
B.	Preparation of 'As Installed Drawings", printing and distribution as specified. Drawings to include:				
	(a) Blue Prints - 4 sets of each.	Sum	1		-
	(b) AutoCAD on CD – 2 No.	Sum	1		-
	(c) Operational Instructions, manuals and test certificates	Sum	1		-
C	Allow for Necessary Insurances (WIBA, etc) for the Works execution	Sum	1		-
D	Provision of Performance Bond as stated under clause 5 of the published conditions of sub-contract.	Sum	1		-
E	Allow for removal of existing equipment/items and handing over to the client.				-
F	Any other item necessary to complete the installations in this section (please state)	Sum			
					-

SECTION D.W. 2.0 TITLE : IP CCTV SURVEILLANCE SYSTEM

Item	Description	Unit	Qty	Rate	KShs.
D.W. 2.0	**<u>IP CCTV Surveillance System</u>** For the supply and Installation of the following complete as specified. **(attach Catalogue)**				
A	3MP IP Indoor Bullet Fixed camera with advanced remote monitoring via POE, auto focus lens and IR mode for night time conditions as AXIS M2026-LE Mk II Network Camera or Approved Equivalent. **(attach Catalogue for other brand)**	No.	1		-
A	3MP IP Indoor Dome Fixed camera with advanced remote monitoring via POE, auto focus lens and IR mode for night time conditions as AXIS M2026-LE Mk II Network Camera or Approved Equivalent. **(attach Catalogue for other brand)**	No.	4		-
B	Allow use and configuration of the above system with Structured Cabling done by others (Cables by others)	Sum.	1		-
C	Allow for interconnection and programming of the the above System	Sum.	1		-
D	Allow for interfacing with other system like Public Address System, Master Clock System, Nurses Call System, CCTV System and Fire Detection & Alarm System as call for and approved by Engineer.	Sum.	1		-
E	Installation, testing & commissioning	Sum	1		-
F	Labeling, Documentation, 2 year Warranties, associated Training and certification. N.B; Provide comprehesive list of spare part and associated part numbers for above system	Sum	1		-
I.	Any other item necessary to complete installation in this section (Please state)	Sum.			
Total carried forward to Main Summary of Prices					-

SECTION D.W. 3.0 TITLE : IP BASED ACCESS CONTROL SYSTEM

Item	Description	Unit	Qty	Rate	KShs.
D.W. 3.0	**<u>IP Based Access Control System:</u>** For the supply and Installation of the following complete with wiring as specified.				
A.	IP Based Intelligent Dual Reader controllers, (5 yerar lithium battery or 3 months full run) 6 MB standard cardholder flash memory, 50,000 of Event memory, maximum of 32 devices, On-board Ethernet, on-board two door control, eight inputs, four outputs, cabinet tamper and power fault input monitors. RoHs, CE marked and UL 294.	No.	2		-
B	IP Based Open prox card reader complete with Biometric, PIN facility, magnetic door lock, door controllers (Dual Reader interface Module (series 2 - Supports OSDP Readers) - 12/24 VDC, 2 Reader interface, W/M, 8 inputs, 6 (%A) form C relays, RoHS, CE and UL294 certified and power supply unit with batteries).	No.	2		-
C	Allow for installation of IP Based Intercom station that support Remote unlocking via the client software as Hik Vision DS-DSKH8350complete with associated accessories to complete the installation	No.	1		-
D	Allow Supplying, Installing, Testing and Commissioning of Gate/Entry Video Call unit (vandal and Weather Proof) complete with any other associated accessories as HIK Vision DS-KB8112- IM or Equal and Approved.	No.	1		-
E	Proximity Cards printed and customised	No.	10		-
F	Break' glass sensor for emergency evacuation/override	No.	1		-
G	Allow use and configuration of the above system with Structured Cabling done by others (Cables by others)	Sum.	1		-

H	Allow for interconnection and programming of the the above System	Sum.	1		-
I	Allow for interfacing with other system like Public Address System, Master Clock System, Nurses Call System, CCTV System and Fire Detection & Alarm System as call for and approved by Engineer.	Sum.	1		-
J	Installation, testing & commissioning	Sum	1		-
K	Labeling, Documentation, 2 year Warranties, associated Training and certification. N.B; Provide comprehesive list of spare part and associated part numbers for above system	Sum			
L	Any other item necessary to complete installation in this section (Please state)	Sum.			

Total carried forward to Main Summary of Prices -

PROPOSED FIT OUTS AND RE-ORGANIZATIONS FOR THE LABOR WARDS IN NAIROBI HOSPITAL

DATA & VOICE SYSTEMS INSTALLATION
MAIN SUMMARY OF PRICES

Item	Description	Unit	Qty	Rate	KShs.
D.W.1	**SECTION 1** Preliminaries & Contractual Requirements				-
D.W.2	**SECTION 2** IP Based CCTV Surveillance System				-
D.W.3	**SECTION 3** IP Based Access Control System				-
	Sub - Total				
Total Carried Forward to Main Summary of Volume I					-

3.3 Schedule of Unit Rates

The tenderers shall provide a schedule of unit rates (under Tables (a) and (b) below) that shall be used to build up rates for variation items not specified in the bill of quantity.

This section, and the terms filled herein shall form part of the contract, and shall be considered locked for the duration of the project.

Rates filled herein shall be evaluated as part of the tender evaluation process. Attention is drawn to the tender evaluation criteria included in this tender package.

The sub-contractor shall disclose the cost of the material offered by the supplier, including or manufacturer or any other sources to the Engineer used to build up the rates in respect to schedule of table (a) and table (b) below. The engineer can reject the disclosed sources where the conflict of interest seems to prevail.

Table (a) and Table (b) shall be deemed to be exhaustive in capturing all cost components and the percentages filled herein shall be considered to be locked for the duration of the contract.

3.3.1 Locally Available Items

Unit rates for items that can be procured locally shall be generated according to table (a) below. Table (a) consists of the below items:

- Material cost – This is the supplier's unit cost for the item, i.e. the cost at the shop/supplier.
- Labor – This is to include all transportation, security, hoisting, installation, tools and consumables, testing, commissioning, costs, etc. The tenderer is to provide his/her labor cost as a percentage of material cost.
- Overheads and Profit – This is to capture all Sub-contractor's overheads, margins, profit, etc. The tenderer is to provide his/her overheads and profit as a percentage of material cost.
- Further to this, tenderers are expected to list all other cost carriers not deemed to have been captured in the table below, as a percentage of material cost.

3.3.1.1 Table (a): Locally Available Items.

Material Cost Kshs. (a)	Labour (as a percentage of material cost) (b)	Overheads and Profit (as a percentage of material cost) (c)	List any other component as necessary (as a percentage of material cost) (d)	Total Installed Cost of item shall Kshs. a + (axb%) + (axc%) + (axd%) (VAT exclusive)
	……..%	……..%	……..%	

3.3.2 Imported Items

Unit rates for items that will require importation shall be generated according to table (b) below. Table (b) consists of the below items:

- Material cost – This is the supplier's unit cost for the item as landed and cleared in Kenya. It includes FOB price, Carriage Insurance & Freight, Inspection Charges, Duty, Port Levies, Clearance Charges and VAT

- Labor – This is to include cost for transportation from port to site, security, hoisting, installation, tools and consumables, testing, commissioning and associated costs, etc. The tenderer is to provide his/her labor cost as a percentage of material cost.
- Overheads and Profit – This is to capture all Sub-contractor's overheads, margins, profit, etc. The tenderer is to provide his/her overheads and profit as a percentage of material cost.
- Further to this, tenderers are expected to list all other cost carriers not deemed to have been captured in the table below, as a percentage of material cost.

3.3.2.1 Table (b): Imported Items.

Material Cost Kshs. (a)	Labour (as a percentage of material cost) (b)	Overheads and Profit (as a percentage of material cost) (c)	List any other component as necessary (as a percentage of material cost) (d)	Total Installed Cost of item shall Kshs. a + (axb%) + (axc%) + (axd%) (VAT exclusive)
	……..%	……..%	……..%	

…….. **(Signed)**

…….. **(Date)**

…….. **(Official Stamp)**

3.4 Day Work Terms for Labour

(To Be Completed by Tenderer)

Description of Artisan	Cost Per Hour
Supervisor	……
Grade A Electrician	……
Grade B Electrician	……
Grade C Electrician	……
Labour	……
Apprentices	……

TECHNICAL SCHEDULE

4 TECHNICAL SCHEDULE

4.1 Documentation Requirements

Document	With Bid	Before Manufacture	During FAT	Upon Delivery
Preliminary general arrangement drawing (with dimensions)	YES			
QA / QC Plan in accordance with ISO 9001:2008		YES		
General arrangement drawing (with dimensions)		YES		
Schematics/Line diagrams for construction	N/A	YES	N/A	N/A
Recommended Spares List	N/A	N/A	N/A	YES
Routine Test Reports / Certificates			YES	
Type Test Reports / Certificates	N/A	N/A	YES	N/A
Commissioning Procedure	N/A	N/A	N/A	YES
As-built General arrangement drawing			YES	
As-built Schematics			YES	
Site Test Reports / Certificates				YES
Special Test Reports / Certificates	N/A	N/A	YES	NO

4.2 Technical Schedule

The tenderer **MUST SUBMIT** comprehensive manufacturer's technical brochures and performance details for all items listed in this schedule (fill forms attached).

ITEM No.	Description	Remarks
A	CCTV system	
B	Access Control System	
C	Work station	

APPENDICES

5 APPENDICES

5.1 Appendix I: Statement of Compliance

Technical Schedules shall be submitted by tenderers to facilitate and enable the Engineer to evaluate tenders but only when the fittings and accessories upon which the tenderer has based his tender sum differs in manufacture, type or performance from the description contained within this specification.

Tenderers shall submit separate leaflets and catalogues giving technical and physical details for all fittings and accessories described in the Technical Schedule at the time of tendering.

Completion of Technical Schedule shall not relieve the Sub-Contractor from complying with the requirements of the Specification except as may be approved by the Engineer.

…….. **(Signed)**

…….. **(Date)**

5.2 Appendix II; Exchange Rate Fluctuations

Adjustment will be made to the price of imported materials to compensate for variations in the foreign exchange rate. For this purpose, the tenderer is required to state the exchange rate in Kenya Shillings for the currency of the Country of origin of imported materials as applied to the actual remittance effecting payment to manufacturers of the materials.

Exchange Rate: ……..

Signed (as in Tender) ……..

Date ……

5.3 Appendix III; System Warranties

The tenderer shall outline the warranties for all systems installed on this site as specified elsewhere.

These shall include but not limited, to the following:

- CCTV system
- Access Control System
- Work station

5.4 Appendix IV; Technical Schedule

TECHNICAL SCHEDULE

The tenderer must complete in full the technical schedule. Apart from the information required in the technical schedule, the tenderer **MUST SUBMIT** comprehensive manufacturer's technical schedules details for all items listed in this schedule (fill forms attached).

Description	Manufacturer	Country of origin	Remarks (Catalogue No. etc.)
CCTV system Access Control System Work station			

GENERAL SPECIFICATION

1 PART A: GENERAL SPECIFICATION

1.1 General:

The site of the proposed Sub-Contract works shall be at The Nairobi Hospital, along Argwings Kodhek Road.

1.2 Reference Sites:

The offered equipment shall have been sold in Kenya in sufficient quantities to provide good proof of a Tenderer's capability of handling similar projects. Tenderers shall supply a detailed record of similar equipment that have been installed by them.

In addition to ensure continued support of the proposed equipment from the manufacturer, the Tenderer must submit documentary evidence that they are indeed authorised and accredited distributor/reseller of the manufacturer.

1.3 Cable Management:

The necessary infrastructure (excluding conduit work and cable raceways) for the Proposed Systems shall be done by the Electrical Sub - contractor, however should additional requirements be necessary the Sub - Contractor shall provide all the working drawings showing all the necessary conduit/trunking cable ways.

1.4 Systems Requirements:

The systems shall comprise but not limited to the following:

- Nurse Call System
- Public Address & Voice Evacuation System

1.5 Commencement of Works:

The Tenderer in submitting his bid shall be deemed to have allowed for commencing the works on site immediately upon appointment.

1.6 Scope of the Sub - contract Works:

The Sub - contract Works shall comprise the supply, delivery, erection, testing, commissioning and setting to work of the complete **systems** as detailed in this Specification and accompanying Sub - contract Drawings.

The Tenderer shall include for all apparatus and appliances not particularly called for in this Specification or on the Sub - contract Drawings but which are necessary for the successful completion and satisfactory functioning of the Sub - contract Works.

It is deemed that if, in the opinion of the Sub - contractor at the time of tendering there exists a discrepancy in the Specification, Drawing or both, that the Sub - contractor clarifies this difference with the Engineer before tendering.

The Tenderer shall provide as an integral part of his bid a statement of compliance in which he shall clearly declare any items of the Specifications to which his offer does not comply and an alternative which is included in the offer.

The Sub - contractor shall be obliged to liaise with other parties involved in the project and to provide any necessary information as and when required.

No claims for extra payment shall be accepted from the Sub - contractor due to his failure to adhere to the above requirements.

The work to be installed under the Sub - contract shall comprise but not restricted to the supply and installation of the following complete as specified elsewhere in this Specification:

1. Wall/ ceiling mounted Outlets.
2. Pull Cords
3. Door Indicators
4. Speakers
5. Etc.

All equipment as far as is practicable shall be designed and manufactured by a single preferred manufacturer. In any case equipment shall be of uniform standards compatible in operation and spare parts trained support and maintenance facilities being available. In this regard the Tenderer shall produce a letter of guarantee and commitment from the equipment manufacturer for production at tender opening. Any tender without such a commitment letter shall be rejected.

1.7 Ordering of Materials:

The Sub - contractor shall order materials from quantities taken from his own approved working drawings and not from the quantities shown on the Sub - contract Drawings or in the Specification.

1.8 Builder's Work Requirements:

All chasing, cutting away and making good of walls and slabs shall be by the Main contractor.

1.9 Tender Return Items:

Drawings and publications illustrating the systems and equipment being offered against the schedules shall be returned with the Tender, together with a comprehensive description of the systems being offered to meet the requirements detailed elsewhere in the Specification.

1.10 Standards and Regulations:

The design, manufacture, selection, installation, testing, commissioning and subsequent maintenance of all equipment and materials described in this Specification shall comply with internationally recognised standards.

1.11 Documentation:

Record Drawings, Operating instructions, log book and certificates of installation and commissioning shall be provided adjacent to the control and indicating equipment at the end of the Sub - contract .

Operating and Maintenance Instructions shall be provided before the system is accepted. The instructions shall describe the system operation, zoning, routine care and maintenance, fault finding procedures and the function and settings of all controls.

The instructions shall include a full set of drawings, other manufacturer's handbooks and proprietary items and a complete list of spare parts provided and which are available. Full details shall be provided of all manufacturers and suppliers.

1.12 Defects Liability and Spares:

The Sub - contract or shall provide a comprehensive routine and emergency call out service for the defects liability period, and shall confirm the response time to be provided. This service

shall include routine examination and any adjustments, cleaning, replacement of parts as required to keep the system in full working order.

All equipment shall have a minimum 1 year warranty period from the manufacturer.

The Tenderer shall include details of a proposed Maintenance Sub - contract to provide regular maintenance from the start of the defects liability period, in accordance with this specification. The Client is not bound to accept the offer from the Sub- contractor.

An appropriate set of spares shall be provided, including consumable and modular items, which can be replaced by on-site maintenance staff. A list of the proposed spare parts shall be provided with the Tender.

1.13 Inspection, Testing and Commissioning:

The Sub - contract or shall inspect, test and commission the works in accordance with the equipment manufacturer's recommendations. The results of all tests shall be recorded on the standard test forms unless otherwise specified.

Before completion of the installation the Sub - contract or shall submit to the Engineer for acceptance, a method statement of the procedure to be used for testing and commissioning, which has been agreed with the equipment manufacturers.

Before cables are terminated each cable shall be tested for continuity, insulation resistance, polarity and markings. Following satisfactory testing, cables shall be terminated in the equipment only by the manufacturer's appointed representative.

Power supplies shall be tested prior to making connections to the control equipment. The Sub - contractor shall allow for all necessary attendance during the testing and commissioning of any ancillary systems interconnected with the security system.

PARTICULAR SPECIFICATIONS

2 PARTICULAR SPECIFICATIONS - NURSE CALL SYSTEM

2.1 General

Equipment includes the following: all equipment listed and described in this document.

- Coordinate all work with other trades.

- Provide all incidental equipment and devices not mentioned herein that are required to provide a complete system and to realize a complete stable and safe operation thereof. All conduit, raceway, power, and grounding for these systems shall be installed or supplied by the Electrician.

- Provide a Renewable Annual Maintenance Agreement Proposal for all service work beyond the warranty period.

- After the system is completely installed and tested, provide the services of one technician to assist the User in adjusting the system and its terminations, connections and its programmed functionality. Provide a minimum of 16 hours unless otherwise specified.

- Drawings and conditions of the Sub - contract, including but not limited to General Conditions, and the Special Conditions listed below, apply to work of this section.

    1. Supplementary Instructions to Bidders
    2. Supplementary Conditions
    3. Summary of the Work
    4. Project Coordination
    5. Cutting and Patching
    6. Definitions and Standards
    7. Submittals
    8. Schedules and Reports
    9. Temporary Facilities
    10. Security Regulations
    11. Safety and Health
    12. Products
    13. Project Closeout

2.2 Project/Work Identification

Sub - contract documents indicate the scope of work of the Sub - contract, and related requirements and conditions that have an impact on the project. Related requirements and conditions that are indicated on the Sub - contract documents include, but are not necessarily limited to, the following:

1. site conditions and restrictions
2. Other work prior to work of Sub - contract
3. Alterations and coordination with existing work
4. Other work to be performed concurrently by User
5. Other work to be performed concurrently by separate Sub - contractors
6. Other work subsequent to work of Sub - contract
7. Requirements for occupancy by User prior to completion of work of Sub - contract

2.3 Project Objective

A. This performance specification provides the minimum requirements for a supervised audio-visual Voice over IP-based Nurse Call System. The System shall include, but not be limited to all equipment, materials, labour, documentation, and services necessary to

furnish and install a complete, operational Voice over IP-based Nurse Call System. The System shall have full duplex audio as well as "push to talk" control for high-noise areas. The System shall comply in all respects with all pertinent codes, rules, regulations, and laws of the hospital authority and local jurisdiction. The System shall comply in all respects with the requirements of the specifications, Manufacturer's recommendations and Underwriters Laboratories Inc. (UL) Listings.

B. Each System shall be capable of supporting in excess of 1,000 Patient Stations (>2,000 beds) and 5,000 Peripheral Stations. The System shall support networking of systems to a single integrated platform for:

1. Wireless communications system(s)
2. Reporting Database
3. ADT Integration
4. Wireless Locating
5. Electronic Whiteboard
6. PC Staff Console (List View and Floorplan view) applications
7. Patient/Staff Assignments
8. Automatic/Manual Messaging

C. It is further intended that upon completion of this work, the User be provided with complete information and drawings describing and depicting the entire System(s) as installed, including all information necessary for maintaining, troubleshooting, and/or expanding the System(s) at a future date, and complete documentation of System(s) testing.

2.4 Manufacturer

1. Acceptable Nurse Call System Manufacturers as Ascom Patient Systems US or any other approved equivalent manufacturer.

A. All equipment and components shall be the Manufacturer's current model. The materials, appliances, equipment, and devices shall be tested and listed by a nationally recognized approval agency for use as part of a Nurse Call System. The Manufacturer's representative shall be responsible for the satisfactory installation of the complete System.

B. The Sub - contract or shall provide, from the acceptable Manufacturer's current product lines, equipment and components, which comply, with the requirements of these specifications. Equipment or components, which do not provide the performance and features required by these specifications, are not acceptable, regardless of manufacturer.

C. The Manufacturer of the System equipment shall be regularly involved in the design, manufacture, and distribution of all products specified in this document. These processes shall be monitored under a quality assurance program that meets ISO requirements. The Manufacturer shall have the financial stability to provide project financing/lease options to the User if desired.

D. All System components shall be the catalogued products of a single Supplier. All products shall be listed by the Manufacturer for their intended purpose.

E. All connected field electronics shall be both designed and manufactured by the same company, and shall be tested to ensure that a fully functioning System is designed and installed. The VoIP-based Nurse Call System shall utilize Ethernet topology, switches, gateways, and devices. These devices shall make up a UL 1069 Listed nurse call LAN/WAN. The Nurse Call System shall be FDA Registered, Class II, 501 (k) exempt.

2.5 Alternates

A. Strict conformance to this specification is required to ensure that the installed and programmed System shall be function as designed, and shall be accommodate the future requirements and operations of the building User. All specified operational features shall be met without exception.

B. The authorized Representative of the Manufacturer of the equipment shall be responsible for the satisfactory installation of the complete System.

C. All equipment and components shall be the Manufacturer's current model. The materials, appliances, equipment and devices shall be tested and listed by a nationally recognized approval agency for use as part of an audio-visual Voice Over IP-based Nurse Call System. The authorized Representative of the Manufacturer shall be responsible for the satisfactory installation of the complete System.

D. All Annunciators, Staff Consoles, VoIP Staff Stations, IP Switches, Station Gateways, Telephone Gateways, IP Devices, Patient Stations, Dome Lights, and Peripheral Devices shall be provided by the same System Supplier, and shall be designed and tested to ensure that the System operates as specified. All equipment and components shall be installed in strict compliance with the Manufacturer's recommendations.

E. Alternates to the equipment specified shall be considered only if all sections of the performance specification are met. Any deviations from System performance as outlined in this specification shall be considered only when the following requirements have been met:

1. A complete description of proposed alternate System performance methods with three (3) copies of working drawings thereof shall be submitted to the User for approval not less than ten (10) calendar days prior to the scheduled date for submission of bids. The Supplier shall submit a point-by-point statement of compliance for all sections in this specification. The statement of compliance shall consist of a list of all paragraphs within these sections. Where the proposed System complies fully with the paragraph, as written, placing the word "comply" opposite the paragraph number shall indicate such. Where the proposed System does not comply with the paragraph as written, and the Supplier feels the proposed System shall be accomplish the intent of the paragraph, a full description of the function, as well as a full narrative description of how its proposal shall be meet its intent, shall be provided. Any submission that does not include a point-by-point statement of compliance as described herein shall be disqualified. Where a full description is not provided, it shall be assumed that the proposed System does not comply.

2. The acceptability of any alternate proposed System shall be the sole decision of the User or their authorized Representative.

2.6 References

General (References)

A. All work and materials shall conform to all applicable Federal, State, and local codes and regulations governing the installation. If there is a conflict between the referenced standards, federal, state, or local codes, and this specification, it is the Bidder's responsibility to immediately bring the conflict to the attention of the Engineer for resolution. National standards shall prevail unless local codes are more stringent. The Bidder shall not attempt to resolve conflicts directly with the local authorities unless specifically authorized by the Engineer.

B. System components proposed in this specification shall be listed by Underwriters Laboratories, Inc. (UL) to operate together as a System. The Supplier shall be responsible for filing all documents, paying all fees (including, but not limited to plan checking and permits), and securing all permits, inspections, and approvals. Upon receipt of approved drawings from the authority having jurisdiction, the Supplier shall immediately forward two sets of drawings to the User. These drawings shall either be stamped as approved or a copy of the letter stating approval shall be included.

2.7 Definitions

ADT: Admission Discharge Transfer System
AFF: Above Finished Floor
AHJ: Authority Having Jurisdiction
Approved: Unless otherwise stated, materials, equipment, or submittals approved by the Authority or AHJ
Circuit: Wire path from a group of devices or appliances to a control module
DL: Dome Light
ESM: Event Subscription Manager
FDA: Food and Drug Administration
HL7: Health Level 7 protocol
IP: Internet Protocol
IPN: IP Network
PD: Peripheral Device
PN: Peripheral Network
PSpkr: Pillow Speaker
RTLS: Real Time Locate System
SC: Staff Console (Master Station)
UL or ULI: Underwriters Laboratories, Inc.
UL Listed: Materials or equipment Listed and included in the most recent edition of the UL Equipment Directory

2.8 System Description

2.8.1 General

A. The System shall be network-based and incorporate decentralized, distributed intelligence architecture. This intelligent architecture shall be built on an IP (Internet Protocol) network. The System shall allow both data and voice to be distributed over a common network infrastructure, which is consistent with the communication industry. Communication devices on the network shall be utilize standards-based protocols. The System shall also provide a means of interoperability with 3rd party wired and wireless network devices within the facility, including PCs, PDA's, phones, databases, pagers, etc.

B. Each System shall be capable of supporting in excess of 1,000 Patient Stations (>2,000 beds) and 5,000 Peripheral Stations. The System shall support networking of up to three Systems of this size.

C. The System shall consist of (include):
   1. Staff Consoles and Annunciator Panels with colour touch screen LCD panels
   2. VoIP Staff Station with configurable colour touch screen for workflow & bed management operation
   3. Station Gateways
   4. Ethernet Switches/powered distribution hubs
   5. Single and Dual Patient Stations
   6. Configurable Single-Gang Push/Pull Type Peripheral Devices
   7. Single-Gang Dual Aux Input Stations with optional electrical isolation
   8. 1, 2, and 4-Section LED Corridor Lights

9. Network Bridge and Configuration Software
10. Telephone Gateway (Supporting Analog, T1 and/or SIP connectivity)

D. The System shall be capable of integrating to:
    1. Most brands of in-building wireless telephone systems
    2. Most brands of pocket paging systems
    3. Hospital data gathering and reporting software
    4. Staff locating systems, wireless call cords, IPTV system, Public Address System, CCTV switching controls, and door access controls
    5. Patient-to-staff assignments, wandering patient alarm systems, bed exit and/or fall prevention alarm systems, and patient equipment calls
    6. Marquee display panels, PC monitors, and large screen monitors such as Flat Panel LCD or Plasma displays
    7. Select Electronic Medical Record (EMR) system(s)

E. The System shall be capable of Hill-Rom and/or Stryker bed side-rail communication compatibility or any other approved equivalent including visual and audible annunciation of patient safety and fall prevention alarms generated by the bed and of disconnected bed.

F. It shall be possible to configure the System using a modular, flexible GUI application that provides the system administrator the ability to manage, (add, delete, modify) and diagnose information within the nurse call network. Systems not supporting administrative access remotely shall not be accepted.

G. The System shall not rely on any computer for operation. Systems requiring a PC to be connected for operation shall not be accepted.

H. The system architecture shall not require external power supplies. Systems requiring power supplies to be installed separately from the control equipment shall not be accepted.

2.8.2 Stations

2.8.2.1 Patient Stations

A. Patient Stations are a primary point of two-way communication between patients and staff. Equipped with three call buttons and a cancel button, they offer users an easy-to-operate means of placing calls on the patient-staff communications system. With a built-in speaker and microphone, these devices also provide patients with the means of opening a full-duplex channel of audio communications with attending staff, and vice versa. On-board LEDs provide operational feedback as well as status indication.

B. Smart Patient Stations provide separate 18-pin receptacles for the connection of pillow speakers. Each station also comes equipped with two ¼" (0.64 mm) receptacles that can be programmed to accept either an input from auxiliary hardware having an FDA approved or cleared nurse call connection, or a bed call cord. An optional Smart Patient Station with two ¼" (.64 mm) receptacles only (no pillow speaker receptacle) shall be available for locations where only call cords are used, eliminating the receptacle concerns of contaminates for infection control.

C. Patient Stations shall provide a durable 18-pin pillow speaker receptacle and two user-configurable ¼" jacks for use with call cords or as non-latching (auxiliary) inputs.

D. Stations shall provide four buttons that are field configurable allowing User to define call priorities without ordering custom stations. Configuration software shall allow the User to select from a list of button templates. The system shall include default templates and allow the User to create and define custom templates.

E. Patient Stations shall be available with an optional 37-pin bed interface receptacle on the front of the station, for use where bed interfaces are shown on plans, eliminating the need for separate devices.

F. Systems unable to provide Patient Stations that support pillow speaker(s), bed interface(s), and up to two auxiliary inputs from the Patient Station shall not be accepted.

G. Removal of the pillow speaker, bed interface or call cord/auxiliary alarm cable shall generate a cord out call.

H. Stations shall NOT require the use of "dummy" plugs for any receptacles including call cord/auxiliary device, pillow speaker, and bed interface connections. Systems requiring a dummy plug to be inserted to cancel cord out calls shall not be accepted.

I. Patient Stations must provide the ability to intentionally remove a device (call cord, pillow speaker, bed interface) without placing a call to the System. When this feature is activated, the removal of any of these items shall not send a cord out call.

J. Stations must provide a cleaning mode to allow housekeeping to clean station surfaces without generating false calls. Activating cleaning mode shall temporarily disable the front panel buttons for a defined period of time.

K. It shall be possible to cancel a call from any cancel button within a patient room by linking stations when configured to do so and code allows.

L. Patient Stations shall be configurable for custom call types without custom ordering devices from the Manufacturer or replacing devices.

M. Patient Stations shall have separate speaker and microphone to support full duplex audio. Systems using half-duplex audio (voice operated switch) shall not be accepted.

N. Patient Stations shall include two independent auxiliary inputs (1/4" jacks) capable of supporting either latching auxiliary hardware having an FDA approved or cleared nurse call connection and/or non-latching call cords. Staff members shall be able to configure these inputs for latching or non-latching inputs at the station via a button press on the face of the station. The Patient Stations shall provide a visual indication of the auxiliary input status being set.

O. Patient Stations shall have a status LED to indicate call and communication status.

P. Each Patient Station button shall have a dedicated LED to indicate that the button has been pressed or is actively indicating a call. Patient Stations using a single LED to indicate the pressing of any button shall be not be accepted.

Q. Patient Stations shall support a staff follow mode that, when activated, alerts staff to calls from other stations by an audible tone at the station in their current location. The staff follow tone shall match the tone of the incoming call priority.

R. Patient Stations shall NOT have DIP switches that require manual setting by field personnel. Each Patient Station shall have a preconfigured identification number that specifies the station type automatically. Stations utilizing manual DIP switches shall not be considered.

S. Patient Stations shall be hot swappable and not require system shutdown or removal of power prior to replacement.

T. Patient Stations shall support simultaneous input of pillow speaker and bed. If either connection is removed, audio must automatically transfer to the remaining device or to the on-board station speaker.

U. Volume levels for each Patient Station shall be adjustable on a station-by-station basis. Universal settings, or settings that affect an entire wing or floor, shall not be accepted.

V. All Patient Stations shall be supervised.

W. Each Patient Station shall connect to the System wiring via a single RJ-45 connector. All connections to television and light controllers shall be via removable lever connectors providing simple, hot swappable serviceability.

X. Patient Stations shall provide on-board lighting to provide visibility in dark rooms.

2.8.2.2 Staff, Duty Stations

A. Staff/Duty Station features shall be identical in operation to the Patient Station with the exception of the call cord, pillow speaker, and bed interface receptacles.

B. Annunciation tones at Staff/Duty Stations must be identical to the tones generated by the Staff Console for each priority to clearly identify call types. Systems having duty tones that are not identical to tones generated by the Staff Console shall not be accepted. Room graphical displays shall be provided

2.8.2.3 VoIP Staff Stations

A. The VoIP Staff Station is a dynamic communication device providing flexible operation via User defined menus and touch points utilizing factory provided templates. The VoIP Staff Station may provide communication needs including, but not limited to surgical communication, Patient room communication, room status signals, and nurse rounding timers, dispatch requests to supporting departments and speed dial operation to any device on the Telligence LAN or any other approved network. It operates as both a user interface and a communications device that sends and receives data and audio signals over the IP network. As an audio device, it provides audible signalling functions and facilitates two-way full-duplex staff patient and staff to staff communications.

B. The VoIP Staff Station shall be IP-based, utilizing Voice over IP technology.

C. The VoIP Staff Station shall have a 5.7" backlit colour touch LCD screen.

D. The touch screen shall provide all necessary touch point soft keys as opposed to mechanical switches. Systems having mechanical switches shall not be accepted.

E. The touch screen shall be configurable to support up to sixteen (16) menus. Each menu shall be capable of supporting up to sixteen (16) configurable touch points. Menus can be created via templates that can be applied to individual devices, or all devices in a given area, allowing simplified and efficient installation and ongoing management.

F. Intercom audio between the VoIP Staff Station to any device on the Telligence or any other approved network shall be full duplex, and provide the ability to switch to half duplex for environments with excessive ambient noise and privacy control. Systems unable to support user selectable full duplex and one-way (half-duplex) audio shall not be accepted.

G. The VoIP Staff Station shall connect to the nurse call LAN/WAN utilizing CAT. 6 cable and powered Ethernet. No separate power supply or wiring shall be used.

H. The VoIP Staff Station shall support room devices for a minimum of two beds, including dome light and up to five peripheral stations. Systems requiring separate cable plan to support the nurse call devices and workflow devices shall not be accepted.

I. The VoIP Staff Station shall provide a screen saver mode reducing ambient light in

patient rooms when staff is not present. The time elapse from last use to screen saver shall be user configurable. With integration of RTLS the screen saver shall give way to the home screen when staff is registered in the room in which the VoIP Staff Station resides.

2.8.2.4 Peripheral Stations

A. Peripheral Stations are addressable initiating devices that provide patient room call-for-assistance indication to the patient-staff communications system. When a Peripheral Station is activated, visual indication of the call displays at the dome light associated with the patient room, and an appropriate call indication registers on the staff console, as well as on any installed and covering annunciators.

B. Each room shall be capable of supporting more than nine Peripheral Stations. These stations shall be configurable to generate any level of call supported by the system configuration. Examples of Peripheral Stations are: Lavatory, Shower, Staff Emergency, Remote Cancel, Housekeeping, Code Blue, Code Pink, Urgent, Family Call, Staff Normal, Manual Presence, Auxiliary Inputs, etc.

C. Pushbutton/Pull Cord Stations shall be field configurable to allow one, two, or three pushbuttons, with or without a pull cord.

D. Call type/priority for each pushbutton or pull cord shall be programmable in system programming to annunciate the User-determined call type. The physical device button label shall be replaceable to match the specified call type/priority.

E. Peripheral Station buttons shall be configurable for 'Toggle On / Toggle Off", supporting bed management, patient flow, workflow and other non-clinical type events, as defined by the User. Check latest configuration options to clarify any limitations.

F. Peripheral Stations shall provide on-board lighting for visibility in dark rooms.

G. Peripheral Stations shall require only two wires for installation.

H. Each Peripheral Station button shall have a dedicated LED to indicate that the button has been pressed or is actively indicating a call.

I. All Peripheral Stations shall have the ability to be individually numbered to represent a separate and distinct location, even stations that are in the same daisy chain.

J. Peripheral Stations shall not require any screws to be removed for maintenance personnel to remove the station.

K. Peripheral Stations shall NOT have DIP switches that require manual setting by field personnel. Each station shall have a preconfigured identification number that specifies the station type automatically. Stations utilizing DIP switches shall not be considered.

L. Peripheral Stations shall be hot swappable and not require system shutdown or removal of power prior to replacement.

M. Peripheral Station pull cords shall be made of a non-contaminant material to reduce the spread of nosocomial infections. Pull cords made of cotton or other absorbent materials shall be not be accepted.

N. Peripheral Stations shall provide a cleaning mode to allow housekeeping to clean station surfaces without generating false calls. Activating cleaning mode shall temporarily disable front panel buttons for a configurable period of time.

O. All Peripheral Stations must be fully supervised.

2.8.3 Consoles, Annunciators and Lights

2.8.3.1 Corridor Lights

A. Corridor (dome) and zone lights provide bright, easy-to-see visual annunciation that speeds response time and increases caregiver efficiency. These devices are typically installed in corridors and outside patient rooms to provide staff with a visual cue as to the origin of a call placed on the system.

B. Corridor (dome) lights operate in a similar fashion to annunciator panels or staff consoles: the light colour and flash rate indicates the type and priority of the call. Models are available with one, two, or four sections.

C. Each Corridor Light shall utilize Light Emitting Diodes (LED) for displaying colours. Corridor Lights utilizing incandescent bulbs shall not be accepted.

D. Corridor and Zone Lights shall be available in one, two, or four sections.

E. To maintain aesthetics, reduce obstruction, and limit risk of damage to devices, the maximum size of each Corridor Light shall not be greater than 5 inches in length, nor shall it protrude more than 3.5" from the mounted surface.

F. Each Corridor Light section shall be capable of indicating in excess of eight User-selected configurable colours. Corridor Lights requiring more than four sections to provide this many colours shall not be acceptable.

G. To allow for maximum flexibility, the Corridor Light shall be configurable via programming to allow multiple sections of a single light to illuminate and/or flash the same colour for higher priority calls.

H. Corridor Lights shall be able to match most existing Corridor Light schemes via programming. Systems with corridor light schemes that are not able to match existing systems shall be not be accepted.

I. Any corridor lights requiring the replacement of filter caps or lenses to obtain facility-requested corridor light colours for any priority shall not be accepted.

J. Corridor Light shall provide a diagnostic indication of room status to prevent maintenance personnel from disrupting patients.

2.8.4 Staff Consoles

A. The Staff Console is a primary point of contact among users of the system. It operates as both a user interface and a communications device that sends and receives data and audio signals over the IP network.

B. As a user interface, the Staff Console alpha-numerically displays incoming calls from stations and connected healthcare equipment, and provides a means for the operator to prioritize and respond to selected events. As an audio device, it provides audible signalling functions and facilitates two-way full-duplex staff/patient and staff/staff communications.

C. The Staff Console shall provide visual identification of the calling station(s) by room number, bed identification, priority, station type or call type. Staff Console audible annunciation shall indicate priority level. Incoming calls shall be displayed on the colour display in the colours for their associated priority levels. Staff Console shall also display an elapsed time for each pending call.

D. The Staff Console shall be IP-based, utilizing Voice over IP technology.

E. The Staff Console shall have a 5.7" backlit colour touch LCD screen.

F. The touch screen shall utilize programmable soft keys as opposed to a mechanical dial/touchpad.

G. Staff Console display shall provide an adjustable tilt mechanism for viewing clarity.

H. Intercom audio between the Staff Console and any station in the System shall be full duplex. Systems providing only one-way (half-duplex) audio shall not be accepted.

I. The Staff Console shall connect to the nurse call LAN/WAN utilizing CAT 6 cable and powered Ethernet. No separate power supply or wiring shall be used.

J. The call pending screen on the Staff Console shall allow five calls to be visible at a time and provide a simple scrolling function to view additional calls when more than six pending calls are present. Pending calls shall be displayed in priority order regardless of the order in which they are received.

K. The Staff Console shall have the ability to "automatically select" incoming calls in order of priority, or to allow the user to select what call to answer from the pending calls list.

L. The user shall have the ability to adjust the volume of the Staff Console incoming call tones.

M. User shall be able to make available or remove selected functions/buttons from the Staff Console screens where selected functions are not to be used and to simplify operation. Functions/buttons that can be removed include Audio Page, Swing/Capture/Share and volume adjustments.

N. User shall be able to make available or password protect selected functions/buttons from the Staff Console where functions are to be restricted to approved users. Functions/buttons that can be restricted include Audio Page, Swing/Capture/Share, Reminder Clear and volume adjustments.

O. The Staff Console shall provide users the ability to go into half duplex mode to provide the ability to not transmit discussions at the nurse station into patient rooms.

P. The Staff Console shall be able to call other Staff Consoles, Annunciators and VoIP Staff Stations on the same network. Staff Console/Annunciator/ VoIP Staff Station to Staff Console/Annunciator/VoIP Staff Station audio shall be full VoIP, full duplex.

Q. Staff Consoles and Annunciators shall be programmable to receive and display selected call priorities from desired areas, or to delay selected calls for a programmable interval.

R. Staff Consoles shall have the ability to adjust independent talk and listen volume levels via easy-to-use touchscreen controls. These settings shall be adjustable on a room-by-room basis. Systems using group or zone-wide audio adjustments shall not be accepted.

2.8.5 Annunciator Panels

A. The Annunciator provides a primary call display for users of the system. It operates as both a user interface and a communications device that sends and receives data and audio signals over the IP network.

B. As a user interface, the Annunciator alpha-numerically displays incoming calls from stations and connected healthcare equipment, and provides a means for the operator to prioritize and respond to selected events. As an audio device, it provides audible

signalling functions and facilitates two-way full-duplex staff/patient and staff/staff communications.

C. The Annunciator shall provide visual identification of the calling station(s) by room number, bed identification, priority, station type or call type. The Annunciator shall indicate priority level. Incoming calls shall be displayed on the colour display in the colours for their associated priority levels. Annunciators shall also display an elapsed timer for each pending call.

D. The Annunciator Panel shall be IP-based, utilizing Voice over IP technology.

E. Annunciators shall have a 5.7" backlit colour touch LCD screen.

F. The touch screen shall utilize programmable soft keys as opposed to a mechanical dial/touchpad.

G. Annunciators shall provide intercom capability via panel speaker and microphone. Intercom audio between the Annunciators and any station in the System shall be full duplex. Systems utilizing one-way (half-duplex) audio shall not be accepted.

H. The Annunciator shall connect to the nurse call LAN/WAN utilizing CAT 6 cable and powered Ethernet. No separate power supply or wiring shall be used.

I. The Annunciator shall be able to call other Annunciators, Staff Consoles and VoIP Staff Stations on the same network. Staff Console/Annunciator/ VoIP Staff Station to Staff Console/Annunciator/VoIP Staff Station audio shall be full VoIP, full duplex.

J. Staff Consoles and Annunciators shall be programmable to receive and display selected call priorities from desired areas, or to delay selected calls for a programmable interval.

K. The call pending screen on the Annunciator shall allow five calls to be visible at a time and provide a simple scrolling function to view additional calls when more than six pending calls are present.

L. The Annunciator shall have the ability to "automatically select" incoming calls in order of priority, or to allow the user to select what call to answer from the pending calls list.

M. User shall be able to make available or remove selected functions/buttons from the Annunciator screens where selected functions are not to be used and to simplify operation. Functions/buttons that can be removed include Audio Page, Swing/Capture/Share and volume adjustments.

N. User shall be able to make available or password protect selected functions/buttons from the Annunciator where functions are to be restricted to approved users. Functions/buttons that can be restricted include Audio Page, Swing/Capture/Share, Reminder Clear and volume adjustments.

2.8.6 Network Equipment

2.8.6.1 Switches and Gateways

A. All control equipment shall be IP-based, utilizing IP Switches and gateways for connection to room devices. These devices shall make up a UL 1069 Listed Nurse Call LAN/WAN. The controller equipment shall mount in a standard rack to be shared with the facility's IT equipment or shall mount in an independent rack. The IP switches and gateways shall have power supplies to support all field devices internally. Systems using a proprietary enclosure/card cage for central equipment and/or requiring power supplies apart from

the control equipment shall not be accepted.

B. IP Switches shall be networked, allowing all units/floors of a facility to connect as a single System. Each nurse call system shall connect to the hospital's network via a software bridge that isolates the hospital network from the nurse call network to maintain UL requirements. This connection to provide connectivity to supplemental features such as display screens, an ADT system, wireless telephones, pocket pagers, wireless Voice over IP devices, and a reporting database.

2.8.7 Call Cords

2.8.7.1 Single Call Cords

A. Provide call cords as required. The call cord shall have a heavy duty, moulded, ¼" connector, a flexible PVC jacketed cable, and a moulded, flame retardant, ABS switch housing. The switch shall be the momentary contact type. The cord shall be <8'> in length, have an integrated sheet clip, and be suitable for ethylene oxide sterilization.

B. Call Cords shall be of a sealed design with a smooth shape and minimal crevices to allow for easy, comprehensive cleaning to assist in keeping infectious contaminants out of the pendant and reduce the potential for cross contamination.

C. An optional call cord shall be available providing a call assurance LED indicating to the patient a call has been placed.

2.8.7.2 Breath Call Cords

A. Provide rate only for Breath call cords where needed for use by patients who do not have adequate use of their hands to initiate a call. The Breath call cord shall have a heavy duty, moulded, ¼" connector, a flexible PVC jacketed cable, and a momentary contact switch that is sensitive to air pressure. The cord shall be 9' in length, feature an adjustable arm for clamping the call cord onto a headboard or bed frame, and be suitable for use in oxygen atmospheres. Each Breath call cord shall be furnished with twelve (12) replacement straws.

2.8.7.3 Air Bulb Call Cords

A. Provide rate only for air bulb call cords where needed for use by patients who must remain distant from electrical fixtures. The air bulb call cord shall have a heavy duty, moulded, combination ¼" connector/air pressure sensitive switch. The "cord" shall consist of <6'> <10'> of flexible tubing terminated with an air bulb, have an integrated sheet clip, be suitable for use in oxygen atmospheres, and be suitable for ethylene oxide sterilization.

2.8.7.4 Geriatric Call Cords

A. Provide rate only for geriatric call cords where for use by patients who have minimal use of their hands to initiate a call. The geriatric call cord shall have a heavy duty, moulded, ¼" connector, a flexible <white> <beige> <gray> PVC jacketed cable with a sensitive, momentary contact reed switch that requires only a gentle squeeze or tap to activate. The cord shall be 10' in length, have an integrated sheet clip, and be suitable for ethylene oxide sterilization.

2.8.7.5 Pillow Speakers

A. Provide one (1) pillow speaker for each Single Patient Station and two (2) pillow speakers for each Dual Patient Station. The pillow speakers shall have an 18-pin, durable plug that can withstand accidental removal from station plug without damage to pillow speaker or patient station. The housing shall contain the nurse call button, a speaker, and buttons for

TV volume control and channel control in a moulded, flame-retardant, ABS housing. The cord shall be 8' in length and have an integrated sheet clip.

B. Optional 37-pin pillow speakers may be used to plug into 37-pin receptacles, either on the patient stations or on a separate device.

2.8.7.6 To Set Priority

While the room and bed number of a patient are selected and appear in the display window of annunciator panel, the system program shall allow the attendant to set any one of three groups of priority types by pressing the priority button (PRIORITY).

Patient Call Group—for assignment of one of three levels (Normal, Priority (Code Red), Emergency (code Blue)) to be displayed at the staff console as a four-character priority name when a patient or staffs places a call from the peripheral devices.

Selecting the desired priority shall cause the new priority to replace the old one, and the system shall acknowledge the successful change. The next time a call is placed by the patient or automatically placed by the device, the new priority (device name) shall be displayed at the master station.

2.8.8 Integrations

2.8.8.1 Interface engine

A. Each nurse call UL 1069 Listed network shall connect to the hospital's network via a software bridge that isolates the hospital network from the nurse call network to maintain UL requirements. This connection to the hospital's network shall be allow the integration of supplemental systems such as:
    1. Wireless communication system(s)
    2. Reporting Database
    3. ADT Integration
    4. Wireless Locating
    5. Electronic Whiteboard
    6. PC Staff Console applications
    7. Patient/Staff Assignments
    8. Automatic/Manual Messaging
    9. This integration shall provide a single database for the entire facility, for ease of administrator maintenance.

B. The integration platform MUST be compatible with other Nurse Call Systems offered by the selected vendor to allow migration options to other Systems. A Manufacturer whose interface platform cannot be shared with their other Systems shall not be accepted. The browser-based Management Reporting is required

2.8.9 Management Reporting

A. A server computer running Microsoft SQL Server and a reporting application shall reside on the hospital's network to monitor all nurse call activity and log events into the SQL database. Reporting applications that do not utilize Microsoft SQL Server shall not be acceptable. The nurse call events shall be retrievable in the form of user-defined reports. The reporting database must provide flexibility to generate reports for facility wide efficiency studies, unit performance statistics, incident report/details, and system performance/device failures.

B. Staff members shall be able to generate and view reports from any networked PC with Internet Explorer 6.0. Systems requiring staff members to go to a dedicated PC to generate or review reports, or requiring special software applications such as pc Anywhere to be loaded on PCs to provide report access, shall not be accepted.

C. The reporting database shall allow up to 25 user logins, and be expandable to 125 logins for access to generate or view reports. Systems that only allow a single user to generate or view reports at a time shall be considered unacceptable.

D. Staff shall gain access to the reporting package via a login name and password. Each staff member's password shall determine which areas within the facility the staff member can include in his or her reports.

E. The reporting system shall include a wizard that provides step-by-step instructions to the user. Help menus shall also be available so that the user does not need to refer to a hardcopy user manual for assistance.

F. The reporting system must be capable of automatically generating scheduled reports. When the report is generated, a hyperlink shall be emailed to predetermined recipients. The recipient may click on the hyperlink and log in to view the report. This is applicable to PC's on the hospital intranet with appropriate access in order to secure the data.

G. The reporting system shall allow report templates to be defined and saved. A user shall be able to select a template for fast and simple report generation. The system shall allow a minimum of 125 report templates to be set up and saved. The Reporting system shall have the option to provide up to 625 templates shall be available.

H. Reports shall be organized by the user to include and sort data by any or all the following categories:

1. Time and Date-Range in days, hours, and minutes
2. Shift-Range in hours and minutes
3. Room/Bed Number-A range of bed numbers between four to six digits
4. Area Name-19 characters assigned to a group of rooms
5. Call Priority-Seven levels
6. Event-Any combination or all nine events
7. Staff Level-Any one or all three levels
8. Patient Name-Up to 25 characters

I. Dependent on the user's report selections, a generated report shall include a statistical summary of the maximum and average times for the following event pairs at each priority level:

1. Place/Answer-The interval between the time a call is placed to the Staff Console and the time the Staff Console answers the call.

2. Place/Clear-The interval between the time a call is placed to the Staff Console and the time a staff member makes the first response by answering from the Staff Console, pressing the presence set button at the originating station, or pressing the CANCEL button at the originating station.

3. Place/Cancel-The interval between the time a call is placed to the Staff Console and the time it takes for a staff member to disconnect the call at the Staff Console (unless the reminder feature is activated), press the CANCEL button at the originating station, or press the presence clear button at the originating station.

4. Connect/Disconnect-The interval between the time a Staff Console either originates or answers a call and the time the Staff Console ends the call.

5. Reminder Set/Reminder Clear-The interval between the time the reminder feature is activated for a particular room/bed number and the time the reminder feature is cancelled.

6. Presence Set/Presence Clear, the interval between the time the presence feature is activated

at a station and the time the presence feature is cancelled, with associated call/event.

J. The reporting system shall then take the Place/Answer, Place/Clear, Place/Cancel, and Reminder Set/Reminder Clear statistical summaries and display them in the report as a percentage in comparison to target rates determined by the administration. A percentage between 0 and 99 indicates that the staff's response time did not meet the standards set by the author of the report or the administrator of the system.

K. The reporting system shall allow each area of the facility to set target response times for each of the call priorities. Various types of exception reports shall be available to provide information about calls that were not handled within the department's target time. Systems with reporting packages that do not allow each area to set target times or to create exception reports shall not be accepted.

L. The reporting system shall record system failure signals, thereby allowing maintenance personnel to generate reports relating to system reliability and service response times.

M. Where supported, wireless phone integration (if present), shall provide the Nurse Call system an 'acknowledgement' of events sent to the wireless interface to be recorded in the reporting system providing historical data on the success of events being automatically routed to caregivers wireless devices. The client-based Shift Assignments are required

2.8.10 Patient, Staff Assignments

A. Staff assignment software to assign staff to wireless devices and staff to beds shall be available via client-based software. The staff assignment screens shall be password protected. The login password shall determine the staff, beds and wireless devices available to the operator.

B. The assignment screens shall allow the user to choose whether the patient name shall be displayed for each bed (requires an ADT interface), or whether each bed shall be simply indicate its current patient stations (occupied or empty).

C. The staff assignment software shall allow for shifts to be created ahead of time and saved so that they can be reused.

D. The staff assignment software shall provide active help to guide the user through the process (without opening a separate help screen). Help screens shall also be available for more detail instructions.

E. The staff assignment software shall provide the ability to manage float staff. The user shall be able to reassign Staff that work in various locations throughout the hospital from one unit to another without entering the staff names into multiple databases.

F. The staff assignment software must be client-based, allowing shift assignments to be completed from any networked computer in the facility. Systems requiring a dedicated PC for completion of staff assignments shall not be accepted.

2.8.11 Messaging

A. The System shall allow text messages to be sent to wireless devices from a messaging browser. Login to the browser shall be password protected.

B. The messaging software shall allow the user to send a message to a caregiver's wireless device by selecting either the caregiver's name, the caregiver's wireless device number, the number of the bed that requires assistance, or the name of the patient that requires assistance (requires ADT interface). Systems that require the

user to know who is assigned to a bed/patient in order to send a message shall not be accepted.

C. The messaging software shall provide feedback to indicate that the wireless system has received the message. Systems that do not provide acknowledgment of sent messages shall not be accepted.

D. The messaging software shall be browser-based, allowing users to send messages from any networked PC with Internet Explorer 6.0. Systems that require a dedicated PC or special software loaded onto individual PCs to provide messaging access shall not be accepted. The Wireless Telephone Integration is required.

2.8.12 Wireless Telephone Integration

A. The Nurse Call System shall allow connection to any brand of in-house wireless telephone system including wireless VoIP systems. This integration shall allow calls from patients to automatically ring the wireless device of the assigned caregiver(s). The wireless device must show the caregiver the bed number of the call, the call type/priority, and optionally either the unit name or the patient name (with presence of ADT interface).

B. The wireless telephone integration shall allow no less than three levels of staff, plus a charge nurse and a "group," to be assigned to each patient/bed or call priority. These assignments shall be performed via the client-based assignments software. The rollover time from the primary staff member to the secondary, tertiary, and charge nurse shall be definable by the facility.

C. A call escalation manager shall manage automatic messaging to wireless devices. The call escalation manager shall also provide group page functions that allow any defined group of devices to receive any selected call type(s). When a call is sent to a group, the call escalation manager shall also provide the ability to transmit a "call cancel" in the event of a call being attended to; remaining staff not yet on-site can be notified that the situation has been attended to.

D. System shall be capable of integrating to wireless devices without the need for additional third party software.

E. The wireless integration shall allow device failures in the Nurse Call System to generate an automatic call directly to a Biomed device.

F. The Wireless integration shall not require User to disable functions of the wireless phones including voice mail.

2.8.13 Pocket Pager Interface

A. The Nurse Call System shall allow connection to most brands of in-house pocket pager systems via TAP 1.8 protocol. This integration shall allow calls from patients to automatically send text messages to their assigned caregiver(s). The pager display must show the caregiver the bed number of the call, the call type/priority, and optionally the unit name or patient name (with presence of ADT interface).

B. The pocket pager integration shall allow no less than three levels of staff, plus a charge nurse and a "group," to be assigned to each patient/bed or call priority. These assignments shall be performed via the client-based assignments software. The rollover times between assigned caregivers shall be definable by the facility. Each Nursing Unit shall be have the ability to define rollover times independent of other department requirements.

C. A call escalation manager shall manage automatic messaging to the pocket pagers. The

call escalation manager shall also provide group page functions that allow any defined group of devices to receive any selected call type(s).

D. The call escalation manager shall also provide the ability to transmit a Call Cancel in the event of a call being attended to; remaining staff not yet on-site can be notified that the situation has been attended to.

The pocket pager integration shall allow device failures in the Nurse Call System to generate an automatic page to a Biomed pager(s).

E. The pocket pager integration shall allow housekeeping events to generate an automatic page to a Housekeeping device.

2.8.14 ADT Interface

A. The System shall allow automatic monitoring of the facility's HL7 (Version 2.2/2.3) Admit, Discharge & Transfer (ADT) transactions, and shall parse selected patient demographic fields into the Nurse Call System's database. This data shall be made available to assignments, messaging, electronic white board, and reporting applications.

2.8.15 Net Board Electronic Whiteboard

A. An electronic 'white board' shall provide automated, real-time patient and staff information. This software client shall display real-time data in a format configurable by the user. There shall be more than 40 fields of data available to display, selectable on a per unit or login basis. Twelve of these fields must allow for on-the-fly manual entry of notes pertaining to the bed/room that remain with the room, and an additional twelve fields for notes pertaining to the patient. Notes associated with the patient must transfer with the patient when moved to another bed/unit.

B. Patient information shall automatically populate (with interface to ADT system).

C. Staff information shall automatically update from the client-based assignments software.

D. The electronic white board must allow up to 125 simultaneous logins, each having the ability to customize their screen as needed.

2.8.16 Telephone Gateway

A. The nurse call network shall be equipped with an SIP compatible device that has SIP IP for connection to PBX extension ports.

B. The telephone gateway shall provide access to wired telephones that are connected to the hospital's telephone system. It shall allow wired or wireless telephones to communicate with Patient and Staff Stations. The call information shall include the room and bed identification, call type, and patient name (if available from ADT). The telephone gateway shall communicate using standard telephone protocols.

C. The telephone gateway shall be programmable via any PC that is connected to the network, either onsite or remotely. The gateway shall support up to 512 stations on the Nurse Call System. The gateway shall accept multiple inputs and outputs to connect to multiple Systems on site.

2.8.17 List View Client Software

A. List View Client Software shall be available to provide a list view of unit activity to supplement the Staff Console. This client shall provide information on:
   1. Pending calls
   2. Active reminders

3. Reminder reason
4. Staff Location (automated with presence of IR Locate)
5. Patient record data (manually or automatically with presence of ADT Interface)
6. Activity history per patient/bed including:
    a) Calls
    b) Audio connection to room
    c) Reminders
    d) Text messages (automatic and manual)
    e) Staff Arrivals
7. Nine levels of staff

B. The List View Client shall automatically expand to show room summary for the first call on the pending calls list.

C. Each List View login shall be capable of having a unique reminder reason and messaging list. Systems requiring all users to share the same remind and messaging list shall not be accepted.

D. The List View Clients shall be password protected. The login password shall determine the units visible and view preferences for each client.

E. List View Client's text colors shall be configurable to match Corridor Light settings.

F. The List View Client shall be capable of messaging a caregiver (one of three levels assigned plus charge or team) from the List View screen

G. Staff icons shall be configurable to match their staff type via one of nine available levels/colors. Systems limited to less than nine staff types shall not be acceptable.

H. The List View Client shall be capable of running on an existing PC at the nurse station or on a PC dedicated to Nurse Call System functions. Systems requiring a dedicated PC for the functions listed shall not be accepted.

I. List View Clients shall be capable of 'filtering' call activity based on call priority and/or what nursing unit the event was generated. Font size and color shall also be configurable. These features shall allow List View Clients to have the flexibility serve as system wide Supplemental Code Blue Display(s) and departmental status screens to allow LCD's or Plasmas to be used as an option to marquee displays.

2.8.18 Map View Client Software

A. Map View Client Software shall be available to provide a map view of each nursing unit via login to supplement the Staff Console. This client shall display the following information:

1. Staff list shall sort by level, name, device type (phone/pager), and device ID
2. 3D unit map
3. Staff location via multi-coloured icons
4. Call activity via room colour change
5. Reminder icons
6. Activity history per patient/bed including:
7. Calls
8. Audio connection to room
9. Reminders (with optional Reminder reason)
10. Text messages (automatic and manual)
11. Staff Arrivals
12. Location list shall be sortable by level, name, location or battery status
13. Patient census list shall be sortable by patient name, bed number
14. Unique icon for each device type (pager, phone, team)

15. Display bed-by-bed, three levels of assigned staff plus charge and active teams

B. Staff presence icons shall be configurable to match staff level/type. Up to nine colours/levels shall be available.

C. The Map View shall be configurable on site using a pick and place set up wizard. Systems requiring CAD files to be imported or graphical software for creation of unit maps shall not be accepted.

D. The Map View Client shall automatically show room summary for any selected room.

E. The Map View Clients shall be password protected. The login password shall determine the units visible and view preferences for each client.

F. The Map View Client shall be capable of running on an existing PC at the nurse station or on a PC dedicated to Nurse Call System functions. Systems requiring a dedicated PC for the functions listed shall not be accepted.

2.8.19 Real Time Locate System Integration

A. The Nurse Call System shall allow connection to a third party Real Time Locate System (RTLS). The Locate "network" shall be an optional infrastructure integrated to Nurse Call via a software connection.

B. The RTLS, when integrated to Nurse Call, shall be configurable to provide the following functionality when staff wearing a RTLS device enters a room:

1. A pending patient normal call shall be cancelled and all associated LED's and signals shall be extinguished, if a Staff Console or Wireless Phone had not previously answered the call.

2. A pending reminder shall be cancelled and all associated LED's and signals shall be extinguished if the appropriate level of staff has entered the room for the given reminder level.

3. The matching coloured section of the corridor light, as assigned to the RTLS device of the staff member entering the room, shall steadily illuminate to indicate staff presence.

4. The Status LED on the Patient Stations shall steadily illuminate while staff is in the room.

5. While staff is registered in a patient room a double press of the call button on the bed rail, pillow speaker or call cord shall generate a Staff Emergency call, providing staff and patients an additional level of safety.

6. MapView, and ListView and NetBoard Clients shall indicate staff locations

C. The Management Reporting software (if present) shall record all events of staff entering and exiting patient rooms. This data shall be available to draw reports showing identification of staff entering patient rooms; time stamped and indicates duration with the patient when associated to a call.

The Nurse Call System's software (i.e. – List View Clients) shall be capable of displaying low battery signals (provided the RTLS sends this data to the Nurse Call System).

D. The RTLS shall be capable of supporting Equipment Tracking. Equipment tags shall be configurable providing the nurse call system the option to display device locations on the corridor lights.

2.8.20 Submittals

2.8.20.1 Project Submittal

A. The Sub - contract or shall purchase no equipment for the System specified herein until the User has approved the project submittals in their entirety and has returned them to the Sub - contractor. It is the responsibility of the Sub - contract or to meet the entire intent and functional performance detailed in these specifications. Approved submittals shall only allow the Sub - contract or to proceed with the installation and shall not be construed to mean that the Sub - contract or has satisfied the requirements of these specifications. The Sub - contract or shall submit three (3) complete sets of documentation within 30 calendar days after a purchase order is awarded.

B. Each submittal shall include a cover letter providing a list of each variation that the submittal may have from the requirements in the Sub - contract documents. In addition, the Sub - contract or shall provide specific notation on each shop drawing, sample, catalogue sheet, installation manual, etc. submitted for review and approval, of each variation.

2.8.20.2 Closeout Submittal

A. Two (2) copies of the following documents shall be delivered to the building User's Representative at the time of System acceptance. The closeout submittals shall include:

1. Project-specific operating manuals covering the installed System.

2. As-built drawings consisting of: a scaled plan of each building showing the placement of each individual item of equipment, as well as raceway size and routing, junction boxes, and the conductor size, quantity, and colour in each raceway. All drawings must reflect point-to-point wiring, device addresses, and programmed characteristics.

3. The application program listing for the System as installed at the time of acceptance by the building User (disk, hard copy printout, and all required passwords).
4. The name, address, and telephone number of the authorized factory Representative.

2.8.21 Quality Assurance

2.8.21.1 Qualifications of Sub - contractor

A. The Sub - contract or shall have successfully installed similar Systems of comparable size and complexity. The User reserves the right to reject any control components for which evidence of a successful prior installation performed by the Sub - contract or cannot be provided.

B. The Sub - contract or shall have in-house engineering and project management capability consistent with the requirements of this project. Qualified and approved Representatives of the System Manufacturer shall perform the detailed engineering design of all control equipment. Qualified and approved Representatives of the System Manufacturer shall produce all drawings, submittals, and operating manuals. The Sub - contract or is responsible for retaining qualified and approved Representative(s) of those System Manufacturers specified for detailed System design and documentation, coordination of System installation requirements, and final System testing and commissioning in accordance with these specifications.

2.8.21.2 Pre-Installation Requirements

A. The provider shall submit a detailed project plan that shall be describe in detail how the provider shall be approach the project from inception to finalization. The plan must include at a minimum the following information:

1. Project Staging
2. Project Management
3. Equipment Schedules
4. Installation Time Lines
5. Other Trade Requirements
6. Final Acceptance Testing
7. Personnel Resumes
8. Progress Report Sample

B. All equipment and components shall be installed in strict compliance with each Manufacturer's recommendations. Consult the Manufacturer's installation manuals for all wiring diagrams, schematics, physical equipment sizes, etc. before beginning System installation. Refer to the Manufacturer's riser/connection diagrams and details for all specific System installation/termination/wiring data.

2.8.22 Delivery, Storage and Handling

2.8.22.1 Receiving and Handling

A. The Sub - contract or shall be responsible for all receiving, handling, and storage of his materials at the job site.

B. Use of loading docks, service driveways, and freight elevators shall be coordinated with the User.

2.8.22.2 Storage

A. The User shall be provide the Sub - contract or with a lockable storage space for the Sub - contractor's use during this project. The Sub - contract or shall be responsible for the security of this space.
B. Overnight storage of materials is limited to the assigned storage area. Materials brought to the work area shall be installed the same day or returned to the assigned storage area unless previously approved by the User.

2.8.22.3 Rubbish

A. The Sub - contract or shall remove rubbish and debris resulting from his work on a daily basis. Rubbish not removed by the Sub - contract or shall be removed by the User and back-charged to the Sub - contractor.

B. Removal of debris and rubbish from the premises shall be coordinated with the User.

2.8.23 Project Conditions

2.8.23.1 Conditions

A. It shall be the Sub - contractor's responsibility to inspect the job site and become familiar with the conditions under which the work shall be performed. Inspection of the building may be made by appointment with the User. Sub - contractors are requested to inspect the building prior to the pre-bid meeting.

B. A pre-bid meeting shall be held to familiarize the Sub - contractors with the project. Failure to attend the pre-bid meeting may be considered cause for rejection of the Sub -

contract or's bid. The minutes of this meeting shall be distributed to all attendees and shall constitute an addendum to these specifications.

C. All work, except for …… may be conducted during normal working hours, 8:00 a.m. to 5:00 p.m., Monday through Friday, by properly coordinating the work with the User. Noise restrictions do apply. The core drilling, testing of signals, and other work disruptive to occupants shall be prohibited between 6:00 a.m. and 6:00 p.m., Monday through Friday, and shall be explained at the pre-bid meeting. The Sub - contract or is to include, in his base bid, all overtime necessary to complete his work.

D. The Sub - contract or shall be responsible for prior coordination of all work and demolition with the User.

2.8.24 Warranties and Maintenance

2.8.24.1 Warranty

A. The Sub - contract or shall warranty all materials, installation, and workmanship for one (1) year from date of acceptance, unless otherwise specified. A copy of the Manufacturer's warranty shall be provided with closeout documentation and included with the operation and installation manuals.

B. The System Supplier shall maintain a service organization with adequate spare parts stock within 75 miles of the installation. Any defects that render the System inoperative shall be repaired within 24 hours of the User notifying the Sub - contractor.

2.8.25 Training

A. The System Supplier shall schedule and present a minimum of 8 hours of documented formalized instruction for the building User, detailing the proper operation of the installed System.

B. The instruction shall be presented in an organized and professional manner by a person who has been factory trained in the operation and maintenance of the equipment and who is also thoroughly familiar with the installation.

C. Optionally, in service training for clinical staff shall be conducted by clinical professionals. Vendors who cannot provide trainers with clinical background for in-service training shall not be accepted.

2.8.26 Installation

2.8.26.1 General

A. All equipment shall be attached to walls and ceiling/floor assemblies and shall be mounted firmly in place. Fasteners and supports shall be sized to support the required load.

2.8.26.2 Conductors

A. The requirements of this section apply to all System conductors, DC power, and grounding/shield drain circuits, and to any other wiring installed by the Sub - contract or pursuant to the requirements of these specifications.

B. All circuits shall be rated and power limited in accordance with the National Electrical Code (NEC), and installed in conduit or enclosed raceway. All System conductors shall be of the type(s) specified herein.

- Category 6

- 16 AWG Power (if applicable)

2.8.26.3 Conductors and Raceways

A. The entire System shall be installed in a skilful manner in accordance with approved Manufacturer's installation manuals, shop drawings, and wiring diagrams. The Sub - contract or shall furnish all conduit, wiring, outlet boxes, junction boxes, cabinets, and similar devices necessary for the complete installation. All wiring shall be of the type required by the NEC and approved for the purpose by local authorities having jurisdiction.

B. Any shorts, opens, or grounds found on new or existing wiring shall be corrected prior to the connection of these wires to any panel component or field device.

C. All penetration of floor slabs and firewalls shall be fire-stopped in accordance with all local fire codes.

2.8.27 Field Quality Control

2.8.27.1 Test & Inspection

A. All wiring shall be tested for continuity, shorts, and grounds before the System is activated.

B. All test equipment, instruments, tools, and labour required to conduct the tests shall be made available by the installing Sub - contractor.

C. The System, including all its sequence of operations, shall be demonstrated to the User or his Representative. In the event the System does not operate properly, the test shall be terminated. Corrections shall be made and the testing procedure shall be repeated until it is acceptable to the User, his Representatives, and the Fire Inspector.

D. At the final test and inspection, a factory-trained Representative of the System Manufacturer shall demonstrate that the System functions properly in accordance with these specifications. The Representative shall provide technical supervision, and shall participate during all of the testing for the System.

2.9 IP Based Public Address and Voice Evacuation System

2.9.1 General Requirements & Scope

The PA/VA system shall be integrated with the fire detection and alarm system to provide the specified cause and effect / alarm sequencing in the event of a fire being detected within the building. The necessary interface units required to achieve the specified cause and effect shall be built within the PA/VA control equipment / racks and pre-wired to clearly marked terminals.

No modification of the CIE is allowable on site and all interface requirements must be carried out as part of the rack build prior to shipping to site.

The PA/VA controllers / routers shall be fully IP configurable and the system must have the capability of allowing up to 250 controllers being connected on a single system. Each controller shall be capable of controlling 4 channels of audio with simultaneous announcements from different sources being operated across all 4 channels.

Connection locally within a rack shall be via a CAT. 6 screened cable, where multiple racks are deployed around the site connection between the racks shall be achieved using a fibre optic cable certified to BS8434-2 for 'enhanced' operation in the event of a fire. Each rack on a network using the fibre optic cable shall be fitted with a fibre switch to control and

manage the network connectivity, the fibre switch shall be EN54-16 certified.

The PA/VA equipment rack shall be supplied with a 4 way, duplex, fibre Patch panel and necessary supporting materials to allow the direct termination of the network fibre optic cable within the rack, external terminations of the network cable shall not be considered. The PA/VA network shall have a 100mbit bandwidth / capacity and be capable of transmitting ~200 concurrent messages.

The CIE shall be battery backed in the event of a failure of the mains supply for a period of 24 hours with the additional capacity of operating at full alarm load for a period of 30 minutes following this period. Standby batteries shall be provided in the form of sealed lead acid cells. The CIE shall be supported using an EN54-4 power supply unit. The racks supplied shall be IP31 rated with a glazed, lockable door. Please note that the PA/VA system indications must be visible with the door closed on the rack from a distance of 600mm.

Prior to the PA/VA racks being shipped to site a Factory Acceptance Test (FAT) shall be carried out at the manufacturer's premises; the FAT shall be confirm the system functionality (cause and effect) and fault free products prior to shipment of the CIE racks. The FAT tests being carried out shall be formally documented, copies of such being handed over as part of the overall O&M manuals on completion of the project.

The design of the loudspeakers required to provide the automatic and manual speech announcements in the building shall be in accordance with the requirements detailed in section 14 of BS5839-3: 2013.

The intelligibility level this project is to be designed to meet is 0.5STI. Where necessary the services of a specialist acoustic engineer shall be engaged and you shall provide a statement in your tender return confirming how you shall be achieve the audibility and intelligibility requirements of BS5839-8: 2013. Where necessary you shall be provide evidence in the form of an academic acoustic model.

The system supplied shall meet the following requirements with respect to audibility and intelligibility:

- 10dB greater than ambient background noise levels for speech messages
- The minimum audibility requirements of BS5839-1: 2013 for the attention grabbing tone preceding the emergency message

The spacing of loudspeakers shall be guided as per section 14 of BS5839-8:2013, particular attention shall be made in the design of loudspeaker layouts to the following:

Loudspeakers should be chosen primarily for their ability to produce an intelligible result rather than for aesthetic considerations such as size or appearance.

In a normal acoustic environment loudspeaker placement shall satisfy the following:

The distance between the centres of loudspeakers shall not greater than:

- 6m for unidirectional loudspeakers; and
- 12m for bi-directional loudspeakers

The unobstructed distance between the loudspeaker and any listener is not greater than:

- 6m for unidirectional loudspeakers; and
- 12m for bi-directional loudspeakers

The fire alarm evacuation zones associated with the PA/VA system specified are detailed within

The Public Address (PA) zones required are detailed in appendix 2.
The loudspeaker circuits to be installed shall be fully monitored and the system shall have the flexibility to be able to provide both impedance and/or end of line monitoring.

Impedance monitoring shall be employed in any circuit where there are 20 loudspeakers or less, where there are greater than 20 loud speakers on a given circuit end of line monitoring shall be employed. All loudspeaker zones shall be wired with a minimum of an A and B circuit with all loudspeakers being evenly distributed and interleaved across both circuits. In the event of a failure of a single circuit 50% of all loudspeakers shall remain in operation and evenly distributed.

The system supplied shall have the capability of having loudspeakers installed in the form of a loop within a single fire or PA zone. The loop shall be fitted with short circuit isolators between every 10 loudspeakers providing a high level of system integrity. A loudspeaker loop shall not exceed 1000M in length with a maximum load of 500 watts.

Paging and Fireman' Microphones shall be installed in accordance with appendix 3. The microphones shall be connected via the system data bus using a screened CAT. 6 cable (fire rated in the case of the Fireman's MIC's to BS8434-2) and wired in the form of a radial circuit back to the PA/VA rack/s.

The MIC's must be controlled and powered by the PA/VA CIE and supplementary PSU's local

to the MIC's shall be not be permissible.

The maximum cable distance using a CAT. 6 cable between the MIC's and the PA/VA CIE shall not exceed 300M, where distances exceed 300M the system shall have the capability of being able to supply the wiring of the MIC's utilizing fibre optic cabling. The units shall be certified to EN54-16.

All amplifiers to be supplied shall be class D and fully monitored and available in sizes of 4 x 125 watts, 4 x 250 watts, 2 x 250 watts, 2 x 400 watts and 2 x 500 watts. The units shall be certified to EN54-16.

Where possible the use of Direct Drive Amplifier (DDA) shall be employed where the 100v loudspeaker line is driven directly from the amplifier and a secondary transformer is not employed. This option shall be allow racks to be both smaller and lighter. Any DDA amplifier used as part of the rack build shall have an internal EN54-4 battery charger. Standby amplification is not required in line with BS5839-8: 2013 section 16.

The voice alarm system specified shall have the capability of being controlled and managed via a Graphical User Interface (GUI). The GUI shall be supplied in the form of a touch screen PC and monitor with graphics pages drawn and imported to provide a visual overview of the site. The GUI provided must be able to control PA/VA zones or groups of zones in order to route messages, control entertainment equipment and make schedule announcements.

The GUI shall be supported on a PC with the following minimum specification:

- 1 GB RAM or higher
- Free hard disk space min 200MB
- CD-ROM / USB
- Network card 100 Mbit or higher
- Microsoft Windows®2000 / XP
- Professional / Vista / 7 compatible
- Monitor with 1280 x 1024 pixel (ratio 4:3, 16:9 not supported)

With the addition of a System Communication Unit (SCU) detailed further within this specification the following functionality shall be achieved via the GUI:

- Recording, prior listening and discarding of announcements
- Simultaneous play back of pre-recorded audio messages
- Scheduler function for automatically controlled audio messages
- System status and indication logging
- Call 'stacking' functionality where two calls may be transmitted to a common area simultaneously but shall be played individually according to their system priority level

Before commencement of construction of the rack/s for this project a User Requirements Document (URD) shall be completed, signed and issued to the specialist supplier conforming that the product being built is in accordance with the design requirements of the project. The URD shall be confirm:

- VA Zones
- PA Zones
- Microphone's to be supplied (Paging and Fireman's)
- Standby battery requirements
- Special message requirements
- Entertainment system requirements

The following cable types shall be employed;

Voice Alarm Product;

Description	Cable type	Fire rated
Loud speaker	Cat 6	Yes
Fireman's microphone	Cat 6	Yes
Fire Interface	2 core	Yes
Network cable	Cat 6	Yes
Music interface	2 pair twisted	No

2.9.2 Technical Specification

Products to be supplied as part of this project shall meet the following technical specifications for each system component as detailed below. PA/VA Controller / Router for up to 24 loudspeaker zones (583362.22) System master control module with audio signal processing for connecting and controlling power amplifiers and associated control equipment with the following functionality:

- Four independent audio outputs for connecting power amplifiers (up to 500W per channel) and for simultaneous processing of up to four different audio channels per controller
- Connection of audio signal to one or up to six user-defined loudspeaker zones for each audio output to obtain up to twenty-four loudspeaker circuits per module (12No A&B Zones)
- Upgrade to a complex alarm/ public address system through integrated LAN interfaces
- Continuous monitoring of power amplifiers by means of a 22 kHz test tone. The defined loudness level is also taken into account for the backup amplifier (where employed)
- Continuous inaudible monitoring of loudspeaker circuits (earth faults, short / open circuits, and impedance deviations with specified tolerances for each loudspeaker circuit)
- Continuous monitoring of line and microphone of up to four connectable Microphones or universal input modules per control module
- Audio filters such as parametric equalizers, high and low-pass filters and delays per audio channel can be set
- Four sensor inputs for optional, continuous and automatic volume control in real time, independent of the ambient noise level
- Eight programmable, potential free contact outputs for controlling external components (e.g. priority relays) or for signalling various indicator states (collective fault messages)
- Four Ethernet 100 Mbit/s interface connections with switch function.
- Integrated TWI bus for optional connection of an additional module (e.g. time synchronization using TCM-GPS)
- Display for indicating operation status, errors, circuit connection, and active power-saving mode via multi-coloured LEDs
- Emergency control operation (Power Save) during a power failure to preserve battery capacity – this means not activating background music or low-priority announcements when there is a failure in the primary power supply. The connected amplifiers are switched to standby mode
- Non-volatile audio memory for up to 1 hour, freely scalable, for user specific canned audio

2.9.3 System communication unit (SCU)

The system communication unit (SCU) shall act as a digital audio memory for the PAVA system. The unit shall be provide a minimum of 50 channels of audio data to be recorded and played back at the same time – regardless of the available bandwidth from the PA/VA network.

The connection to a PA/VA system network shall be established via Ethernet and is monitored continuously, the SCU shall be housed within one of the equipment racks to be supplied as part of this project. As per EN54-16, the audio data for critical alarms and evacuation messages shall be stored on non-volatile flash memory. The memory capacity within the SCU shall be a minimum of 2 hours.

Additional messages, such as announcements, signals, music files or advertising texts, shall be stored on a hard drive within the SCU. The memory capacity shall be a minimum of 1,000 hours.

2.9.4 VCM display/control module

The View control module for clear and easy display of collective messages and for operation of the voice alarm system in accordance with the EN 54-16 standard with the following:

Each rack or system must have control and display indications to ensure compliance with EN54-16. In a networked system confirmation prior to the building of the control racks shall be sought to confirm which rack shall house the VCM module.

- 5 keys for operating the voice alarm system
- Integrated buzzer for acoustic signals

2.9.5 Power Amplifier

Power amplifier 4 x 125W; class D, 24 V DC (580242) highly efficient class D power amplifier having the following characteristics: Certified to EN54-16

- 4 x 125 watt channel Direct-Drive amplifier for voice alarm application that utilize industry standard 100V speakers (no step up secondary transformers on loudspeaker output) High efficiency (80% typical) Class D Amplifiers Delivers maximum possible power under any overload or overdrive condition to maintain intelligibility of voice messages
- Integrated temperature compensated battery charger certified to EN54 Part 4, capable of charging up to 65Ah battery pack
- Compliant with IEC BS EN 60268-3, 55013 55020 norms
- Microcontroller based extensive self-monitoring and control
- Protection against overload and wiring short
- Protection against overheating
- Temperature management with variable speed fan assisted cooling
- LED status display per audio channel for POWER, SIGNAL,
- CLIP, and FAULT
- LED status display for MAINS POWER; BATT POWER, CPU
- STATUS, SYSTEM FAULT
- Symmetrical audio inputs and control via CAT 5 cable with RJ45
- connector
- 100 V outputs via pre-assembled system cable, lockable

2.9.6 Fully digital paging microphone (MIC)

Fully digital paging microphone (MIC) with electret microphone (cardioid characteristic) on a flexible 300 mm long gooseneck with the following functionality:

- Integrated broadband loudspeaker for monitoring and previewing purposes as well as intercom functions
- Continuous acoustic monitoring of microphone capsule. Acoustic monitoring is not only used to check the functioning of the voice
- coil but also of the capsule
- 12 freely programmable buttons, which can be individually labeled
- 13 integrated and 12 freely programmable LED display elements

including a combined operation and error display
- Digital transmission of control signals and all four audio signals to and from the digital paging MIC and the supply voltage via DAL link
- The paging MIC shall be connected to the PAVA system controller via CAT 6 cable (screened) and RJ45 socket (up to 300 meters distance)
- Optional fiber optic connection for distances up to 2,000 meters
- RJ12 socket for connection with up to 6 expansion modules via
- daisy chain
- An audio input with 2 cinch sockets at the back of the digital call station for connecting an auxiliary device allows audio playback outside of the central control unit

2.9.7 Fireman's Microphone

Fully digital Fireman's microphone with handheld microphone and built in loudspeaker for monitoring and previewing purposes and intercom functions in surface-mounted or flush-mounted housing with the following functionality:

- Continuous acoustic monitoring of microphone capsule. Acoustic monitoring is not only used to check the functioning of the voice coil but also of the capsule
- Five freely programmable buttons for the alarm
- One button for the all-clear signal
- One button for reset/acoustic
- Three integrated LED display elements (in operation, fault, busy)
- Digital transmission of control signals and all audio signals to and from the digital call station and the supply voltage via DAL link
- The Fireman's MIC shall be connected to the PAVA system in star-shaped topology via CAT 5 cable and RJ45 socket (up to 300 meters distance)
- Optional fiber optic connection for distances up to 2,000 meters
- Display window and locking mechanism in accordance with EN 54-11
- Enclosure to be coloured Red

2.9.8 GPS time synchronization module

Module to all the PA/VA system to be time synchronization by means of GPS signals. This will allows accurately timed, automated announcements time-controlled volume adjustments or simply precise time-logging of announcements or trouble alarms.

The module shall be connected to the VA/PA system directly using a standard CAT. 6 cable (max. 10m) and shall be contained within one of the PA/VA racks to be supplied as part of this project.
A fault in the module or satellite reception is entered in the message list.
The GPS signal is transmitted to the receiver via the antenna and coaxial cable.

2.9.9 Graphical User Interface (GUI)

The Graphical User Interface is used to easily address zones, transmit and preview and voice announcements, and input and display text messages.

It shall be operated by means of a graphical user interface which displays the individual object with the loudspeaker or display zones. The application can also be used by means of a touch screen, so it has a simple and clear design and saves on space. The GUI shall be have the following functionality:

The graphics shall be created simply and conveniently using a bitmap of the building. A paging microphone shall be required local to the GUI for voice announcements.

- Full-screen application, suitable for use via touch screen
- Graphical view (e.g. building layout) for zone selection and status display
- Zone display in table form with selection and status display
- LIVE announcements via PTT (press to talk) button on screen or paging microphone
- Record, preview and transmit announcements.
- Input text messages for display view
- Text display in conjunction with voice announcements
- Time-controlled text display, in intervals or loops
- Status display for each zone – assigned or error
- Several PC call stations on one TCP/IP LAN
- Project-specific Help function

2.9.10 Loudspeakers

Loudspeakers shall be supplied for this project meeting the specifications detailed below as a minimum. All loudspeakers supplied shall be EN54-24 certified.

2.9.11 5" Ceiling Loudspeaker

EN54-24 certified voice alarm ceiling loudspeaker designed for flush fixing into suspended ceiling c/w fire dome.

Note maximum spacing between ceilings loudspeakers shall not exceed 6M.

Technical Specification:

Max power Rated	9w
Power Rated	6w
SPL AT 1W/1M (100 HZ - 10 KHZ)	91dB
FREQUENCY RANGE (-10DB)	180 Hz - 20 KHz
RATED IMPEDANCE	1.7k Ω / 3.3k Ω / 6.7k Ω / 13k Ω
POE enabled	Yes

2.9.12 Network Equipment

2.9.12.1 Switches and Gateways

A. All control equipment shall be IP-based, utilizing IP Switches and gateways for connection to room devices. These devices shall make up a UL 1069 Listed PA/VA system LAN/WAN. The controller equipment shall mount in a standard rack to be shared with the facility's IT equipment or shall mount in an independent rack. The IP switches and gateways shall have power supplies to support all field devices internally. Systems using a proprietary enclosure/card cage for central equipment and/or requiring power supplies apart from the control equipment shall not be accepted.

B. IP Switches shall be networked, allowing all units/floors of a facility to connect as a single System. Each PA/VA system shall connect to the hospital's network via a software bridge that isolates the hospital network from the nurse call network to maintain UL requirements. This connection to provide connectivity to supplemental features such as display screens, an ADT system, wireless telephones, pocket pagers, Nurse Call, wireless Voice over IP devices, and a reporting database.

2.9.13 Examination

A. Examine conditions, with the Installer present, for compliance with requirements and other conditions affecting the performance of the wireless clock system.

B. Do not proceed until unsatisfactory conditions have been corrected.

2.9.14 Installation

2.9.14.1 General:

Install system in accordance with applicable codes. Install equipment in accordance with manufacturer's written instructions.

A. Wiring Methods:

1. Conceal wiring except in unfinished spaces.

2. All new wiring on this project must be properly rated for the application.

3. Cable to the new devices at new locations shall be installed in a neat and professional manner, following the standard procedures used in the electrical Sub - contract ing trade.

4. Exposed wiring shall not be permitted under any circumstances on this project.

5. Any wiring, which is considered sloppy by the Engineer, shall be strictly unacceptable.

6. Upon installation completion, a room-by-room test shall be conducted for every device in the system. A technician shall perform the test after school hours, and repairs shall be performed as needed at no cost to the Engineer to any devices, which do not function correctly, including cable. A written room-by-room report following testing and repairs shall be prepared and submitted to the Engineer.

2.9.14.2 Field Quality Control

A. Sub - contract or Field Service:

1. Provide services of a service representative for this project location to supervise the field assembly and connection of components and the pre-testing, testing, and adjustment of the system.

B. Inspection

1. Make observations to verify that units and controls are properly labelled.

C. Testing:

1. Rectify deficiencies indicated by tests and completely re-test work affected by such deficiencies at the Sub - contractor's expense. Verify by the system test that the total system meets the specifications and complies with applicable standards.

2.9.15 Commissioning

Train Engineer's maintenance personnel in the procedures and schedules involved in operating, troubleshooting, servicing, and preventative maintenance of the system. Operator Manuals and User Guides shall be provided at the time of this training.

Schedule training with Engineer through the Architect, with at least seven (7) days advance notice.

2.9.16 Cleaning and Protection

Prior to final acceptance, clean system components and protect from damage and deterioration.

PRICE SCHEDULES

3 PRICE SCHEDULES

3.1 General Notes to Tenderers

1. The Bills of Quantities form part of the Sub - contract documents and are to be read in conjunction with the Sub - contract drawings and general specifications of materials and works.

2. The prices quoted shall be deemed to include for all obligations under the Sub - contract including but not limited to supply of materials, labour, delivery to site, storage on site, installation, testing, commissioning (**excluding 16% VAT**).

3. All prices omitted from any item, section or part of the Bills of Quantities shall be deemed to have been included to another item, section or part thereof.

4. The brief description of the items given in the Bills of Quantities are for the purpose of establishing a standard to which the Sub - contractor shall adhere. Otherwise alternative brands of **equal** and **approved** quality shall be accepted.

5. Should the Sub - contractor install any material not specified here in before receiving **written approva**l from the Project Manager, the Sub - contractor shall remove the material in question and, **at his own cost**, install the proper material.

6. The grand total of prices in the price summary page must be carried forward to the **Form of Tender for the tender to be deemed valid**.

7. The Bills of Quantities are divided generally into three sections:-

a. Sub - contractual Requirements – Bill 1

Sub - contractors Sub - contractual requirements as called for the bill of quantities shall be priced and included in the tender. However the Tenderer is free to include and price any other items he deems necessary taking into consideration conditions he is likely to encounter on site.

b. Installation Items – Other Bills

The brief description of the items in these Bills of Quantities should in no way modify or supersede the detailed descriptions in the Sub - contract Drawings, conditions of Sub – contract and specifications. The unit of measurements and observations are as per Volume 1 or as indicated in the Bills of Quantities.

c. Summary

The summary contains tabulation of the separate parts of the Bills of Quantities carried forward with provisional sum, summary volume included. The Sub - Contractor shall insert his totals and enter his grand total tender sum in the summary of prices of Volume 1.

3.2 Bills of Quantities

(Continue to next page)

PROPOSED FIT OUTS AND RE-ORGANIZATIONS FOR THE LABOR WARDS IN NAIROBI HOSPITAL					
NURSE CALL SYSTEM INSTALLATIONS					
A	**Section DW 1: Preliminaries and Contractual Requirements**				
S/N	**Contractual Power Requirements**	**Unit**	**QTY**	**Rate (Kshs)**	**Total (Kshs)**
1	Preparation of working drawings, printing and distribution.	Sum	1		-
2	Preparation of 'As Installed Drawings", printing and distribution as specified.Drawings to include:				
	(a) Blue Prints - 4 sets of each.	Sum	1		-
	(b) AutoCAD on CD – 2 No.	Sum	1		-
	(c) Operational Instructions, manuals and test certificates	Sum	1		-
3	Allow for Necessary Insurances (WIBA, etc) for the Works execution	Sum	1		-
4	Provision of Performance Bond as stated under clause 5 of the published conditions of sub-contract.	Sum	1		-
5	Allow for removal of existing equipment/items and handing over to the client.				-
6	Any other item necessary to complete the installations in this section (please state)	*Sum*	*1*		-
	Sub - Total Carried Forward to the Main Summary Page				-

E	Section DW 5: Nurse Call System Installations

S/N	Nurse Call System Installations	Unit	QTY	Rate (Kshs)	Total (Kshs)
	Server Supply and installation of rack mounted server unit configured Visio Call by Shrack Seconet or ZKR or equal and approved complete with Dual redundant modular power supplies and associated accessories, licences and a programming work station to management softwares, complete the installation.	No.	1	ON - SITE	
A					-
	Network Switch 24 Port Data POE switch as SWI-9 Series configured per Shrack Seconet or equal and approved to support Nurses Call System complete with links, 24 Port patch panels,				
B	cables organizers, Dual redundant modular Power supplies and associated accessories.	No.	1		-
	Staff Terminal; IP Based Answering unit for staff as centralized communication and information terminal of a ward. Speech connections and telephone calls are possible via the integrated hands-free facility or the receiver as Seconet Schrack (ST-TOUCH)				
B.		No.	1		-
C.	Connection module as Shrack Seconet SM-S	No.	9		-
D	Room Communication Terminal Unit (KMT)	No.	9		-
	Patient Terminal Unit	No.	8		-
E	Washroom Call - Pull Cord	No.	16		-
	Power Supply Unit (REDIN240-24)	No.	9		-
F	Call and Cancel button	No.	9		-
	Light Module Complete with Relay as (LM-IO)	No.	15		-
H.	Allow for Connecting of the above system with UTP Cabling done by others	Lot	1	-	-
	Sub - Total Carried Forward to the Main Summary Page				-

IP BASED PUBLIC ADDRESS AND PIPED MUSIC SYSTEM

Item	Description	Unit	Qty	Rate	KShs.
4.1	**<u>IP Based Public Address and Piped Music System</u>** For the supply, Installation, testing & commisioning of the following complete with associated accessories as specified and shown on the drawings.				
A.	IP Based 91dB, 9W RMS, 5" ceiling/ surface mounted speakers as Honeywell or approved equivalent complete with associated accessories as follows;	No.	4		-
B.	IP Based microphone as Honeywell or approved to be installed at the announcement station/ remote paging complete with associated accessories	No.	1		-
C.	Supply and installation of rack mounted IP Based Public Address controller Server complete with Back Ground Music Player and associated accessories, management softwares, licences to complete the installation.	No.	1	AT THE SITE	
D.	Allow use and configuration of the above system with Structured Cabling done by others (Cables by others)	Sum.	1		-
E.	Allow for interconnection and programming of the the above System	Sum.	1		-
F	Installation, testing & commissioning	Sum	1		-
G	Labeling, Documentation, 2 year Warranties, associated Training and certification. N.B; Provide comprehesive list of spare part and associated part numbers for above system	Sum	1	Included	
H	Any other item necessary to complete installation in this section (Please state)	Sum.			
Total carried forward to Main Summary of Prices					-

	Summary of Costs				
S/N	**Description**	**Unit**	**QTY**	**Rate (Kshs)**	**Total (Kshs)**
	MAIN SUMMARY OF PRICES				
A	SECTION 1 Preliminaries & Contractual Requirements	Lot	1		-
B	SECTION 2 Nurse Call System	lot	1		-
C	SECTION 3 IP Based P.A System	lot	1		-
	Figures are Inlcusive of 16% VAT				
	Sub Total for Nurse Call System				-
	Sub - Total Carried Out to Main Summary				-

4 TECHNICAL SCHEDULE

4.1 Documentation Requirements

Document	With Bid	Before Manufacture	During FAT	Upon Delivery
Preliminary general arrangement drawing (with dimensions)	YES			
QA / QC Plan in accordance with ISO 9001:2008		YES		
General arrangement drawing (with dimensions)		YES		
Schematics/Line diagrams for construction	N/A	YES	N/A	N/A
Recommended Spares List	N/A	N/A	N/A	YES
Routine Test Reports / Certificates			YES	
Type Test Reports / Certificates	N/A	N/A	YES	N/A
Commissioning Procedure	N/A	N/A	N/A	YES
As-built General arrangement drawing			YES	
As-built Schematics			YES	
Site Test Reports / Certificates				YES
Special Test Reports / Certificates	N/A	N/A	YES	NO

4.2 Technical Schedule

The tenderer **MUST SUBMIT** comprehensive manufacturer's technical brochures and performance details for all items listed in this schedule (fill forms attached).

ITEM No.	Description	Remarks
	Nurse Call system Public Address system	

APPENDICES

5 APPENDICES

5.1 Appendix I; Statement of Compliance

Technical Schedules shall be submitted by tenderers to facilitate and enable the Engineer to evaluate tenders but only when the fittings and accessories upon which the tenderer has based his tender sum differs in manufacture, type or performance from the description contained within this specification.

Tenderers shall submit separate leaflets and catalogues giving technical and physical details for all fittings and accessories described in the Technical Schedule at the time of tendering.

Completion of Technical Schedule shall not relieve the Contractor from complying with the requirements of the Specification except as may be approved by the Engineer.

…….. **(Signed)**

…….. **(Date)**

5.2 Appendix II; Exchange Rate Fluctuations

Adjustment will be made to the price of imported materials to compensate for variations in the foreign exchange rate. For this purpose, the tenderer is required to state the exchange rate in Kenya Shillings for the currency of the Country of origin of imported materials as applied to the actual remittance effecting payment to manufacturers of the materials.

Exchange Rate: ……

Signed (as in Tender) ……..

Date ……

5.3 Appendix III; System Warranties

The tenderer shall outline the warranties for all systems installed on this site as specified elsewhere.

These shall include but not limited, to the following:

- Nurse Call system
- Public Address system

5.4 Appendix IV; Schedule of Unit Rates

The tenderers shall provide a schedule of unit rates (under Tables (a) and (b) below) that shall be used to build up rates for variation items not specified in the bill of quantity.

This section, and the terms filled herein shall form part of the contract, and shall be considered locked for the duration of the project.

Rates filled herein shall be evaluated as part of the tender evaluation process. Attention is drawn to the tender evaluation criteria included in this tender package.

The sub-contractor shall disclose the cost of the material offered by the supplier, including or manufacturer or any other sources to the Engineer used to build up the rates in respect to schedule of table (a) and table (b) below. The engineer can reject the disclosed sources where the conflict of interest seems to prevail.

Table (a) and Table (b) shall be deemed to be exhaustive in capturing all cost components and the percentages filled herein shall be considered to be locked for the duration of the contract.

Locally Available Items

Unit rates for items that can be procured locally shall be generated according to table (a) below. Table (a) consists of the below items:

- Material cost – This is the supplier's unit cost for the item, i.e. the cost at the shop/supplier.
- Labor – This is to include all transportation, security, hoisting, installation, tools and consumables, testing, commissioning, costs, etc. The tenderer is to provide his/her labor cost as a percentage of material cost.
- Overheads and Profit – This is to capture all contractor's overheads, margins, profit, etc. The tenderer is to provide his/her overheads and profit as a percentage of material cost.
- Further to this, tenderers are expected to list all other cost carriers not deemed to have been captured in the table below, as a percentage of material cost.

1.1.1.1 Table (a): Locally Available Items.

Material Cost Kshs. (a)	Labour (as a percentage of material cost) (b)	Overheads and Profit (as a percentage of material cost) (c)	List any other component as necessary (as a percentage of material cost) (d)	Total Installed Cost of item Kshs. (VAT exclusive) (a+b+c+d)

Imported Items

Unit rates for items that will require importation shall be generated according to table (b) below. Table (b) consists of the below items:

- Material cost – This is the supplier's unit cost for the item as landed and cleared in Kenya. It includes FOB price, Carriage Insurance & Freight, Inspection Charges, Duty, Port Levies, Clearance Charges and VAT

- Labor – This is to include cost for transportation from port to site, security, hoisting, installation, tools and consumables, testing, commissioning and associated costs, etc. The tenderer is to provide his/her labor cost as a percentage of material cost.
- Overheads and Profit – This is to capture all contractor's overheads, margins, profit, etc. The tenderer is to provide his/her overheads and profit as a percentage of material cost.
- Further to this, tenderers are expected to list all other cost carriers not deemed to have been captured in the table below, as a percentage of material cost.

1.1.1.2 Table (b): Imported Items.

Material Cost Kshs. (a)	Labour (as a percentage of material cost) (b)	Overheads and Profit (as a percentage of material cost) (c)	List any other component as necessary (as a percentage of material cost) (d)	Total Installed Cost of item Kshs. (VAT exclusive) (a+b+c+d)

…….. **(Signed)**

…….. **(Date)**

…….. **(Official Stamp)**

5.5 Appendix V; Day Work Terms for Labour

(To Be Completed By Tenderer)

Description of Artisan	**Cost Per Hour**
Supervisor	……..
Grade A Plumber	……..
Grade B Plumber	……..
Grade C Plumber	……..
Labour	……..
Apprentices	……..

…….. **(Signed)**

…….. **(Date)**

…….. **(Official Stamp)**

5.6 Appendix VI; Technical Schedule

TECHNICAL SCHEDULE

The tenderer must complete in full the technical schedule. Apart from the information required in the technical schedule, the tenderer **MUST SUBMIT** comprehensive manufacturer's technical schedules details for all items listed in this schedule (fill forms attached).

Description	Manufacturer	Country of origin	Remarks (Catalogue No. etc.)
• Nurse Call system • Public Address system			

PART A

GENERAL MECHANICAL SPECIFICATION

1 PART A - GENERAL MECHANICAL SPECIFICATION

1.1 General

This section specifies the general requirements for plant, equipment and materials forming part of the Contract Works and shall apply except where specifically stated elsewhere in the Specification or on the Contract Drawings.

1.2 Quality of Materials

All plant, equipment and materials supplied as part of the Contract Works shall be new and of first-class commercial quality, shall be free from defects and imperfections and where indicated shall be of grades and classifications designated herein.

All products or materials not manufactured by the Contractor shall be the products of reputable manufacturers and so far as if they had been manufactured by the Contractor.

Materials and apparatus required for the complete installation as called for by the Specification and Contract Drawings shall be supplied by the Contractor unless mention is made otherwise.

Materials and apparatus supplied by others for installation and connection by the Contractor shall be carefully examined on receipt and stored. Should any defects be noted, the Contractor shall immediately notify the Engineer.

Defective equipment or that damaged in the course of installation or tests shall be replaced or repaired to the approval of the Engineer.

1.3 Regulations and Standards

The Contract Works shall comply with the current editions of the following:-

(a) The Kenya Government Regulations.

(b) The United Kingdom Institution of Electrical Engineering Regulations for the electrical equipment of buildings.

(c) The United Kingdom Chartered Institution of Building Services' Engineers Guides.

(d) The Kenya Bureau of Standards Specifications.

(e) European Standards/Codes of Practice published by British Standards Institution.

The Local Council By-laws.

The electricity Supply Authority By-laws.

The Kenya Building Regulations.

Other International Standards.

1.4 Electrical Requirements

Plant and equipment supplied under this Contract shall be complete with all necessary motor starters, control boards, and other control apparatus. Where control panels incorporating several starters are supplied they shall be complete with a main isolator.

The supply power up to and including local isolators will be provided and installed by the Electrical Contractor, all other wiring shall be as described in the Particular Specification.

The Contractor shall supply three copies of all schematic, cabling and wiring diagrams for the Engineer's approval.

The starting current of all electric motors and equipment shall not exceed the maximum permissible starting currents described in the Kenya Power and Lighting Company Ltd's By-laws.

All electrical plant and equipment supplied by the Contractor shall be rated for the supply voltage and frequency obtained in Kenya, that is 415 volts, 50HZ, 3-phase or 240 volts, 50HZ, 1-phase as specified in the particular specification.

Any equipment that is not rated for the above voltage and frequencies may be rejected by the Engineer.

1.5 Transport and Storage

All plant and equipment shall, during transportation be suitably packed, crated and protected to minimise the possibility of damage, and to prevent corrosion or other deterioration.
On arrival at site all plant and equipment shall be examined and any damage to parts and protective priming coats made good before storage or installation or replaced.

Adequate measures shall be taken by the Contractor to ensure that plant and equipment do not suffer any deterioration during storage.

Prior to installation all piping, plant and equipment shall be thoroughly cleaned.

If, in the opinion of the Engineer any equipment has deteriorated or been damaged to such an extent that it is not suitable for installation, the Contractor shall replace this equipment at his own cost.

1.6 Site Supervision

The Contractor shall ensure that there is an English-speaking supervisor on the site at all times during normal working hours.

1.7 Installation

Installation of all special plant and equipment shall be carried out by the Contractor under adequate supervision form skilled staff provided by the plant and equipment manufacturer or his appointed agent, in accordance with the best standards of modern practice to the relevant regulations and standards described under clause 1.3 of this section.

1.8 Testing

1.8.1 General

All testing shall be carried out to the entire satisfaction of the Engineer.

The following sub-clause are intended to define the Contractor's responsibilities with respect to testing and inspection.

1.8.2 Materials Tests

All materials for plant and equipment to be installed under this Contract shall be tested, unless otherwise directed, in accordance with the relevant B.S. Specification.

For materials where no B.S Specification exists tests are to be made in accordance with the best modern commercial methods to the approval of the Engineer having regard to the particular type and application of materials concerned.

The Contractor shall prepare specimens and performance tests and analysis to demonstrate conformance of the various materials with the applicable standards.

If stock material, which has not been specifically manufactured for the plant and equipment specified is used, then the Contractor shall submit satisfactory evidence to the Engineer that such materials conform to the requirements stated herein in which case test of material may be partially or completely waived. Certified mill test reports of plates, piping and other materials shall be deemed acceptable.

1.8.3 Manufactured Plant and Equipment - Works Tests

The rights of the Engineer relating to the inspection, examination and testing of plant and equipment during manufacture shall be applicable to the Insurance Companies or Inspection Authorities so nominated by the Engineer.

The Contractor shall give two weeks' notice to the Engineer of the manufacturer's intention to carry out work tests and inspection.

The Engineer or his representative shall be entitled to witness such tests and inspections. The costs of such tests and inspections shall be borne by the Contractor.

Six copies of all test and inspection certificates and performance graphs shall be submitted to the Engineer for his approval as soon as possible after the completion of such tests and inspections.

Plant and equipment which is shipped before the relevant test certificate has been approved by the Engineer shall be shipped at the Contractor's own risk and should the test and inspection certificate not be approved, new tests may be ordered by the Engineer at the Contractor's expense.

1.8.4 Pressure testing

All pipework installation shall be pressure tested in accordance with the requirements of the various sections of this Specification. The installation may be tested in sections to suit the progress of the works but all tests must be carried out before the work is buried or concealed behind building finishes. All tests must be witnessed by the Engineer or his representative, and the Contractor shall give 48 hours' notice to the Engineer of his intention to carry out such tests.

Any pipework that is buried or concealed before witnessed pressure tests have been carried out shall be exposed at the expense of the Contractor and the specified tests shall then be applied.

The Contractor shall prepare test certificates for signature by the Engineer and shall keep a progressive and up-to-date record of the sections of the work that have been tested.

1.9 Colour Coding

Unless stated otherwise in the Particular Specification all pipework shall be colour coded in accordance with the latest edition of B.S.1710: 1984.

1.10 Welding

1.10.1 Preparation

Joints to be made by welding shall be accurately cut to size with edges sheared, flame cut or machined to suit and the required type of joint. The prepared surfaces shall be free from all visible defects such as laminations, surface imperfections due to shearing or flame cutting operation, etc., and shall be free from rust scale, grease and other foreign matter.

1.10.2 Method

All welding shall be carried out by the electric arc process using covered electrodes in accordance with B.S. EN ISO 1071:2003

Gas welding may be employed in certain circumstances providing that prior approval is obtained from the Engineer.

1.10.3 Welding Codes and Construction

All welded joints shall be carried out in accordance with the following specification:-

a) Pipe Welding

All pipe welds shall be carried out in accordance with the requirements of B.S. 2633:1987

b) General Welding

All welding of mild steel components other than pipework shall comply with the general requirements of B.S.5135:1984.

1.10.4 Welder's Qualifications

Any welder employed on this Contract shall have passed the trade test as laid down by the Government of Kenya.

The Engineer may require to see the appropriate certificate obtained by any welder and should it be proved that the welder does not have the necessary qualifications the Engineer may instruct the Contractor to replace him by a qualified welder.

PART B

GENERAL PLUMBING & DRAINAGE SPECIFICATION

2 PART B - GENERAL PLUMBING AND DRAINAGE SPECIFICATION

2.1 General

This section specifies the general requirements for plant, equipment and materials.

2.2 Authoritative Standards and Codes of Practice

The authoritative standard referred to in this Specification are European and other International Standards Codes of practice. Should the contractor wish to substitute any other authoritative standard or code of practice for any referred to in the specification, he must submit details of any such standard or code of practice with two copies of the document for approval by the Engineer. Approval will only be given to use an alternative standard or code of practice if the Engineer considers the proposed standard or code of practice will produce work of a standard equal or better than that of the specified standard or code of practice.

The whole of the plumbing works is to be executed by a registered plumber and drain layer in strict accordance with the Regulations of the Local Authorities and to the satisfaction of the Architect.

2.2.1 Materials

1.2.1 Pipework and Fittings

(a) Black Steel Pipework

All black steel pipework up to 65mm nominal bore shall be manufactured in accordance with European and other International standards medium Grade, with tapered pipe threads in accordance with B.S. EN 10226 – 1: 2004. All fittings shall be malleable iron and manufactured in accordance with B.S. 143 AND 1256:2000

Pipe joints shall be screwed and socketed and sufficient couplings unions shall be allowed so that fittings can be disconnected without cutting the pipe. Running nipples and long screws shall not be permitted unless exceptionally approved by the Engineer.

All black steel pipework, 80mm nominal bore up to 150mm nominal bore, shall be manufactured to comply in all respects with the specification for 65mm pipe, except that screwed and bolted flanges shall replace unions and couplings for the jointing of pipes to valves and other items of plant. All flanges shall comply with the requirements of B.S. 10, to the relevant classifications contained hereinafter under section C of the Specification.

(b) Galvanised Steel Pipework

Galvanised steel pipework shall be manufactured to comply in all respects with the standards described for black steel pipework in paragraph (a) above.

Galvanising shall be carried out in accordance with the requirements of B.S. EN 10255:2004 and B.S 143 respectively.

(c) Copper Tubing

All copper tubing shall be manufactured in accordance with B.S.EN 13349:2002 from C.160 'Phosphorus De-oxidized Non-arsenical Copper' in accordance with B.S. 1172.

Pipe joints shall be made with soldered capillary fittings and connections to equipment shall be with compression fittings manufactured in accordance with B.S.864.

Short copper connections tubes between galvanised pipework and sanitary fitments shall not be used because of the risk of galvanic action.

If, as may occur in certain circumstances, it is not possible to make the connections in any other way than by the use of copper tubing, then a brass straight connector shall be positioned between the galvanised pipe and the copper tube in order to prevent direct contact.

(d) Galvanised iron Pipework

i) Internal Services

Internal iron pipework and fittings for use above ground in connection with internal buildings services, shall be manufactured with spigot and socket joints of the weight required by the Local Authority and shall comply fully with the requirements of B.S. 416.

All joints on galvanised iron spigot and socket pipes shall be made with an approved cold caulking compound and contraction which may take place.

All galvanised iron pipework, branches, tees, bends and other fittings shall be supplied complete with inspection covers for cleaning purposes. These inspection covers shall be included as part of the fittings and shall comply with the requirement of B.S. 416.

ii) External Services

Galvanised iron pipework which is used in connection with buried external services, shall be manufactured, coated and tested in accordance with the requirements of B.S. 1211:1958

All buried galvanised iron bends, elbows swept tees and other fittings, shall comply with the requirements of B.S EN 10242:1995

Jointing on external galvanised iron pipes shall be carried out in accordance with one of the methods described in B.S. Code of Practice 301, Clause 505c (v) to the approval of the Engineer.

(e) Fibre Cement Pipes and fittings for Sewers

Fibre Cement Pipework and fittings for use in connection with external drainage services shall be manufactured in accordance with the requirements of dn 19850-1 Part 1. Pipes shall be connected by means of purpose made tapered joints manufactured in accordance with DN 19850-1. Part 1.

(f) Concrete Pipes

Where concrete pipe and fittings are used in connection with the conveyance of surface water or sewage under atmospheric pressure, they shall be manufactured in accordance with the requirements of B.S. 5911-1:2002 Class 1 except where otherwise stated.

The joints of concrete pipe and fittings may be one of the following depending upon application and conditions:

1. Flexible spigot and socket type
2. Flexible rebated type (Stormwater drainage only)
3. Ordinary spigot and socket type
4. Ordinary rebated type (Stormwater drainage only).

Joints (1) and (2) shall be sealed with suitable rubber gaskets manufactured in accordance with B.S. 2494 except where they are likely to be contaminated by oil products in which case the gaskets shall be manufactured in accordance with B.S. 3514.

Joints (3) and (4) shall be made with an approved cement mortar mix.

(g) P.V.C. (Head) Pressure Pipes and Fittings

All PVC pipes and fittings shall be manufactured in accordance with B.S. EN 1452:2000.

i) Jointing

The method of jointing to be employed shall be that of Solvent Welding, using the pipe and manufacturers approved cement. Seal ring joints shall be introduced where it is necessary to accommodate thermal expansion.

ii) Anchoring

All bends, valves and hydrant tees etc., in the line of the water main shall be adequately anchored to resist thrust due to internal water pressure. A concrete block shall be cast under and around the pipe and between it and sides of the trench. Well rammed material shall be used to support the pipe and either side of the concrete.

iii) Pipe Bed

Pipe shall be uniformly laid on a 75mm thick bed, (the full width of trench) of fine grained material (sand or red soil) and must not be allowed to rest on the joint or on stones etc.

iv) Supports to Fittings

In underground installations care shall be taken to ensure that heavy components such as valves are fully supported so that no weight is carried by the pipeline.

v) Backfilling

For the protection of the pipe initial backfilling shall be carried out as soon as possible after laying. The initial backfill shall be fine grained material thoroughly compacted around the pipe and consolidated to a depth of 6" above the crown of the pipe at no time shall heavy rocks, stones or other objects be included in the balance of the backfill that might protrude through the initial backfill layer and come into contract with the pipe.

vi) Testing

Pipelines shall be tested in sections under the internal water pressure- normally one and half times the maximum allowable working pressure for the class of pipe used. Testing shall be carried out as soon as practicable after laying and when the pipeline is adequately anchored. Precautions shall be taken to eliminate all air form the test section and to fill the pipeline slowly to avoid risk of damage due to surge.

(h) PVC Soil system

The Contractor shall supply and fix PVC soil pipe and fittings as indicated on the drawings and schedules.

Pipes and fittings shall be in accordance with relevant B.S. including B.S. 4514:2001, and fixed to the manufacturer's instructions, and B.S. 12056-2:2000

The soil system shall incorporate synthetic rubber gaskets as provided by the manufacturers whose fixing instructions shall be strictly adhered to.

Connections to W.C. and pans shall be effected by the use of a W.C. connector, gasket and cover, sized to suit pan outlet.

Suitable supporting brackets and pipe clips shall be provided at maximum of one metre centres.

The Contractor shall be responsible for the joint into the Gully Trap on Drain as indicated on the drawings.

2.2.2 VALVES

(a) Draw-off Taps and Stop Valves (up to 50mm Nominal Bore)

Draw off taps and valves up to 50mm nominal bore, unless otherwise stated or specified, for attachment or connection to sanitary fitments shall be manufactured in accordance with the requirements of B.S. 1010.

(b) Gate Valves

All gate valves 80mm nominal bore and above, other than those required for fitting to buried water mains shall be of galvanised iron construction, in accordance with the requirement of B.S. EN 12288:2003, BS 5163-1;2004 AND DIN 3546-1. All gate valves required for fitting to buried water mains shall be of galvanised iron construction in accordance with the requirements of B.S. 1218.

All gate valves up to and including 65mm nominal bore shall be of bronze construction in accordance with the requirements of B.S. 5163-1:2004.

The pressure classification of all gate valves shall depend upon the pressure conditions pertaining to the Site of Works.

(c) Globe Valves

All globe valves up to and including 65mm nominal bore shall be of bronze construction in accordance with the requirements of B.S. 13709:2002.

The pressure classification of all globe valves shall depend upon the pressure conditions pertaining to the Site of Works.

(d) Check or Non-Return Valves

All check or non-return valves 800mm nominal bore and above shall be of the swing check type of galvanised iron construction in accordance with the requirements of B.S. EN 12288:2003.

The pressure classification of all check or non-return valve shall depend upon the pressure conditions pertaining to Site of the Works.

(e) Ball Valves

All ball valves for use in connection with hot and cold water services shall be of the ports mount type in accordance with the requirements of B.S. EN 1983:2006 constructed from bronze or other corrosion resistant materials. These valves fall into three pressure classifications as follows:-

(i)	Low Pressure	-	3.58 b maximum
(ii)	Medium Pressure	-	7.72 b maximum
(iii)	High Pressure	-	12.62b maximum

The pressure classification required for each ball valve will be designated in the description of its associated equipment.

(f) Manually Operated Mixing Valves

Mixing valves for shower fittings and other appliances being provided under the Contract Works shall be manufactured in accordance with the requirements of B.S. EN 1286:1999 from bronze or other corrosion resistant materials.

2.2.3 WASTE FITMENT TRAPS

(a) Standard and Deep Seal P & S Traps

Where standard or deep traps are specified they shall be manufactured in suitable non-ferrous materials in accordance with the full requirements of B.S. 1184:1976

In certain circumstances, galvanised iron traps may be required for galvanised iron baths and in these instances bath traps shall be provided which are manufactured in accordance with the full requirements of B.S. 1291.

(b) Anti-Syphon Traps

Where anti-syphon traps are specified, these shall be similar or equal to the range of Antisyphon Traps.

2.2.4 PIPE SUPPORTS

(a) General

This Sub-Clause deals with pipe supports securing pipes to the structure of buildings for above ground application.

The variety and type of supports shall be kept to a minimum and their design shall as such as to facilitate quick and secure fixing to metal, concrete, masonry or wood.

Consideration shall be given when designing supports, to the maintenance of desired pipe falls and the restraining or pipe movement to a longitudinal axial direction only.

The Contractor shall supply and install all steelwork forming part of the pipe support assemblies and shall be responsible for making good any damage to builders work associated with the pipe support installation.

The Contractor shall submit all his proposals for pipe supports to the Engineer for approval before any erection work commences.

(b) Steel and Copper Pipes and Tubes

Pipe runs shall be secured by pipe clips connected to pipe hangers, wall brackets, or trapeze type supports. 'U' bolts shall not be used as a substitute for pipe clips without the prior approval of the Engineer. An approximate guide to the maximum permissible supports spacing's in metres for steel and copper pipe and tube is given in the following table for horizontal runs.

Size Minimal Bores	**Copper Tube to B.S. 659**	**Steel Tube to B.S. 1237**
15mm	1.25	2.0m
20mm	2.0m	2.5m
25mm	2.0m	3.0m
40mm	2.5m	3.0m
50mm	2.5m	3.5m
65mm	3.0m	3.5m
80mm	3.0m	3.5m
100mm	3.0m	4.0m
125mm	3.0m	4.5m
150mm	3.5m	4.5m

The support spacing for vertical runs shall not exceed one and a half times the distances given for horizontal runs.

(c) Concrete and Pitch Fibre Pipes

These pipes shall not be used for above ground application.

(d) Expansion Joints and Anchors

Where practicable, cold pipework systems shall be arranged with sufficient bends and changes of direction to absorb pipe expansion providing that the pipe stresses are contained within the limits prescribed in the relevant B.S. Specification.

The Contractor shall pay particular care when supporting galvanised iron in order to ensure that settlement and building movement do not break the pipe joints.

Where piping anchors are supplied, they shall be fixed to the main structure only. Details of all anchor design proposals shall be submitted to the Engineer for approval before erection commences.

The Contractor when arranging his piping shall ensure that no expansion movements are being transmitted from pumps to piping systems or vice versa.

(e) Jointing Pipes

Joints shall be made strictly in accordance with the manufacturer's instructions. The Contractor shall make use of the technical advisory services offered by manufacturers for instructing pipe jointers in the methods of assembling joints.

Where manufacturers recommend the use of special jointing tackles, the contractor shall use these for the assembly of all joints to pipes. Sockets shall be laid looking uphill unless otherwise approved.

Before making any joints, all jointing surfaces shall be thoroughly cleaned and dried and maintained in such condition until the joints have been completely made or assembled. Notwithstanding any flexibility provided in the pipe joints, pipes must be securely positioned to prevent avoidable movement during and after the making of the joint.

The space between the ends of the spigot shall be as recommended by the manufacturer or ordered by the Engineer.

After flexibly jointed pipes, other than PVC pipes have been jointed the gaps between the barrel of the pipes and the internal face of the socket shall be sealed with puddle clay, inculcate rope yarn or other approved material. The rope yarn or other material must have treated so as not to support bacterial growth.

Where loose collars are used to join the pipes cut for closers, special tools shall be employed to keep the inside of the pipes flush and the collar concentric with the pipe while the joint is being made.

Pipes provided with spigot and socket joints of the self-centering, instantaneous joint type, such as the rubber ring push fit joint, shall be laid and jointed strictly in accordance with the maker’s instructions. Generally the joint ring shall be cleaned

and inspected for cuts and defects, and socket and spigot examined to ensure freedom from oil, grease, tar and grit. The makers recommended lubricant will be used.

(f) Galvanised iron Joint Fittings

Galvanised iron detachable joint collars and flanges shall be tested by striking lightly with a spanner immediately before they are placed and if they fail to ring true shall be set aside and not incorporated in the work until proven sound.

The flanges shall be correctly positioned and the component parts including any insertion ring cleaned and dried.

Insertion rings shall be fitted smoothly to the flange without folds or wrinkles. The face and bolt holes shall be brought fairly together and the joints shall be made by gradually and evenly tightening bolts in diametrically opposed positions. Only standard length spanners shall be used to tighten the bolts. The protective coating if any, of the flange shall be made good when the joint is completed.

Bolt threads shall be wrapped with PTFE tape where directed before use.

No washers shall be used on flanged pipework to be laid below ground. Bolts shall be as specified and shall be of the correct length, leaving a maximum of two threads exposed.

(g) **Solvent Welded Joints**

Only the solvent cement recommended by the manufacturer for his pipe joint system shall be used and his instructions on the making of the joint shall be closely followed.

Excess solvent cement shall not be applied to the inside of the pipe socket and all surplus solvent shall be removed from the joint and the pipe. Any solvent falling on the trench formation shall be removed by excavating the contaminated soil.

Solvent welded pipes jointed outside the trench shall not be lowered into the place until the elapse of time recommended by the manufacturer. The time allowed for curing shall be increased with lower temperatures.

2.2.5 Connection of Tubing to Cold Storage Tanks, Hot Water Cylinders and Sanitary Fittings

Each connection of tubing to cold water storage tanks shall be made by drilling a hole in the tank side and using a long screw, union and two backnuts all well screwed up in red lead. Joints of tubing to flanged and bossed connections of hot water cylinders shall be made with a boiler screw, union and backnut screwed up in red lead.

Connections to sanitary fittings shall be made with 450mm lengths of copper tubing bent to shape as required with copper to iron couplings at each end, and red lead joint to joint union of fittings and tubing.

All sanitary-ware fittings shall be left in a clean and good condition to the satisfaction of the Engineer.

All fittings shall be fixed in accordance with the manufacturer's instructions and shall comply with the general requirements of B.S. Code of Practice 305 and the Particular requirements of the latest applicable B.S. Specification.

Lavatory basin brackets shall be cut and pinned to walls in cement mortar including making good rendering, tiling or plastering etc.

2.2.6 Pipe Sleeves

Main runs of pipework are to be fitted with sleeves where they pass through walls and floors. Generally the sleeves shall be of P.V.C. except where they pass through the structure, where they shall be mild steel. The sleeves shall have 6mm - 12mm clearance all around the pipe, or for insulated pipework all around the insulation. The sleeve will then be packed with slag wool or similar.

2.2.7 Cutting Pipes

Iron pipes shall be cut by a method and with apparatus which provides a clean square cut of the pipe and of the lining, if any, without damage to pipe or lining.

All cut or trimmed ends, and the parts of any pipe on which the coating may have suffered damage shall be recoated with bitumen before the pipes are laid. The external area at cut spigot ends of ductile iron pipes shall be ground for a distance of at least 125mm.

Pitch-impregnated fibre pipes shall be cut by saw and where necessary the end shall be filled or machined to the required 2 degrees taper.

Concrete pipes shall be cut to a square and even finish without splitting or fracturing the wall of the pipe. Reinforcement shall be cut back flush with the concrete and bare metal protected with bituminous paint or cement grout as directed.

Only steel pipes supplied rounded throughout their length shall be used as cut pipes to form closures. The cutting shall be done by an approved method and apparatus which provides a clean square cut, without separation of the lining from the pipe wall. Minor damage to the lining may, if permitted be repaired on site in accordance with the manufacturer's instructions. Where in the opinion of the Engineer the damage is serious the pipe or special shall be returned to the manufacturer for reconditioning.

2.2.8 Pipes Built into Structures

The outside surface of all pipes and special castings to be built into structures shall be thoroughly cleaned immediately before installation. Where ordered protective coatings to metal pipes shall be removed from the sections to be built in, while the external surfaces of fireclay and concrete pipes shall be roughened to form a key for concrete or mortar. Sheathing to steel pipes shall be cut away from the sections to be built-in and after erection the protection shall be completed by applying approved bituminous material around the barrels of pipes at the junctions with structures.

Pipes passing through water retaining walls and floors shall, where possible, be built into the structure in-situ. Shuttering shall be formed closely to the outside of the pipes, and concrete shall be placed and compacted thoroughly round pipe and puddle flange, if any.

Where fixing in the course of construction is not possible, temporary opening in structures, formed to the dimensions shown by the Engineer shall be left where indicated or directed to accommodate the subsequent erection of pipes and special castings. In water

retaining structures, they shall taper to a smaller dimension towards the external faces of structures and shall include where indicated a waterstop. In basements, dry chambers at pumping stations etc., temporary openings shall taper to a smaller dimensions towards the internal faces of structures and shall also include, where indicated a waterstop.

Prior to in-filling, all surfaces against which fresh concrete is to be placed shall be prepared as specified, while the external surfaces of pipework shall be prepared as described in this clause.

2.2.9 Setting Valves

Care must be taken to prevent damage to all valves, fire hydrants and the like, and their ancillary equipment. Valves etc., and ancillary apparatus shall be stored in clean conditions and in a manner that excludes all water. Where directed, head-stock, motors, gearing or indicators shall be removed, adequately labelled for identification, stored carefully in weather-proof premises and be reconnected after erection of the valves. Electrical equipment shall be protected from damp and the damp-proofing seals shall remain intact until the electrician is ready to connect up the equipment.

The gunmetal faces and seats of all valves must be kept clean. No valve shall be closed without first wiping the faces with a clean cloth. The cavity beneath the valve door shall be thoroughly cleaned by hand. In the event of accident, fouling matter shall be either dissolved or carefully removed by methods that do not involve scraping or gunmetal faces.

All valves shall be set so that operating spindles are truly vertical unless otherwise detailed or directed.

Every stuffing box shall be examined when the main is charged with water and leaking boxes shall be adjusted or replaced with square plaited lubricated hemp packing or approved manufacture. The stuffing box shall not be so tightly packed as to materially affect the friction of the packing on the spindle.

No air valve shall be stored before erection in the open in sunlight, or upside down to expose the balls and air cavities. Air valves shall be checked before the main is charged to ensure that the balls and faces are not scored or split and that there is no direct or other deleterious materials in the cavities of the body. All air nozzles shall be probed to see that they are clean.

Fire hydrants and similar fittings shall be checked before being incorporated in the line and before the main is charged to ensure that all passageways are clean.

The installation of special types of valve and metering equipment must be strictly in accordance with the manufacturer's instructions.

The direction of opening of the valve shall be indicated on the headstock and on the underside of hydrant covers.

2.2.10 Pressed Steel Plate Storage Tanks

The water capacity of the tanks and the diameter of all pipes and pipe connections therewith will be as detailed on the Drawings and Bills of Quantities. Unless otherwise detailed the proportions of a tank will be such that the height is not less than three quarters of the length and not less than the width. All dimensions must be approved by the Engineer.

Elevated Pressed Steel Plate storage tanks will comply with B.S. 1564 and will be constructed of 4.76mm (top row only) and 6.35mm thick galvanised pressed steel tank plates, 1.22m or 1.00m square nominal size, embossed and with external flanges bolted together. Where detailed in the Contract the tank will be partitioned centrally, the division wall to be adequately stayed to permit emptying of either half of the tank whilst maintaining full water depth in the other half.

The tank will be complete with a pitched or vaulted cover and gable ends of 3mm thick steel plates, lap jointed and supported on bearers with hinged insect proof cover; 1 No. float operate water level indicator; and will be provided with internal and external ladders as follows. Where the tank is constructed to operate in two halves 2 No. access manholes and internal ladders will be provided.

The external ladder will have 40mm x 6mm mild steel flat stringers with 12mm diameter mild steel rungs and will be cleated to the tank at 1.2m intervals. The stringers will be taken 750mm above the tank cover and bent to return to the cover a distance of 450m from the edge. This ladder will be complete with 40mm x 3mm mild steel flat safety hoops of 600mm diameter, spaced at 1.2m vertical centres, truly bent and welded to the stringers. The safety hoops will be jointed by 3 No. 40mm x 3mm mild steel flat vertical guard strips, evenly spaced and flat fillet welded to the hoops.

The internal ladders will have 65mm x 12mm steel flat stringers with 20mm diameter mild steel rings and will be cleated to the tank at 1.2m intervals.

The tank bottom plates will be provided with a single pipe pad for the washout pipe connections and double pipe pads for all other pipes which pass through the bottom of the tank.

The tank will be provided and erected complete with all bolts, nuts, washers, internal braces and approved non-toxic jointing materials (fibre-glass or bitumen impregnated filler strip or approved equal).

The whole of the tank steelwork and plates will be galvanised as specified before dispatch and after erection, painted with an approved etching primer and two coats of a bitumen based aluminium paint externally and two coats of non-toxic black bitumen paint internally, both as specified.

The tank after final erection on its permanent foundation will be filled with water to overflow level for a period of 24 hours. Any leaks which become apparent will be made good to the satisfaction of the Engineer before acceptance of the work. Both halves of the tank will be tested separately.

2.2.11 Pipework for Pressed Steel Tank

All pipework associated with the tank and stand will be mild steel pipe to B.S. 534 with flanged joints. The pipework will comprise one ball mounted standing inlet pipe at designed top water level, one outlet pipe with ball mounted and approved strainer to take water from the level as detailed on the Drawings. Where not detailed the outlet pipe will take water from not less than 75mm above the tank bottom. One ball mounted standing overflow pipe with its lip 50mm above designed top water level, and one washout pipe which will be capable of completely draining the tank will be provided. Where the tank is constructed to operate in two halves the inlet, outlet, overflow and washout pipes will be duplicated in each half of the tank.

2.3 INSTALLATION

2.3.1 General

Installation of all pipework, valves, fittings and equipment shall be carried out under adequate supervision from skilled staff to the relevant codes and standards as specified herein. The Contractor shall be responsible for ensuring that all builders work associated with his piping installation is carried out in a satisfactory manner to the approval of the Engineer.

2.3.2 Above Ground Installation

(a) **Water Services**

Before any joint is made, the pipes shall be hung in their supports and adjusted to ensure that the joining faces are parallel and any falls which shall be required are achieved without springing the pipe.

Where falls are not shown on the Contract Drawings or stated elsewhere in the specification, pipework shall be installed parallel to the lines of the buildings and as close to the walls, ceilings, columns, etc., as is practicable.

All water systems shall be provided with sufficient drain points and automatic air vents to enable them to function correctly. Valves and other user equipment shall be installed with adequate access for operation and maintenance where valves and other operational equipment are unavoidably installed beyond normal reach or in such position as to be difficult to reach from a short step ladder, extension spindles with floor or wall pedestals shall be provided.

Screwed piping shall be installed with a sufficient number of unions to facilitate easy removal of valves and fittings, without the need to cut the pipe.

Full allowance shall be made for the expansion and contraction of pipework precautions being taken to ensure that any force produced by pipe movements are not transmitted to valves, equipment or plant.

All screwed joints to piping and fittings shall be made with Polytetra Flouroethylene (P.T.F.E.) Resin Skived Tape in accordance with ASTM D3308-06

The test pressure shall be maintained by the pump for about one hour and if there is any leakage, it shall be measured by the quantity of water pumped into the main in that time. A general leakage of one gallon per 25mm of diameter, per 1.6 kilometre per 24 hours per 30 metres head, may be considered reasonable but any visible individual leak shall be repaired.

(b) **Sanitary Services**

Soil, waste and vent pipe systems shall be installed in accordance with the best standards of modern practice as described in B.S. 5572 now replaced with BS EN 12056-2:2000 to the approval of the Engineer.

The Contractor shall be responsible for ensuring that all ground floor waste fittings are discharged to a gulley trap before passing to the sewer via a manhole.

The Contractor shall provide all necessary roding and inspection facilities within the draining system in position where easy accessibility is available.

Where a branch requires roding facilities in a position to which normal access is unobtainable, then that branch shall be extended so as to provide a suitable purpose made roding eye in the nearest adjacent wall or floor to which easy access in available.

The vent stacks shall terminate above roof level and where stack passes through roof, a weather skirt shall be provided. The Contractor shall be responsible for sealing the roof after installation of the stacks.

The open end of each stack shall be fitted with a plastic coated, or galvanised steel, wire guard.

Access for roding and testing shall be provided at the foot of each stack.

(c) **Sanitary Appliances**

All sanitary appliances associated with the Contract Works shall be installed in accordance with the best standard of modern practice as described in BS 6465-3:1996 to the approval of the Engineer.

2.3.3 Underground Installation

(i) **General**

All underground water and drainage service installation shall be installed in accordance with the best standard of modern practice as described in BS EN 13566-1:2002.

(ii) **Bedding**

(a) **Granular Bedding Material - Type A**

Granular bedding Type A shall comprise broken stone or gravel, crushed brick or concrete to pass a 25mm sieve and be retained on 5mm sieve thoroughly mixed with free draining coarse sand in the ratio of one part sand to two parts stone or gravel; or aggregate to B.S. 882 Table 3 or other material which in the opinion of the Engineer has similar characteristics.

Particles shall be rounded or angular but not flaky or elongated and of adequate crushing strength to produce when tested in accordance with B.S. 812 a 10 percent fines value, greater than 5 tonnes.

(b) **Selected Fill - Type B**

Type B selected fill shall be uniform readily compatible material from tree roots, vegetable matter and building rubbish. All clay lumps retained on a 75mm sieve and all stones retained on a 25mm sieve shall be excluded.

(c) **Granular Bedding Material - Type C**

Granular bedding Type C shall be as type A bedding material but with all material passing a 10mm sieve. In addition, where used to be flexible not exceeding 0.1. The compaction factor test shall be carried out as follows:-

Equipment

1. An open ended cylinder 225mm long and 150mm internal diameter, (a pitch fibre or PVC pipe is suitable)

2. A metal rammer with a skirting face 40mm diameter weighing 0.9 to 1.1 kg

3. A measuring ruler.

Method

A representative sample more than sufficient to fill the cylinder is obtained, (about 12 kg). It is important that the moisture content of the sample should not differ significantly from that of the material from which the sample was obtained at the time of the use of the trench.

The cylinder is placed on a firm surface and the material sample poured into it loosely and without tamping. The top surface of the material is struck off level with the top of the cylinder and all surplus material removed. The cylinder is then lifted clear of its contents and placed on a clean area of the flat surface.

About one quarter of the material is then placed back in the cylinder and tamped thoroughly until no further compaction can be obtained. This procedure is repeated until with the second, third and final quarter tamping each successive surface as level as possible.

The height from the material surface to the top of the cylinder is then measured with the ruler and this distance divided by the height of the cylinder, (225mm), is referred to as the Compaction Factor.

For each batch of material three (3) Compaction Factor Tests will be made and if the average value is greater than 0.1 then the batch of material will be deemed to be unsuitable for use as Type C bedding material. Material sufficient for the bed and surround of 200 linear metres of pipe will be considered to comprise a batch.

(d) **Bedding and Surround for Concrete Pipes**

The material to be used for bedding and surround for concrete pipes shall not contain more than 0.3 per cent sulphate expressed as sulphur trioxide nor shall it be obtained from a site where the ground water contains more than 0.1 per cent sulphate.

(iii) **Field or French Drains**

Pipes for French drains shall be either British Standard Surface pipes glazed or unglazed manufactured to B.S. 65 and 540, with Type 2 sockets or plain ended supplied with sleeve couplings or type 1 perforated socketed and sleeve coupled pipes porous concrete pipes to B.S. 1194.

(iv) **Definitions**

For the purpose of underground piped services the following definitions shall apply:-

(a) Top soil shall mean the top layer of soil that can support vegetation.

(b) Suitable material shall mean all material capable of being compacted, forming a stable fill and approved as such by the Engineer.

(c) Unsuitable material shall mean material other than suitable material and shall include material from swamps, marshes or bogs, peat, logs, stumps, or other perishable material, clay of liquid limit exceeding 80 and/or plasticity index exceeding 55, or materials having greater moisture content than approved for use.

(d) Rock in excavation shall mean such material which cannot be excavated by hand methods and individual solid boulders exceeding 0.2 cu.m.

(e) `Rigid pipes' shall mean pipes of cast or spun iron, concrete cement, clay or similar materials.

(f) `Flexible pipes' shall mean pipes of steel, PVC or other plastic, ductile iron or similar materials.

(g) `Rigid joints' shall mean joints made of bolting together flanges integral with the barrels of the pipes, by welding together the barrels of the pipes, by caulking sockets with non-deformable material, such as cement mortar, run lead or by similar techniques.

(h) `Flexible joints' shall mean joints made with factory-made jointing materials, loose collars, rubber rings etc., and which allow some degree of flexing, however small, between adjacent pipes.

(v) **Types of Pipe**

The Contractor shall construct the pipelines using the designs of pipe, bed, haunch and surround detailed on the Drawings.

Where the Contractor wishes to use a type of pipe not manufactured in the minimum internal diameter indicated in the Contract, he may substitute the next larger diameter manufactured, subject to compliance with the design requirements, clearance and cover. The Contractor shall not use pipes and fittings supplied by more than one manufacturer without approval.

(vi) **Setting Out**

The Contractor shall set out the underground services to the lines shown on the Drawings. Where the service is required laid to falls these shall be set by means of proper sight rails and boning rods.

Sight rails shall be of the following minimum standard. They shall be adjustable sight rails of 150mm x 30mm wrought softwood of length 1m painted black and white as directed secured to strong uprights embedded in the ground at distances not exceeding 60 metres.

Care shall be taken to ensure that these sight rails are not obscured by spoil from the excavation.

(vii) **Excavation**

The Contractor shall carry out the excavation in accordance with the Drawings and shall comply with the slopes, levels, depths and heights shown thereon.

Unless otherwise directed top soil shall be stripped, laid aside and kept separate from other excavated materials for reuse. Road bottoming and surfacing material which is approved as suitable for re-use shall be laid aside and kept separate from other excavated materials.

Where shown in the Contract or directed top soil shall be stripped over the full width of the working area before any other operation is carried out and soil deposited in dumps. On completion of the other operations the soil shall be evenly spread over the stripped surface.

Excavation shall be carried out the dry and both trenches and general areas shall be kept free from water by pumping, provision of temporary drains, sumps and the like.

Excavations shall be taken out to the least dimensions required to accommodate the service and the working space necessary for its installation subject to the following restrictions. All excavations shall be carried so that the soil beneath receives the maximum amount of disturbance.

Unless otherwise directed the overall width of pipe trench excavation from the trench bottom to a level 300mm above crown of the pipe shall be in accordance with the following table:

Table 40.1 - Pipe Trench Widths

Nominal Internal Diameter (mm)	Minimum Overall Trench Width (mm)	Maximum Overall Trench Width (mm)
100	430	630
150	500	700
200	550	750
225	580	780

300	680	880
375	950	1150
400	1000	1200
450	1330	1230
525	1120	1320
600	1240	1440
675	1330	1530
750	1400	1600
825	1490	1690
900	1920	2120
1050	2100	2300
1200	2290	2490
Above 1200	Outside diameter of pipe plus 800mm	Outside diameter of pipe plus 1000mm

Battering or stepping of the sides of trenches, if approved, will only be permitted from 300mm above the crown of the pipe to the original ground level.

The maximum trench width given above shall be measured to the earth face of any sheeting or trench supports.

Excavation shall be taken to the depth required for the class of bedding shown on the drawings. Any excavation greater than this depth shall be filled with the same material as required for bedding to the Engineer's satisfaction and at the Contractor's expense.

When concrete is directed to be cast directly against existing soil the excavation shall be neatly executed to the shape required.

Excavation shall be timbered, sheet piled or otherwise supported to ensure the stability of the surrounding ground, the Works and adjacent structures and to ensure the safety of all persons. The sides of excavation will be battered only where approved or directed. All over-excavation due to slips, overbreak and the like shall be remedied at the Contractor's expense, by infilling with suitable material as directed by the Engineer.

Should the Engineer regard the Contractor's support of any excavations as inadequate then the Contractor shall comply with any instruction by the Engineer to alter or increase the support. Any instruction so given by the Engineer will in no way relieve the Contractor of his responsibilities under the Contract.

Material from excavations other than unsuitable material shall be set aside clear of the sides of excavation for reuse. Unsuitable material shall be removed to the Contractor's tip.

When the final level of the foundation, as shown on the Drawing or directed by the Engineer, has been reached the Engineer will inspect and approve the foundation prior to the commencement of concreting or other work thereon. The bottoms of all excavations shall be carefully shaped for slop as shown or directed. Any pockets of soft or loose material shall be removed and any cavities or fixtures filled as directed.

The Contractor shall at his own expense make good with mass concrete or as directed exaction greater than required for the complete work. Material which the Contractor has

allowed to become unsuitable shall be removed and replaced with mass concrete or as directed, at the Contractor's expense.

The Contractor shall provide whatever additional pipe protection is directed specified maximum width be exceeded due to his method of working.

Where rock or boulders are present in pipe trenches specified to have Class C or FD bedding the sides of the trenches shall be so trimmed that when the pipe is laid to the correct level and alignment no projection of the rock comes within 100mm of the outside of the pipe barrel at any point.

Where rock is found in the bottom of trenches for pipes specified to have Class C or FD bedding, the trenches shall be excavated to the additional depth necessary to allow for Class B or FC bedding respectively.

The Contractor shall avoid unduly disturbing the finished trench formation and shall make good disturbed areas and excavate any wet or puddled material which might result from his failure to do so.

Where directed trenches close to existing structures shall be opened in short lengths and refilled or partly filled with mass concrete or other approved material.

Trenches for pipes carrying water under pressure, except where otherwise required by the Contract, shall be excavated to a sufficient depth to ensure, after consolidation of the refilling, a normal minimum depth of cover of 1800mm from the ground surface to the top of the pipe. Under roads a normal minimum depth of cover of 900mm shall be provided. Where the pipeline is required to be laid to a depth which does not permit this condition to be fulfilled the ground surface shall be made up locally with banking as directed.

(viii) **Pipe laying General**

On arrival at the Site, pipes shall be carefully inspected for damaged ends, cracks or other defects and any found to be faulty shall be marked and set aside for a decision from the Engineer as to their acceptability.

Pipes with damaged ends may be either completely replaced or have the ends cut off and trimmed as directed by the Engineer.

The Contractor shall ensure that all pipes are properly handled both by his staff and by any cartage Contractor employed by him. During transport, pipes shall not be allowed to rest on narrow cross-members of vehicles or anything else that might give concentrated loads due to the weight of the pipe or bumping of the vehicle but shall be properly supported on soft material. Sufficient labour and equipment shall be on hand before loading and unloading is commenced and under no circumstances shall any pipes be dropped or thrown from a vehicle.

The Engineer will have the right to reject consignments or stocks of piping from which failed pipes have been drawn, or order them to be pressure tested to works pressures outside the pipelines at the Contractor's expense even though no defects are apparent, if there is reason to believe that mishandling has taken place.

Flat braided wire slings shall be used for slinging all pipes except externally coated pipes and plastic pipes for which only special band slings not less than

300mm wide shall be used. Chain or rope slings, hooks, or other devices working on scissor or grab principles shall not be used.

Subject to the requirements of inspection before acceptance, protective bolster, caps or discs on the ends of flanges of pipes, specials or fittings shall not be removed until the pipes, specials, or fittings are about to be lowered into the trench.

Before a pipe is lowered into the trench, it shall be thoroughly examined to ensure that the internal coating or lining and the outer coating or sheathing are undamaged.

Where necessary the interiors of pipes, specials and fittings shall be carefully brushed clean.

Any damaged parts of the coatings or lining shall, before a pipe is used, be made good as directed.

Pipeclaying shall not commence until the bottom of the trench and the pipe bed have been approved. Pipes shall be brought to the correct alignment and inclination concentric with the pipes already laid.

(ix) **Bedding and Protecting Pipes Generally**

Pipe bedding refers to all bedding haunching and surrounding of pipes and shall be carried out to the types arrangements and dimensions shown on the Drawings.

During the placing of pipe bedding temporary side supports and sheeting shall be removed except where directed to be left in and the full width of the trench shall be infilled with bedding, haunching, surrounding or anchoring materials.

A cavity of adequate size shall be excavated in the sides and bottom of the trench or left in the pipe bed at each joint and at each sling position.

The bottom of the trench or surface of the bed shall be finished to a smooth even surface at the correct levels to permit the barrel of the pipe to be solidly and evenly bedded throughout its whole length between joint and sling holes.

For water pipes the preparation of the trench bottom or surface of the bed shall be completed for at least one full pipe length in advance of the pipe laying, except where in exceptional circumstances another arrangement is approved.

For sewer pipes the trench bottom or surface of the bed shall be completed between adjacent manholes for inspection by the Engineer prior to laying the pipes.

No pipe bedding material shall be placed in trenches containing water.

Where granular bedding is to be used, stones, bricks or similar materials shall not be used below or against the pipe to locate them in position in the trench or to level the pipes.

Where directed, puddle clay dams 500mm thick shall be constructed around the pipe and across the trench as haunching proceeds. The dams shall be at

intervals not exceeding 30 metres or as directed and their height shall be determined by the Engineer.

Where directed by the requirements for testing pipelines the method of haunching and surrounding pipes shall be modified to leave pipe joints exposed.

Where there is high ground water table all pipes shall be surrounded in an approved free draining bedding material as specified.

(x) **Laying of Pipes**

Every pipeline shall be accurately laid to correct line and level perfectly true from joint to joint.

Whenever work is suspended, the open ends of all pipes and junctions shall be adequately plugged to prevent the ingress of any coil or rubbish etc. Care shall be taken at all joints to prevent ingress of any material.

Immediately after laying, the open end of a pipe shall be sealed with a wooden plug or approved stopper of appropriate size to prevent the entry of material which might contaminate the pipeline, damage the linings, obstruct the waterway or affect the working of valves, meters etc. Plugs shall be unperforated and shall be shaped to fit exactly so that water from the trench excavations cannot gain access to the pipeline.

Water pipes and fittings 150mm and under in diameter shall have a brush equal in diameter to the internal bore of the pipe drawn through them as the work proceeds. The brush shall not be removed from the pipeline from commencement until completion.

The plugs in sewers may, with the Engineer's approval, be provided with small holes for drainage purposes, but water from the trench excavation which is heavily charged with silt shall not be allowed to gain access to the pipe.

Where work is interrupted for a period, the plugs left in position shall be regularly inspected for their fixing to ensure that there has been no tampering by unauthorised persons. Whenever any plug is removed, the immediate length of pipe shall be examined for dirt or obstructions and shall be cleaned as required.

Adequate precautions shall be taken by way of backfilling or other means to anchor each pipe securely to prevent floatation of the pipeline in the event of trench being flooded.

No equipment, clothing or apparel shall be left or stored inside pipeline.

If the normal continuity of construction would otherwise be interrupted pending the delivery of valves or specials, the exact extent of the temporary gaps to be left shall be pre-determined after reference to the Engineer. The Contractor shall submit dimensioned sketches, to the Engineer for approval, showing details of the pipes and jointing arrangements to be adopted to effect ultimate closures. Care shall be taken to preserve the accurate alignment of the pipeline across all such temporary gaps.

(xi) **Laying to Curves**

Where flexibly jointed rigid pipes are to be laid to curve, the outside of spigots in the joints shall not butt hard against the inside of the socket. An angle of pull shall not exceed that laid down by the pipe manufacturer.

Where curves are to be negotiated with straight steel piping with welded joints, no joint shall be flexed more than one degree. Up to two degrees will be permitted with Couplings.

Where curves are to be negotiated with straight prestressed concrete pipes no joint shall be flexed more than half a degree. For sharper curves purpose made level pipes, level pipes, level adaptors and standard bends shall be provided.

(xii) **Manholes**

(1) **General**

All manholes provided under the Contract Works shall be constructed of approved materials and in an approved manner.

All manholes shall be water-tight and if constructed of brickwork, solid blockwork or stonework, they shall be rendered internally with a cement mortar of at least 12mm thickness and finished with a smooth surface.
The sides of all channels in every manhole shall be brought up vertically to a height of not less than the diameter of the drain and shall be benched in good concrete from the top of the channels at an angle of 30^0 to the horizontal and floated to a smooth hard surface with a coat of 1:1 cement mortar.

In all other respects, manholes shall be constructed in accordance with B.S. Code of Practice 301.

(2) **Rectangular and Square Manholes**

Rectangular and square straight through manholes shall be constructed from brickwork, solid blockwork, stonework or concrete to comply with the following minimum internal dimensions (millimetres).

Depth Below Ground of Outgoing Invert	Internal Access Shaft Dimensions L X W	Size of Main Channel Diameter	Internal Chamber Dimensions L X W	Height of Chamber above Benching	Wall Thickness
Up to 740	-	100 to 150	610 x 450	-	150
Up to 740	-	230 to 460	760 x 760	-	150
Up to 1200	-	100 to 150	760 x 760	-	150
160 to 1200	-	230 to 460	910 x 910	-	150
1220 to 1800	-	100 to 150	910 x 910	-	150
1220 to 1800	-	230 to 460	1070 x 910	-	150
1830 to 4550	760 x 760	100 to 150	1370 x 910	1370	230
1830 to 4550	760 x 760	230 to 460	1370 x 1070	1370	230
4570 and Over	760 x 760	100 to 150	1370 x 1140	1680	230
4570 and Over	760 x 760	230 to 460	1370 x 1140	1680	230

When branches are connected into the manhole, the length and width dimensions of the chamber shall be increased as follows:-

Length

Branch Diameter

100mm 300mm/branch on the side with most branches.

150mm 380mm/branch on the side with most branches.

230 and 300mm 460mm/branch on the side with most branches.

460mm 610mm/branch on the side with most branches.

Width

Branch Diameter

100mm to 300mm for each side with branches plus 160mm 460mm or the diameter of the main drain whichever is the greater.

3. **Precast Concrete Circular Manholes**

Where specified straight through precast concrete manholes shall be manufactured and constructed to comply with B.S. 556 and the following dimensional requirements, (Dimensions in millimetres).

Ground Depth of Outgoing Invert	Internal Access Shaft Diameter	Size Main Channel Diameter	Height Chamber Diameter	Chamber Above Benching
Up to 740	-	100 to 460	910	-
760 to 2410	-	100 to 460	1070	-
2440 to 4550	760	100 to 460	1200	1370
4570 and Over	760	100 to 460	1370	2680

When branches are connected into manholes the internal diameter of the chamber shall be increased as necessary, up to a maximum chamber diameter 1830mm.

4. **Step Irons and Covers**

Access shaft to manholes of depths greater than 760mm shall be provided with approved step irons at suitable intervals.

Every manhole or manhole access shaft shall be fitted with a removable air-tight galvanised iron cover to adequate size and strength, fixed in a manner which prevents surface water gaining access into the drainage system.

Cast manhole covers and frames shall be manufactured in accordance with the requirements of B.S. 497 and shall generally fall into the following categories:-

Heavy Duty	:	1For Carriageways
Medium Duty	:	For Footpaths

5. **Back Drop Connections**

Where the level of the branch drain entering the manhole is higher than can be suitably accommodated by the normal type benching, then the branch drain shall be connected to the manhole by means of a back drop connection.

Back drop connections shall be made in accordance with the details shown on the relevant Contract Drawings and the requirements of B.S. Code of Practice 301.

6. **Channels**

Where the branch channel connects to the main channel in the manhole, the invert of the branch channel shall be a minimum of 38mm higher than the main channel.

(xiii) **Testing of Pipelines**

After pipelines are connected up and joints have been sealed, the pipeline shall be tested before pipes are, if required, haunched or surrounded in concrete.

Methods of testing and inspection shall be in accordance with Clause 4 of the Specification.

xiv) **Concrete Bedding, Haunching and Surround**

Concrete bedding, haunching and surround shall be provided as necessary or where called for by the Engineer in accordance with the requirements laid down in B.S. Code of Practice 301, Clause 310.

xv) **Backfilling**

Backfilling of trenches, headings and around manholes shall be carried out in accordance with the methods described in B.S. Code of Practice 301, Clause 508.

xvi) **Reinstatement of Surfaces**

Following the final backfilling of all trenches, headings and manhole surrounds, the surface of the excavated areas shall be fully reinstated to the approval of the Engineer.

Where excavations have been carried out in public highways or other areas not forming part of the site, the Contractor shall be deemed to have allowed in his price for all charges associated with the temporary and final reinstatement requirements of the Local of Highway Authority, whether this is carried out by the Contractor or by the Authority concerned.

No claims for extras in this respect will be accepted.

2.4 Testing and inspection

2.4.1 Site tests - pipework systems

(a) **Underground Water Mains**

After laying, jointing and anchoring, the main shall be slowly and carefully charged with water, so that all air is expelled and allowed to stand full for three days before testing under pressure.

A long main shall be tested in sections as the work of laying proceeds and all joints shall be exposed for inspection during the testing.

The open end of the main may be temporarily closed for testing under moderate pressure by fitting a water pipe expanding plug, of which several types are available. The end of the main and the plug should be secured by struts or otherwise, the resist the end thrust of the water pressure in the main.

If the section of main terminates with a sluice valve, the wedge of the valve shall not be used to retain the water, instead the valve shall be fitted temporarily with a blank flange, or if a socket valve with a plug and the wedge shall be placed in the open position while testing. The Contractor shall provide suitable end supports to withstand the end thrust of the water pressure in the main.

(b) **Above Ground Internal Water Service Installation**

All water service pipe system installed above ground shall be tested hydraulically for a period of one hour to not less than one and a half times the design working pressure.

If preferred, the Contractor may test the pipelines in sections. Any such section found to be satisfactory need not be the subject of a further test when the system has been completed, unless specifically requested by the Engineer.

During the test, each branch and joint shall be examined carefully for leaks and any defects revealed shall be made good by the Contractor and the section re-tested.

The Contractor shall take all necessary precautions to prevent damage occurring to special valves and fittings during the tests. Any item damaged shall be repaired or replaced at the Contractor's expense.

(c) **Underground Drainage System**

A site test shall be carried out on all drainage pipes before concrete haunching or surrounds are applied. These tests shall be carried out preferably from manhole to manhole.

Short branch drains connected to a main drain between manholes shall be tested as one system with the main drain. In long branches a testing junction shall be inserted next to the junction with the main drain and the

branch tested separately. After the test has been passed, the testing junction shall be effectively sealed.

All tests on underground drains shall be permitted on galvanised iron drains at the discretion and to the approval of the Engineer.

Water tests shall be carried out in accordance with the methods described under B.S. Code of Practice 301, Clause 601 (b) and (c) and the test pressure shall not be less than 1,520mm head at the highest point in the pipe section and not more than 10,360mm head at any point in the section.

The test pressure shall be maintained for a period of one hour during which time the pipe and joints shall be inspected for sweating and leakage. Any leak discovered during the tests shall be made good by the Contractor and the section re-tested.

In addition to pressure tests, drain pipe runs shall also be tested for straightness where applicable. This test shall be carried out in accordance with one of the two methods described in B.S. Code of Practice 301, Clause 601 (e).

Testing of manholes shall be carried out in accordance with the methods described under B.S. Code of Practice 301, Clause 601 (f).

(d) **Above Ground Soil Waste and Ventilation Pipe System**

All soil, waste and ventilating pipe system forming part of the above ground installation, shall be given a smoke test to a pressure of 38mm of water gauge and this pressure shall remain constant for a period of not less than three minutes.

Water tests on above ground soil, waste and ventilating pipe systems shall not be permitted.

Pressure tests shall be carried out before any work which is to be concealed is finally enclosed.

Any defects revealed by the tests shall be made good by the Contractor and the test repeated to the approval of the Engineer.

In all other respects, tests shall comply with the requirement for B.S. EN 12056-2:2000

2.4.2 Site test - performance

Following satisfactory pressure tests on the pipework systems, operational tests shall be carried out in accordance with the relevant B.S. Code of Practice on the systems as a whole to establish that special valves, gauges, controls, fittings, equipment and plant are functioning correctly to the satisfaction of the Engineer.

All hot water pipework shall be insulated with performed fibre glass sectional lagging to a thickness of 25mm.

Cold water pipework shall be installed with preformed fibre glass lagging to a thickness of 25mm where the pipe runs above a false ceiling or in areas where the ambient temperature is higher than normal with the result that pipe "sweating", due to condensation will cause nuisance.

All lagged pipes which run in a visible position after erection shall be given a cover and prepared for painting as follows:-

i) Apply a coating of a suitable filler until the canvas weave disappears and allow to dry.

(ii) Apply two undercoats of an approved paint and finish in suitable gloss enamel to colours approved by the Engineer.

All laggings for cold and hot water pipes erected in crawlways, ducts and above false ceiling which, after erection are not visible from the corridors or rooms, shall be covered with a reinforced aluminium foil finish and banded in colours to be approved by the Engineer.

In all respects, unless otherwise stated, the hot and cold water installation shall be carried out in accordance with the best standards of modern practice as described in C.P. 342 and C.P. 310 respectively, to the approval of the Engineer.

The test pressure shall be applied by means of a manually operated test pump or, in the case of long main or mains or larger diameter, by a power driven test pump which shall not be left unattended. In either case precautions shall be taken to ensure that the required pressure is not exceeded. Pressure gauges should be recalibrated before the tests.

The Contractor shall be deemed to have included in his price for all test pumps, and other equipment required under this Clause of the Specification.

The test pressure shall be one and a half times the maximum working pressure except where a pipe is manufactured from a material for which the relevant B.S. Specification designates a maximum test pressure as in the case of cast or spun iron pipes, where the test pressures should not exceed 120, 180 and 240 metre/head of Clause B, C, or D pipes.

2.4.3 Sterilization of Hot and Cold Water Systems

All underground water mains and above ground water distribution systems, cisterns, tanks, calorifiers, pumps, etc., shall be thoroughly sterilized and flushed out after the completion of all tests and before being fully commissioned for handover.

The sterilization procedures shall be carried out by the Contractor or specialist employed by the Contractor in accordance with the requirements of B.S. Code of Practice 310, Clause 409, to the approval of the Engineer.

PART C

GENERAL TECHNICAL SPECIFICATION

3 PART D - GENERAL TECHNICAL SPECIFICATION

3.1 Materials and Workmanship

All materials shall be of adequate quality for the duty specified and the workmanship shall be in accordance with the best accepted modern practice. Unless otherwise stated the Contractor shall be obliged to comply with the requirements of the latest edition of the relevant Kenya Bureau of Standards Specification where applicable. Failing this, the latest edition of the relevant Britain Standard Specification shall provide the required standard. If the Contractor desires to use any other standard specification or code of practice, it shall be referred to the Engineer for approval.

3.2 Structural Steelwork

The structural steel used in the Mechanical Contract shall be mild steel to B.S. 15. Black bolts and nuts shall be in accordance with B.S. 916. Black metal washers shall be in accordance with B.S. 916.

High Strength friction grips, bolts, nuts and washers shall be in accordance with B.S. 3139, Part 1, and their application shall conform to B.S. 3139, Part 1, and their application shall conform to B.S. 3294, Part 1 torque wrenches or impact tools where used be recalibrated before each shift.

All fabrication and erection procedures shall be in accordance with B.S. 449 as amended, Part 5. Before commencing the fixing of the steelwork the erector shall check the seating for line, level and bolt setting, and any errors which cannot be accommodated by the steelwork erector shall be reported to the Engineer.

3.3 Steel Fabrication and Baseplates

The manufacture of all fabricated items of plant shall be generally in accordance with B.S. 449 as amended, Part 5.

The fabrication and manufacture of the plant and equipment shall be completed in the Mechanical Contractor's workshops before delivery to site. No fabrication of complete units shall take place on site, site work shall be confined to only such minor alterations and adjustments as are found to be necessary during erection. If major alterations are found necessary the items of plant covered shall be returned to the Mechanical Contractor's workshop for modification on replacement and shall be tested and checked before re-delivery to site.

Drive baseplates shall be robustly constructed and adequately stiffened to prevent twisting and distortion. The ration of the base length to its height shall not be more than 10:1.

All surfaces shall be free from recesses and cavities to prevent the accumulation of dirt and/or waste material, and shall be designed to facilitate ease of cleaning and maintenance.

Where driving units are directly coupled to the driven component all mounting surfaces shall be accurately machined to ensure alignment. After final assembly and testing, the individual items of plant shall be accurately dowelled in position on the baseplate to prevent misalignment during installation or during operation.

The Mechanical Contractor shall include in the design for any measures required to counter the effects of vibration which might be caused by operation of equipment.

3.4 Stainless Steel

All items fabricated in stainless steel shall be in the grade specified and detailed designs shall be compatible with fabrication techniques. The designs of articles to be pressed or welded shall be discussed with the fabricator before manufacture. All stainless steel items shall have a 'half-moon' finish to the satisfaction of the Engineer. Edges shall be finished by either welding on 12mm stainless steel round bar in the same grade as the article or by turning down to an acceptable radius.

3.5 Welding

3.5.1 WELDING

Welding shall be carried out in accordance with the BC Code of Practice for welding No.044 Parts 1, 2, 3, & 4.

3.5.2 Freedom from Surface Defects

All welded fillets or butt joints shall be ground smooth and shall be free from porosity, cavities and entrapped slag. All welds shall conform to the requirements of B.S. 1856.

Welds which are to be hot dip zinc coated shall be neatly formed and the surfaces shall be acceptable and free from cracks in the welds or heat affected zone, from overlap undercuts, porosity, entrapped slag and spatter in or associated with the welds. The welds shall seal completely the edges of all overlapping or contacting surfaces.

3.5.3 Smoothness of joints where Weld is re-commenced or terminated

The joints in the weld run where welding has been recommenced or terminated shall be smooth and shall show no pronounced hump or crater in the weld surface.

3.5.4 Shape of Profile

The profile of the weld shall be uniform, of appropriately equal leg length and free form overlap at the toes of the weld. Unless otherwise specified the surface shall be either flat or slightly convex in the case of welds and with a reinforcement of not more than 3 mm in the case of butt welds.

3.5.5 Uniformity of Surface

The weld face shall be uniform in appearance through its length.

3.5.6 Electrodes

Electrodes shall be of an approved type for the material being used and shall be kept in a dry condition. All electrodes shall conform to the latest issue of B.S. 693 'Electrodes for Manual Metal Arch Welding of Mild Steel and Medium High Tensiles Steel'.

3.5.7 Qualification of Welders

Welding on or off the site shall be carried out only by welders qualified to the approval of the Engineer. Each welder to be used on the Mechanical Contract Works will be required to carry to test welds to the approval of the Engineer and in the presence of the Engineer's Representative. Only welders whose test welds have been passed by the Engineer shall be employed on the Mechanical Contract Works and then only for the class of welding for which they have been tested. Initial testing of welders and such periodical tests as may be required by the Engineer shall be carried out at the Mechanical Contractor's expense using materials supplied by the Mechanical Contractor.

3.6 HOT DIP (Galvanised Zinc Coatings)

3.6.1 General

All hot dip zinc coatings shall conform to the requirements of the latest issue of specification 'Hot-Dip (Galvanised Zinc coatings' with particular reference to the following.

Tubular constructions shall be provided vent holes in appropriate locations to prevent internal pressure build-up during the hot zinc bath shall be referred to the galvaniser who shall state his requirements for the vent holes desired. Welding flux shall be chipped away, all welds shall be wire brushed, ground or grit or shot blasted if necessary before hot zinc coating.

The surfaces to be hot-dip coated shall be free from paint, oil, grease, and similar impurities. Identification numbers of individual pieces shall be clearly stamped on surfaces of members prior to hot-zinc coating, numbers painted or welded on the surfaces of these members shall be unacceptable.

Exposed surfaces, except welds when necessary, need not be grit or shot blasted, but the engineer shall decide to call for grit or shot-blasting in cases of unsuitable surface finish on material for hot-dip zinc coating. The Engineer shall have the right to inspect all steel components before galvanising, and shall have the right to reject or ask for remedial treatment of any material which is considered unsuitable. This applies particularly to welds, burrs, and surfaces having visible surface defects.

Globular extra heavy deposits for zinc which interfere with the intended use of the material shall not be acceptable. Excessively protuberant lumps and nodules shall be removed by hot wiping or skilful application of mechanical means provided that a sufficient minimum thickness of unbroken zinc coating remains after such treatment. Flows on small parts and working surfaces shall be repaired only by stripping, dressing and re-dipping.

3.6.2 Threads

The galvanising on threads or bolts shall be such as to fit a gauge made by overtapping a nut to the following increased limits of size to 7H tolerances:

		Bolt Sizes	M6	M8	M10		M12	M16	M24
Overcut,mm	To be	To be	0,33	0,33	0,38	0,38	0,38		

For threaded articles less than 10mm diameter mechanical plating will be acceptable instead of hot dip zinc coating (galvanising).

Nuts shall be capable of being spun over the full length of the thread by hand ungalvanised internal threads shall be coated immediately after cutting, before they are allowed to rust, with preventive compound of type agreed between the supplier and the Engineer.

3.6.3 Bolts

Bolts to be galvanised shall be standard black bolts manufactured according to B.S 916 (and having threads produced to medium class tolerances G8). Any bolt which has been subjected to cold forming (heading) operation during manufacture shall be stree-relieved at a temperature between 600^0C for a minimum period of 20 minutes and subsequently cooled in air.

3.6.4 Protection of Coating (Passivation)

Immediately after withdrawal from the bath of molten zinc, galvanised material shall be quenched in water containing approximately 1% of sodium dichromat slightly acidified with sulphuric acid. Other bath compositions may be used provided that they contain recognised passivating agents unless otherwise specified.

Alternatively by agreement between the galvaniser and the Engineer, protection may be applied by other means, such as, for instance, a lacquer containing chromate salts.

3.6.5 White Rust (White Storage Stain)

All galvanised material shall be free from gross deposits of white rust. If material has been affected by white rust, the deposit may be removed, by means of non-metallic brushes and provided that the thickness of zinc coating in the affected area meets the requirements of the specification the material can be accepted.

No galvanised material shall be used for erection unless such material:-

a) Has been zinc coated under the Kenya Bureau of Standards certification scheme, and this is indicated by the diamond standardisation mark, which should appear on all labels, delivery notes, and other similar documents relating to such material. Such documents should also indicate the name of the galvaniser concerned.

Structural material should also bear a paint mark applied by the galvaniser to indicate standardisation mark quality. The Engineer may call for certificates from the galvaniser indicating that each consignment of material complies with the specification and was galvanised under the certification mark scheme: or

b) The galvanised material has been inspected, and each consignment is accompanied by an inspector's certificate indicating that the material is acceptable and complies with the requirements. Structural material should also bear a paint mark applied by the inspector to indicate that the material has been inspected and accepted. Bolts,

nuts and other material of small size should be in a bag or container containing a label bearing the inspector's stamp.

3.7 CASTINGS

Because of the corrosion-inducing conditions, and in order to obtain satisfactory mechanical properties of tensile, shear and yield strengths, resistance to impact and transverse loads and hardness properties, all ferrous castings other than those included in the proprietary 'bought out' items of equipment shall comply with the specification hereunder. If the Contractor wishes to offer alternative materials, he shall submit comprehensive details of such alternatives and obtain the prior written approval of the Engineer before proceeding with manufacture.

Material:	Pearlitic Nodular Structure.
Mechanical Properties:	Ultimate Tensile Strength - 725 mpa Elongation - 2% Hardness - 240 to 300 brinell (after normalizing)
Inoculation:	All castings shall be inoculated with 3% copper.
Heat Treatment:	To provide the optimum physical properties consistent with the pearlitic nodular structure of the material, and to provide a hardness within the range 207 to 235 brinell.
Test Certificates:	The contractor shall submit to the Engineer all test certificates of analysis including all relevant details of the micro-structure and mechanical properties. The number of tests to be performed and for which certificates of analysis are required shall depend on the respective casting and shall be a greed in writing with the Engineer.

3.8 VEE-BELT DRIVES

All vee-belt drives shall conform to B.S. 1440: 1962 - "Endless V-belt drives" and shall be as specified below:

a) Application

Unless otherwise specified or agreed to by the Engineer, Vee-Belt drives shall only be used in applications of constant and slightly varying load conditions. Belt speeds shall not exceed 900 metres per minute, unless otherwise agreed. For reasons of spares interchangeability and maintenance, standard stock vee-belts shall be used.

b) Pulleys

The belt pulleys shall be manufactured from a close-grained galvanised iron and shall be accurately balanced. The belt grooves shall be properly machined to the correct groove angle and depth.

All sharp corners at the top of the groove shall be removed and the groove sides shall be polished smooth to avoid excessive belt wear. The grooves of mating pulleys shall accurately match each other, particularly regarding width, angle and alignment.

c) Adjustment

Adjustment inward, i.e. towards the driven pulley, shall be provided to ensure sufficient movement of the driving pulley to enable the vee-belts to be fitted by hand, without the use of a lever of any king to force the belts over the pulleys.

The outward adjustment shall provide for correct belt tensioning to ensure that slipping does not occur. All belt tensions shall be re-checked within 24hours and again within a week to start-up to ensure that the initial slack, if any, is taken up.

d) Speed Ratio

Speed ratios greater than 7:1 shall not be acceptable unless otherwise agreed by the Engineer.

3.9 BEARINGS

1.9.1 Anti-Friction

Anti-friction bearings shall include all bearings which provide rolling contact between one or more sets of hardened steel balls or rollers located between hardened steel rings or raceways. Anti-friction bearings shall be of approved manufacture.

To facilitate maintenance, spares interchangeability and standardisation, anti-friction bearings of standard designs and manufacture shall be employed. All anti-friction bearings shall be provided with greasing facilities in accordance with the manufacturer's requirements.

1.9.2 Bushed Bearings

Only where specifically stated and in cases of low velocities and light loads in moisture-free conditions will bushed bearings be accepted. All bushed bearing shall be made of an approved friction quality and shall be capable of withstanding severe usage.

All bushed bearings shall be provided with lubrication facilities to ensure adequate lubrication and shall be properly grooved to distribute the lubricant uniformly over the bearing surface. Grooves shall not be cut into the journal, but always into the surrounding bush. The edges of all chamfers and grooves shall be rounded to avoid sharp corners and to facilitate the introduction of the oil or grease.

1.9.3 Self Lubricating or Oil-less Bearings

Self-lubricating or oil-less bearings shall only be used on application of light loads and low velocities in moisture-free and low humidity conditions and where bearings are of difficult access and likely to be neglected during servicing. The types of bearing metal composition used shall have frictional and wear resistant properties akin to those of grease lubricated bushed bearings.

3.10 KEYS AND KEY WAYS

All keys and Keyways and taper pins shall conform to B.S. 46: Part 1, 1958.

3.11 LIMITS AND FITS

Limits and tolerances for shafts and hoes shall conform to B.S.3614.

3.12 GENERAL MACHINERY PROTECTION

3.12.1 Coupling and Shaft Guards

All high speed couplings, projecting shaft ends and every dangerous moving part of machinery shall be protected by a guard manufactured from not less than 1.6mm mild steel plate. The guards shall be neatly formed and securely fixed in position.

3.12.2 Belt Guards

All belt or rope drives shall be adequately protected by a belt guard.

The guard shall be manufactured from wire mesh or open type expanded metal, securely braced and stiffened with suitable rolled steel sections and bolted in position. Guard supports shall not short-circuit vibration isolators on form. Provision must be made for test openings to permit RPM reading of fan and motor without the removal of the belt guard.

3.12.3 Painting

All guards shall be finished in a light orange colour to B.S. 381C in accordance with Clause 2.8.4 Class 'C'.

3.12.4 EQUIPMENT BASES

Unless stated elsewhere in this specification, inertia base formers for machinery shall be provided to the Main Contractor for casting, by the Contractor for casting, by the Contractor. The bases shall consist of reinforced concrete cast into sheet metal formers at least 150mm deep.

The formers shall comply with the standard set by Mason Industries, for both size and construction. Bases shall be mounted on properly selected spring isolators incorporating noise isolation pads.

Either free-standing stable steel spring or caged spring with snubber may be used. Spring isolators shall be provided with levelling bolts. Noise isolation pads shall be large enough to prevent excessive rocking of equipment during start up and normal operation. Bases and supports shall be arranged to give a clearance of approximately 25mm between the underside of the bases and the floor. Bases shall be large enough to accommodate motors and the equipment they drive.

3.13 IDENTIFICATION AND LABELLING

All plant and equipment items, including items such as dampers, pumps, etc, shall be labelled in a clearly visible position with the item name and, in the case of duplicate items, a number. Plant labels shall correspond with labels on starters, isolators, etc.

Labels shall be of sandwich thermosetting plastic with black lettering on a white background. Lettering shall be at least 6mm high and labels shall be in keeping with the size of equipment and legibility with regard to position.

3.14 PAINTING

3.14.1 Painting Materials

All paint, driers and the like, and other materials shall conform with the requirements of the relevant British Standard Specification. All paints shall be of the best quality and of approved brand and manufacture. All materials shall be used in strict accordance with the manufacturer's instructions and otherwise in strict accordance with the best standard practice. Undercoats of paintwork and primers shall be as supplied by the manufacturer of the paint begin used for the finishing coat. If necessary, paint shall be strained free from skins and similar impurities immediately before application. Priming coats shall be applied over the whole surface and well brushed in order to obtain the maximum penetration. All materials shall be delivered to the job in their original unopened containers with the manufacturer's name and description of contents thereon and no adulteration will be allowed.

3.14.2 Colours

Samples of the final colours required shall be submitted for approval before painting the work in hand and the work shall then be finished to the colour or colours as approved. Each coat of paint shall be a distinctive colour working up to the finished colour as approved.

3.14.3 External Painting

External painting shall not be undertaken during rainy, damp, frosty or other inclement weather or where such weather is reasonably to be expected within the next 24 hours.

3.14.4 Internal Painting

Before internal painter's work is commenced all floors shall be swept clean, and dirt and rubbish removed, and the rooms left practically free from dust; dust-free conditions being maintained during the progress of the work. No sweeping or dusting shall be done whilst the painting is in progress.

Unless otherwise stated, no paint shall be applied within 50mm of areas which are to be welded. Welds and adjacent parent metal shall be de-slagged, inspected and approved and area shall be abrasive-blasted or ground, and all contaminants shall be removed prior to painting. Wire brushing of the weld shall only be allowed if the paint specification calls for wire-brushing. The weld area shall then be flushed with fresh water and allowed to dry before receiving the full paint system.

Areas where the paint coating has been damaged during transportation erection or by any means whatever, shall be repaired as follows:

Damaged areas or rust spots shall be removed by means of a wire brush or emery paper and the surrounding paint which is still intact shall be feathered for a distance of 20mm beyond the damaged area. Spot priming shall consist of all the coats previously applied and shall overlap the undamaged area by 20mm. Surfaces which are to rest on concrete or other floors or which will be inaccessible after erection shall receive full specified paint system before erection or assembly. Unless otherwise specified, steel embedded with concrete shall not be painted except to within 50mm below the concrete/air interface.

Mating or contact surfaces shall be protected from corrosion by ensuring that the two surfaces brought into contact with each other shall be prepared and primed in accordance with the specification. The primed surfaces shall be brought together while the paint is still wet. Surfaces which are to be friction-bolted shall be prepared in accordance with the specification (i.e. blast-cleaned or wire-brushed) but shall receive no paint coating. All sharp edges shall receive the specified dry film thickness of paint.

Where the shop coat has been allowed to age for a few months before painting, it shall be lightly sanded or rubbed with steel wool and scrubbed with clean water suing a bristle brush.

Before painting galvanised iron surfaces, they shall be treated with galvanised Iron Cleaner" or equal and approved cleaner, used in strict accordance with the manufacturer's instructions. Where a temporary protective coating has been applied to prevent wet storage stain, the surface shall be thoroughly scrubbed down by means of a bristle brush and the approved cleaner until all the temporary protection has been removed. The treated surfaces shall then be thoroughly washed down with clean water and the surfaces allowed to dry before painting.

All galvanised sheeting shall be painted on the ground before erection. This will also ensure that overlaps are well protected. Where it is impracticable to apply the coating system before erection, prior consent to paint after erection shall be obtained form the Engineer.

Paint dry-film thickness shall be measured using a non-destructive thickness gauge such as the MIKROTEST or equivalent.

3.14.5 Inspection of Surfaces

All surfaces to be painted shall be carefully inspected by the Contractor who shall satisfy himself that the surfaces are in a perfect state to take the paintwork specified. No claim will be entertained arising form defective work due to not strictly insisting on receiving from defective work due to not strictly insisting on receiving from other trades, surfaces in a proper condition, fit to receive the type of paint specified. All surfaces shall be perfectly clean, free from dust, dirt, grease, blotches, and other blemishes before painting, staining or application of any coat.

All surfaces shall be properly prepared before painting or staining. Each coat of paint, except the last, shall be rubbed down with a fine glass paper before the next coat is applied.

Unless otherwise directed, the last coat of paint or finishing shall be done when all other work in the Contract is completed and the premises free from all rubbish and dirt. On completion, all painter's work shall be touched up where necessary and any defects made good. All paint and stain spots shall be removed and all surfaces left in a perfect condition.

3.14.6 Iron and Steel Surfaces

The contractor shall ensure that primed steelwork which is to be delivered to site is stacked on bearers and is clear of the ground. Wherever possible channels, angles, and other equipment and material shall be stacked so that water cannot collect on the steel.

Iron and steel surfaces shall be scrapped or shot blasted to produce a clean surface before painting. Paint shall not be applied over any surface containing traces of grit, grease, oil and the like, loose rust, loose millscale or corrosion products and foreign matter of any kind.

All air used for blast-cleaning or spraying shall be free from all traces of water and oil. When blast-cleaned, a satisfactory blast profile (i.e. anchor pattern) shall be achieved.

If the abrasive used for blast-cleaning is sand, it shall be free of clay. All metal surfaces to which paint is to be applied shall be moisture dry paint surfaces which are to be over-coated shall be hard-dry before over-coating, unless otherwise specified.

3.14.7 Painting of Steel Surfaces with Polyurethane System

This system is based on a polyurethane which is cured with an Aliphatic Di-Isocyanate. No polyurethane products which are cured with Aromatic Di-Isocyanate curing agents will be acceptable. This system shall be used as specified in highly corrosive conditions and where a high quality finish is required.

a) In Fabricator's Premises

i) Surface Preparation. All steel surfaces shall be abrasive blast-cleaned to a near-white finish and shall be free from oil and grease and any corrosive contaminants.

ii) Priming. Within 4 hours of blast-cleaning, one coat of an approved zinc chromate epoxy primer shall be applied to give a minimum dry film thickness of 38 micrometers.

iii) Undercoat. One coat of an approved undercoat compatible with both the primer and the finishing coat to give a minimum dry film thickness of 50 micrometers

b) On Site Painting

After erection the following procedures shall be adopted:-

i) Damaged areas shall be repaired as per clause 15.4 above, and spot priming shall comprise all the shop coats.

ii) Undercoat. Unless the undercoat has already been applied it shall be applied before erection as described in Sub-Clause (a) iii) above.

iii) Finishing. Two finishing coats of approved polyurethane enamel in the specified colour shall be applied to give a minimum dry film thickness of 25 micrometers per coat. The two coats shall be distributable in colour and the second coat shall be applied within 24 hours of the first. The total Minimum dry film thickness for the complete paint system shall be 138 micrometers.

3.14.8 Painting of Steel Surfaces with Alkyd System

This system shall be used as specified on columns, roof trusses, steel window frames and door jambs, pipes, pumps and equipment in areas where corrosion is mild and a decorative appearance is required.

i) Surface.

Where a decorative rather than corrosive resistant finish is required, steel surfaces may be specified to be mechanically or hand wirebrushed to remove loose rust millscale.

Where a more corrosive resistant finish than the above is specified, all steel surfaces shall be abrasive blast-cleaned to a near white finish. The abrasive shall be free form oil and grease and corrosive contaminants such as chlorides and the like.

ii) Etch Priming. (Applicable to abravise-blasted surfaces only).

Within 24 hours of cleaning, apply one coat of an approved single pact within 4 hours of cleaning, apply one coat of an approved single pack zinc chromate etch primer to give a dry film thickness of not less than 20 micrometers.

iii) Priming. (For abrasive - blasted surfaces).

Apply one coat of an approved zinc chromate primer (green) to give a dry film thickness of not less than 38 micrometers.

For wire brushed surfaces to the clean steel apply one coat, by rush or roller, of an approved red lead primer to give a dry film thickness of not less than 38 micrometers.

b) On-Site Painting of Steelwork

i) Damaged Areas

Before and after erection damaged areas shall be repainted as for Clause 14.4 above, and spot priming shall comprise all the shop coats.

ii) Undercoat

Apply one coat of an approved undercoat to give a minimum dry film thickness of 38 micrometers. The undercoat may be tinted to a shade just lighter than the finishing colour using approved stainers.

iii) Finishing

Apply at least one coat of an approved high gloss enamel in the specified colour, to give a minimum dry film thickness of 25 micrometers.

The total dry film thickness for the complete system shall not be less than 100 micrometers for wire-brushed surfaces, and 120 micrometers. The total dry film thickness for the complete system shall not be less than 100 micrometers for wire-brush surfaces and 120 micrometers for abrasive-blasted surfaces.

Note: Where window frames, door jambs and the like have been painted in the fabricator's yard with red oxide primer, this shall be rubbed down and primed in accordance with Clause 14.7 (a) III.

c) Painting of Motors, Gear Boxes and other Equipment

i) Surface Preparation

The surfaces to be painted shall be completely free from oil, grease, rust and foreign matter of any kind.

ii) Priming

One coat of an approved epoxy primer shall be applied to form a uniform coat and to fill all porosities in the castings. After 24 hours the primer shall be wet sanded to produce a uniform smooth surface.

iii) Undercoat

One coat of suitable undercoat tinted to a shade just lighter than the finishing colour with suitable staining agent, which is compatible with the paints, shall be applied.

iv) Finishing

One coat of approved high gloss enamel in the specified colour shall be applied. N.B. Flanged faces shall receive the full specified coating.

d) Painting of Pipes

i) Surface Preparation

The surfaces shall be wire brushed to remove loose rust and loose millscale.

ii) Priming

An approved one coat primer shall be applied.

iii) Undercoat

Undercoat shall be specified in Clause 14.8.

iv) Finishing

The finishing coat shall be as specified in Clause 14.8 (c) (iv). The total dry film thickness for the coating system shall not be less than 90 micrometers. N.B. Flanged faces shall receive the full specified coating.

3.14.9 Painting of Galvanised Surfaces with Alkyd System

This paint system shall be used as specified for painting of side sheeting, ducting and plenum walls, underside of roof sheeting and the outside surfaces of rain water gutters where a decorative effect is required. It shall only be used where the corrosive conditions are mild.

i) Surface Preparation

The surfaces shall be prepared in the manner as described in Clause 14.4 above.

ii) Priming

To the cleaned surfaces apply one coat of an approved Calcium Plumbate primer.

iii) Undercoat

Apply one coat of approved high gloss enamel in the specified colour. The total paint dry film thickness for the system shall not be less than 100 micrometers.

3.14.10 Painting of Equipment and Steelwork with Epoxy System

i) Surface Preparation

a) Equipment

Where the equipment is specified to be painted after installation it shall be delivered to site unpainted. The surfaces to be painted shall be completely free from oil, grease, rust and all other foreign matter. If possible, castings shall be fettled prior to priming.

b) Supports and Steelwork

All surfaces shall be abrasive blast-cleaned. The abrasive shall be free from oil, grease, and corrosive contaminants such as chlorides and the like.

ii) Priming

Apply one coat of approved epoxy primer to form a uniform coat, and to fill all porosities in the casting. After 24 hours the primer shall be wet sanded to produce a uniform, smooth surfaces.

iii) Finishing

Apply two coats of an approved Epoxy Enamel in the specified colour, the second coat to be applied within 24 hours of the fist. N.B. Flanged faces shall receive the full specified coating system.

3.14.11 Painting of Galvanised Surfaces with Epoxy System

This paint system shall be used for painting of galvanised surfaces in highly corrosive conditions.

i) Surface Preparation

These surfaces shall be prepared in the manner as described in Clause 15.4 above.

ii) Priming

To the cleaned surfaces apply one coat of approved Epoxy Zinc Chromate Primer.

iii) Finishing

Apply two coats of an approved epoxy enamel. The second finishing coat shall be applied within 24 hours after the application of the fist finishing coat, and shall be distinguishable in colour from the first. The total minimum dry film thickness for the paint system shall be 88mm.

3.14.12 Painting of Chequer Plate of Egg-Crate Flooring and Supporting

Frames with Epoxy Tar System

This paint system shall be abrasive blasted or acid pickled and passiveated.

i) Surface Preparation

Surfaces shall be abrasive or acid and passivated.

ii) Finishing

Three coats of approved epoxy Tar shall be applied. Consecutive coats shall be in distinguishing colours.

3.14.13 Painting of Galvanised Surfaces with Epoxy Tar System

This paint system shall be used for the painting of internal surfaces of galvanised gutters.

i) Surface Preparation shall be described in Clause 14.4

ii) Finishing

To the cleaned surfaces apply one coat of approved Calcium Plumbate Primer.

iii) Undercoat

Apply one coat of suitable undercoat tinted to a shade just lighter than the finishing colour with a suitable tinting agent which shall be compatible with the paint.

iv) Finishing

The Contractor shall apply two coats of approved Epoxy Tar. The second coat shall be applied within 24 hours of the first coat. The total paint dry film thickness shall be not less than 200 micrometers.

3.14.14 Painting of Steelwork with Chlorinated Rubber System

This system shall be used in areas where the steelwork is exposed to occasional corrosive conditions.

a) In Fabricator's Yard

i) Surface Preparation

Abrasive blast-clean all steel surfaces. The abrasive shall be free form oil, grease and any corrosive contaminants.

ii) Priming

One coat of approved chlorinated rubber undercoat shall be applied to give minimum dry film thickness of 75 micrometers.

iii) Undercoat

One coat of approved chlorinated Rubber Undercoat shall be applied to give a minimum dry film thickness of 75 micrometers.

b) On-Site Painting

After erection, the following procedure shall be adopted:-

i) Damaged areas shall be repaired as described in clause 14, 4 above and spot priming shall comprise all the shop coats.

ii) Finishing

One coat of approved chlorinated rubber enamel shall be applied in the specified colour, to give a dry film thickness of not less than 25mm.

3.14.15 Painting of Galvanised Surfaces with Micaceous Iron Oxide Pigmented Alkyd System

Unless the Engineer has given his written consent, the galvanised sheets shall be primed on the ground before erection.

i) Surface Preparation. The surfaces shall be prepared in the manner as described in Clause 1.14.4.

ii) Priming To the clean surfaces apply one coat of an approved calcium plumbate primer.

iii) Undercoat. Apply one coat of an approved Alkyd micaceous Iron Oxide structural paint.

iv) Finishing. Apply one coat of an approved Alkyd micaceous Iron Oxide structural paint in colour as specified.

(v) Damaged Areas these shall be repaired in a manner as described in clause 1.14.4

The total paint dry film thickness shall not be less than 114 micrometers.

3.14.16 Specialised Painter

All painting shall be carried out by a painting specialist employed by the contractor.

3.15 PROTECTION OF UNPAINTED SURFACES

Bright Machined Parts

All bright machined parts shall have a protective treatment applied by the manufacturer before despatch and this treatment shall be kept intact up to the time of handover unless it has been removed for installation. If the surface is exposed after installation a further protective coating shall be applied in accordance with the manufacturer's requirements.

3.16 PIPING AND FITTINGS

3.16.1 Materials

Pipework shall be run as shown on the contract drawings. All piping used in the construction of the works shall be straight, cleanly finished, round in cross-section, free from cracks, surface flows, laminations and other defects and free from scale.

3.16.2 Neatness

All pipe runs shall be arranged to present a neat appearance with where practicable shall be parallel both with one another and with the building structure, paying due regard however to the grading and venting requirements. All vertical pipes shall be plumb.

Pipes shall be bent round piers and all other projections and recesses and all offsets due to varying thicknesses of plaster, walls, floors and ceilings and other structural works were such changes in direction of piping are indicated on the drawings or not. Details of the skirting heights, sill heights and floor finishes shall be determined before any work is commenced. No pipework offsets shall be allowed on piping.

3.16.3 Prevention of Dirt Entering Pipes, valves etc.

All pipes, fittings, valves, etc. shall be guaranteed to be free from corrosion and internal obstruction. Pipes and fittings showing signs of corrosion shall not be fitted.

The open ends of all pipework and valves shall be protected. Wrought-iron screwed caps or plugs or plastic covers only shall be used to cover open ends. Wood, rag or paper plugs shall be used. Pipework delivered for use on the Contract Works shall

be stored clear off the ground on suitable racks or stands and with the ends protected as described above.

3.16.4 Pipe Cutting and Cleaning

All cuts from Standard lengths of pipe shall have all burrs and swarf removed, the ends shall be trimmed square and the pipe shall be thoroughly cleaned both internally and externally before erection.

3.16.5 Accessibility

All valves, drains and supports shall be positioned so as to facilitate maintenance. Grouping of valves, drains unions flanges etc. shall be preferred to scatted siting. Joints shall not be formed in the thickness of walls, floors or ceilings. All pipework, valves fittings and equipment forming the piping installation shall be erected so that it can be dismantled and be readily accessible for repair and replacement.

Readily accessible means that the flange, union, etc., can be reached and worked upon either in the open or else by removal of a purpose made duct cover, manhole or similar cover. The fitting is not accessible if as fixed it cannot be manipulated.

Where pipework is to be installed in an inaccessible position it shall be welded or brazed. Unions or flanges shall be provided as equipment to facilitate dismantling. Care shall be taken to ensure that pipe flanges, valves etc are staggered relative to similar projections or adjacent pipes and obstructions such as bemas columns and pipe supports, where necessary.

3.16.6 Grading of Pipework

All pipework shall be installed with continuous gradients to allow for drainage and for venting air. The rise or fall of piping in the direction of flow shall be as laid out in the schedule below (unless noted otherwise on the drawings or instructed by the Engineer.

Service	Rise or Fall	Minimum Gradient mm per meter
Water	Rise (preferred)	2
Steam	fall	4
Condensate	fall	4
Compressed Air	fall	8

3.16.7 Pipes laid in Ground

Pipes laid in the ground shall be assembled with care and shall be well bedded in to ensure that pipework and fittings shall not be damaged by movement of the ground. (Steel pipes shall either be supplied with factory applied bitumen/fibreglass wrapping and joints site-wrapped with bitumen tape, or the entire pipeline shall be primed with Densopaste, protected with Denso tape applied with a 55% overlay and protected with PVC wrapping securely fixed).

Excavation in ground and backfilling of trenches with sealed backfill shall be by others unless specified otherwise.

3.16.8 Pipes Joints

a) Types of Joints

Joints shall be screwed, welded or flanged as specified for each particular service elsewhere in this specification. Joints shall comply with relevant Kenya Bureau of Standards or BS specification. All flanges shall be at 90^0 to the centre line of the pipe and the holes shall straddle the centre line.

b) Screwed Joints

Pipes for screwed joints shall be provided with taper threads to B.S. 21 Part 1. Steel pipes shall be carefully reamed out before the plain end is threaded. Threads shall be right, clean and free of burrs prior to installation. Before making a joint, the male screw thread shall be wrapped with Polytetrafluoroethene (PTFE) tape. Alternative jointing compounds shall not be used without the express approval of the Engineer. Should a screwed joint prove defective under test or in operation, the joint shall be broken and remade, caulking will be permitted.

c) Flanged Joints - Steel Pipes

All flanges, bolts, nuts and washers shall be manufactured from mild or stainless steel to B.S. 4504 Part 2 "Table of Piped Flanges (for land use)" to the table appropriate to the pressure specified. Bolt holes in flanges shall be drilled, not punched, and spot faced for nuts.

Pipes not galvanised shall be provided with flanges crewed or welded for nominal bores of 80mm and below and with welded flanges for larger sizes. Galvanised pipes shall be provided with galvanised screwed flanges for nominal bores 80mm and below and with welded flanges for larger sizes. For galvanised piping all welding shall be carried out before galvanising.

Welded flanges shall be of the machine-faced, slip-on pattern with neck secured by welding both at the neck and bore of the flange to pipe, with the pipe finishing 3mm inside the bore. Care shall be taken not to distort the machined face. The use of alternative flanging to the ASA standards throughout the installation will be considered upon application.

d) Flanged joints - Polypropylene Pipe

Flanges on polyprolene pipes shall be of the full face type up to and including 100mm NB, and the stub flange type with mild steel backing ring for sizes 125mm NB and above, these shall also be used on sizes below 100 mm NB upon the Engineer's request.

All drilling in flanges and backing rings shall be to B.S. 4504 Part 2 "Table of Pipe Flanges" (for land use) and the holes shall be drilled, not punched, and spot faced.

Thickness of flanges and backing rings shall be as specified for each service and the material for the flanges and stub flanges shall be identical to that of the pipe. The

use of the alternative flanging to ASA standards throughout the installation will be considered upon application.

e) Gaskets and Bolts

The joint between flanges shall be made up with a joint ring graphite faced on both sides. Joint strings shall be suitable for the pipeline pressure and temperature duty and shall be identified for duty for which they are suitable. Joint rings shall be cut from sheets on site.

Bolts heads and nuts shall be hexagonal in form and washers shall be fitted beneath bolt heads and nuts. The lengths of bolts shall be such that not less than one thread nor more than 5mm of bolt protrudes through each nut when the joint is pulled up. All bolts and nuts shall be corrosion resistant.

f) Welded Joints - General

Welding technique, edge prepatin and welding rods or electrodes shall be selected to be suitable in all respects for the materials and duty of the pipeline, and comply with the applicable British Standards.

Each approved welder will be assigned a reference number which shall be stamped on each weld carried out by him. During the progress of the site work ultrasonic or radiographic examination or welds may be carried out by an independent authority at the expense of the Employer Welds found to be defective shall be cut out and the pipe made good, all the contractor at his own expense, and the new welds retested at the contractor's expense.

The Contractor shall cut out and prepare for mechanical testing in the presence of the Engineer, welded joints selected by the Engineer. Cutting out and preparing of test pieces and the making good of pipelines shall be at the contractor's expenses. The total number of such tests will not exceed one per cent of welded joints except that welds found to be defective shall not form part of this total.

Should a significant proportion of the tested welds of a particular welder prove to be defective due to faulty workmanship, all welds carried out by the particular welder shall be cut out and the pipeline made good by another welder whose work has proved satisfactory.

When the general hydraulic test of the completed systems is carried out, each weld shall be lightly hammered during the time pressure is maintained. If any leaks occur at welds, the portion of weld near the leak shall be removed by cutting or grinding and welded. Repairs shall not be attempted by caulking or fusion of surrounding metal.

g) Welded Joints - Steel Pipes

Oxy-acetylene welding shall generally be carried out in accordance with the "Recommended practise of oxy-acetylene welds in mild steel pipelines" publishing by the Heating and Ventilation Contractors Association. Metal arc welding shall be in accordance with Technical Memorandum T.3 issued by the British Welding Research Association.

The contractor shall obtain from the manufacturers tests certificates representative of welding rods and electrodes used and in accordance with B.S. 1453 or B.S. 639 respectively.

All welded joints, whether produced by oxy-acetylene flame or metal are processes shall be of prime quality. The butts shall be slightly convex with regular ripples and no undercutting, washing away or surface cavities shall be present. Notches at the root into the pipe bore in excess of 1.5mm will be accepted and the external reinforcement shall run out smoothly to the pipe surface on either side. All slag shall be removed after each run. Undercut edges, slag pockets, unsound metal and blowholes shall be chipped out as the work proceeds.

h) Welding - Polypropylene

The use of radial welding equipment for pipework joints shall be preferred. The butt machine used for the welding of polypropylene pipes shall be of a design approved by the Engineer. The machine is to carry out the butt welding of pipes from 100 mm NB up to and including 300 mm NB, must be capable of welding flanges and fittings onto the pipe, and be able to do angular butt welds for development of special bends.

The machine shall be capable of maintaining a welding force of 3500 N. The welding force to be maintained at each weld shall be 10N for each square centimetre of annular pipe surface, at a temperature of 250 plus of minus 10^0C, and therefore provision shall be made for the heating of both mating surfaces to a temperature of, and maintaining, 250 plus of minus 10^0C. All heating surfaces in contact with the piping material shall be Teflon coated.

i) Pipe Fittings

General

Fittings shall be to the standards specified elsewhere in this specification and shall be compatible in all respects with the materials and class of piping being installed. Where standard fittings are not available for the duty required, reductions on the run and to the branch shall be in all cases be made with reducing sockets. Reducing bushes and long screw connectors with backnuts shall not be used.

Bends shall preferably be of the long radius type except for the compressed air system and where space is restricted. In these cases short radius elbows may be used subject to the approval of the Engineer.

In general standard tees shall be used for all connections to pipes and headers. The welding on of sockets or branch pipes will be permitted only with the authority of the Engineer. Reducers shall be of the eccentric type, except on vertical pipelines where concentric reducers may be used. Transitions shall be swept and not abrupt. All connections to plant items shall be so arrange that the plat can be easily disconnected. All steam, compressed air and water connections shall be made to the top of the line unless noted otherwise on the drawings.

3.16.9 Pipe Supports and Guides

a) General

All supports, brackets, hangers clips and other fixing accessories necessary to support all piping system from the building structure or concrete bearers shall be provided and fixed under this Contract. As far as practicable standard bought dip galvanised components shall be used. Samples of these components shall be submitted for approval prior to the placing of order.

Steam and other pipes for high temperature duties be supported on rollers and guided with rollers at changes of direction or other points where necessary to prevent pipes leaving the supports, or on hangers with spherical washers or suitably articulated to take up movement.

Brackets and supporting frames of rolled steel sections shall be fabricated in accordance with the best accepted practice to form true, rigid, neat structures. Makeshift, untidy or unstable supports will be acceptable. Woodscrews, pop-rivets, self-tapping screws, or other fastenings subject to loosening by vibration shall not be used in the fabrication or attachment of pipe supports or fixings. Spring washers, lock nuts or other locking devices shall be used on nuts. Contact between dissimilar metals shall be avoided. A pipe shall not be supported from another pipe unless approved by the Engineer or specifically called for the drawings. Where a common hanger is used for more than one pipe, provision shall be made to accommodate unequal expansion.

b) Fixing to Structure

Fixing to the building structure shall not be carried out in any manner other than that specifically approved by the Engineer for the particular area of the building and type of finish. Care shall be taken to avoid unnecessary damage to finishing.

Competent labour shall be employed to ensure that supports are correctly sized, spaced and set out prior to fixing. All work shall be made good to the Engineer's approval.

For fixing to brick and concrete, holes of correct size shall be neatly drilled using special purpose twist drills, and fixings made by rowl-bolts or equal or bolts of the grouted type approved by the Engineer. Shot fixings shall not be used nor shall fixings be made into mortar between bricks. Fixing to lightweight or hollow structures shall be by means of suitable screw anchors, toggle bolts or approved alternative.

c) Spacing of Supports

Spacing of supports for steel and copper pipes shall not exceed the centres given in the following table:

MAXIMUM SPACING OF SUPPORTS (M)

Nominal Bore of pipe (mm)	Steel Pipes		Copper Pipes	
	Horizontal	Vertical	Horizontal	Vertical
15	2.0	2.4	1.4	1.9

20	2.4	3.0	1.4	1.9
25	2.7	3.0	1.7	2.2
32	2.7	3.0	1.7	2.7
35	3.0	3.6	2.0	3.0
40	3.4	4.0	2.0	3.0
50	3.7	4.5	2.0	3.4
65	3.7	5.0	2.4	4.0
80	4.1	5.0	3.0	4.0
100	4.4	5.0	3.0	4.0
125	4.4	5.5	3.0	4.0
150	4.8	6.0	-	-
200	5.1	6.3	-	-
250	5.8	6.5	-	-
300 and over	6.1		-	-

Special supports shall be provided for all heavy items of pipeline equipment such as stainers, valves, etc.

d) Positions of Supports

Supports shall be positioned to reduce, as afar as possible, stress on joints, valves and items of equipment. Due to regard shall be given to the maintenance of accessibility and to the requirements of access to their services to be fixed in the area.
Vertical pipes shall be supported at the bottom of the riser, or at an intermediate anchor point, to allow for expansion and to carry the entire weight of the riser. Intermediate supports will act as guides. Branches from risers shall not act as supports for the riser.

e) Guides

Guides shall be provided and fixed to prevent pipes leaving their supports due to expansion compensating devices.

f) Anchor Points

Anchor points shall be provided to resist the axial stress transmitted by the flexure of expansion loops or bellows.

Anchors shall be provided complete for attachment to the structure and where applicable shall be bolted or welded to the structure or positioned accurately for grouting in by others.

On steel pipelines anchors shall consist of heavy mild steel saddles welded all round to the pipe surface and provided with exterior lugs for bolting to the building structure or thrust block. Saddles shall be not less than the thickness of the pipe to which they are welded and of width equal to its nominal bore. On polypropylene pipelines shall const of 3mm thick polypylene pads completely surrounding the pipe and then attached to the supporting steelwork with U Bolts. Alternatively, anchors may consist of slip on flanges welded to the pipe and not bolted or welded in the approved manner to rolled steel members attached to the structure.

In the case of copper pipes, anchors shall generally consist of two flanges-to-copper adaptors interposed into the pipe run at the anchor point. Mild steel sections shall be bolted to either side of the flanged joint and attached to the building structure.

3.16.10 Provision for Expansion in Piping

Piping shall be installed in such a manner as to allow for thermal expansion. Where sufficient flexibility is not provided by changes of direction in the run, expansion loops or expansion compensators shall be provided. In general, fabricated expansion loops shall be used to allow 'nesting' of loops in adjacent pipes but purpose made expansion loops may be used if they are suitable for the pressure and expansion duty.

Expansion compensators shall be used only on Engineer's approval and then must be suitable for the working conditions and installed in full compliance with the manufacturer's recommendations regarding guiding, alignment and all other respects of erection and commissioning.

Care shall be taken that the compensators are not overstressed during pressure testing of pipelines, and if necessary, made-up spool-pieces of pipe shall be substituted during these tests.

All supports shall provide for the expansion movement in pipes. Hangers shall be free to 'swing' and rigid supports shall be of the roller type or pipes shall have 'slides' of rolled steel sections welded to them to permit free movement on supports without damage to the pipe or insulation.

3.16.11 Pipe Sleeves

a) General

Pipes shall not be build rigidly into walls, floors, ceilings, footings or under roads. Sleeves shall be provided under this contract, unless noted otherwise on the drawings, for building-in by others at all such locations.

The Contractor shall provide all sleeves in advance of building requirements and shall be responsible for ensuring that sleeves are properly positioned, aligned and built-in. Rectangular or circular openings will be provided by the builder in structural concrete slabs and it shall be the Contractor's responsibility to supply, position, align and secure sleeves, ready for casting in by the builder.

Puddle flanges shall be provided for building-in where pipes pass through bound walls or below ground.

b) Sizes

Sleeves shall not be used as pipe supports and a free annular space of at least 6mm shall be allowed between a pipe and its covering, if any and its sleeve. In load bearing walls or footings the annular space shall be of a minimum of 25mm. Where pipes change direction, sleeves shall be oversized to accommodate expansion movement of the pipe.

Sleeves shall extend through walls to within 5mm of the finished surface on both sides to allow for flush caulking over the sleeve with water proofing compound. Vertical

sleeves shall be project 50mm above the finished floor level and end 5mm above the underside of the slab. Polystyrene or similar material spacer discs shall be provided to locate the sleeve during casting of concrete, so that when the discs are removed the caulking clearance is left.

c) Materials

Sleeves in load-bearing walls and under roads shall be of cast-iron. Other sleeves shall be of standard galvanised pipe cut to length. Sleeves shall properly cut, reamed and trimmed square. Sleeves for casting in the concrete shall be securely fixed to form work by the contractor before concrete is poured. The annular space between each pipe and sleeve shall be firmly caulked at each end with polysulphide or equal waterproof compound which does not set hard.

3.16.12 Ventilation and Draining of Pipework

a) General

Sufficient provision shall be made at high points of piping and equipment for ventilation and at low points for draining. Drains shall be provided on all major sections of pipework so that they can be drained without draining the entire system. Vents shall be adequate to ensure that airlocks cannot form in the system.

b) Manual Vents

Manually operated air release points shall be provided on all water piping to permit the initial charging of the system. Each point shall comprise an air bottle fitted on tope of the pipe and with a welded cap and 15mm discharge pipe run to a fullway air-release valve at hand level and then to discharge at an agreed point. Pipes up to 40mm shall have air bottles of the same diameter as the pipe, air bottles for larger pipes shall be 40mm diameter. All air bottles shall be 300mm long.

c) Automatic Vents

Automatic vents shall be provided with lockshield isolating valves and 15mm discharge pipes run to approved positions. Steam mains shall be provided with thermostatically operated air vents at all high points in the system to allow for quick warming up of the system after a shutdown.

d) Drain Points

Steam lines shall be provided with steam trapped condensate drain points at all low points at least every 40 meters on long lines. Drain pockets of diameter equal to that of the steam pipe shall be provided on lines up to 100mm diameter and of diameter 50mm less than the pipe diameter for pipes above 100mm. The condensate line from the trap shall enter the top of the condensate in the header or main.

Water lines and equipment shall be drainable through 15mm lockshield isolating valves and discharge pipes run to approved positions. Compressed air lines shall have trapped automatic condensate drains at all low points in the system.

3.16.13 Valves and Strainers

a) General

Valves and strainers shall be of the types specified elsewhere in this specification, of best quality and suitable in all respects for the duties for which they are intended.

b) Valves

Except where loose key or lever operation is specified, all manual valves shall be provided with handweels. Closing shall be by clockwise rotation of the handwheel. All valves shall conform to the following design and materials specification:

Bronze	B.S. 1400 LG-2C or A.S.T.M.B. 62-63
Galvanised iron	B.S. 1452 GR14C or A.S.T.M.A. 445-63T
Ductile Iron	B.S. 1504-161A or A.S.T.M.A. 216 Grade WCB.

Mixing, thermostatic and other automatic valves shall be of 'fail-safe' design and where practicable self-acting.

1.16.14 Pressure Reducing Valve Sets

Pressure reducing valves shall be as equal and approved. They shall be installed complete with separator, isolating valves, strainer, pressure gauges, by-pass and control valves, etc. and a pressure relief valve mounted on the low pressure side, sized in accordance with accepted practice, to fully protect any equipment in the event of failure of the pressure reducing valve. The relief valve shall be set, and all gauges shall be in place before steam is allowed to pass through any P.R.V. set. The discharge pipe from the pressure relief valve shall be run to the nearest drain point approved by the Engineer.

1.16.15 Instruments and Gauges - Pipework

Where shown on the drawings pressure gauges and thermometers shall be provided. Pressure gauges shall be of the dial type with minimum 100mm dials and scaled to 50% in excess of maximum anticipated pressure.

They shall be fitted with isolating valves, gauge cocks and syphon bends and installed on extension pipes extended to a convenient position and properly supported. Gauges shall be tested against a deadweight tester in the presence of the Engineer and shall be accurate to within 2% over the working range. Pressure gauges shall be calibrated in KPA. Blow off holes in gauges shall be aimed in a safe direction, away from the operator. Thermometers shall be of brass mercury-in-glass type at least 150mm long and installed in thermometer pockets so that they may be removed without draining the pipeline. Angle or staring pattern thermometers as appropriate shall be used. Calibration shall be in ^{0}C.

3.16.14 Identification and Labelling

a) Pipework

All pipework, both insulated and uninsulated shall have coloured identification band and direction arrows marked on in clearly visible positions at maximum spacings of 6 meters on all runs. This spacing shall be reduced if necessary to ensure that each pipe and branch-passing through any form of space is coded, each branch has at least one coding band and there shall be a coding band within one meter of each valve, plant connections and flange or union.

The colours to be used for banding and arrows shall be agreed with the Engineer but shall comply as far as is possible with B.S. Bands and arrows shall be neatly stencilled using paint system compatible with the surfaces to which they are to be applied. Bands will consist of a base colour band and identification bands of contrasting colours and each 50mm wide.

All insulated pipework other than stainless steel, copper galvanised and polypropylene, shall be painted over the entire length prior to insulating with an approved anti-corrosive inert bituminous based paint, suitable for use on steam pipework. All other pipework shall be pained and code banded, as indicated elsewhere in this specification. On bare polypropylene, identification and direction of flow arrows shall be made by the sue of coloured adhesive tape (of a type approved by the Engineer) banded around the pipe in accordance with the foregoing positions.

b) Equipment Items

All plant and equipment items shall be labelled in a clearly visible position with the items name and, in the case of duplicate items, a number. Plant labels shall correspond with designations on the drawings. Labels shall be of rear engraved and filled 'trefoiled" of sandwich thermosetting plastic with black lettering on white background. Lettering size shall be at least 6mm.

c) Valves

Section isolating valves and valves in service areas shall be labelled to identify the zones they serve and with an abbreviated code to identify the service. A schedule of labels required will be provided by the Engineer.

Valve labels shall be sandwich thermosetting plastic with black lettering on a white background secured to the valve stem with a light chain. Sample labels shall be submitted for approval.

3.16.15 Pipework System Materials

1.17.1 General

All materials shall be suitable for the temperature rating of the system in which they are installed. These ratings are given in the detailed specification.

1.17.2 Steam Reticulation and Condensate Return

a) Piping

150 mm and below for welding.	B.S. 1387, heavy class seamless, plain ends prepared
Above 150 mm 6,35mm min.	B.S. 3601/22 or AP1 5.L Sch 20 with wall thickness

b) Fittings

Steel but-weld fittings to B.S. 1640 or equal, wall thickness not less than pipe thickness.

c) Flanges

B.S. 4504

d) Valves

Steam Isolating Valves

Upto to 40mm globe valves with cast bronze or ductile iron bodies, replaceable seat, bronze or stainless steel trim, union bonnet pattern and screwed by B.S. 21.

50mm to 150mm globe valves with cast bronze or ductile iron bodies, replaceable seat, bronze or stainless steel trim, union bonnet pattern and flanged to B.S. 4504.

200mm and above globe valves with cast bronze or ductile iron bodies valves with galvanised iron or ductile iron bodies replaceable seat, bronze or stainless trim, rising spindle pattern and flanged to B.S. 4504.

Steam Regulating Valves

These valves shall be needle valves of materials specification similar to isolating globe valves.

Condensate Valves

Upto to 40mm	Cast bronze of ductile iron bodies, replaceable seat, bronze or stainless steel trim, union bonnet pattern and screwed by B.S. 21.
50mm to 150mm	Galvanised iron or ductile iron bodies, replaceable seat, bronze or stainless steel trim, union bonnet pattern and flanged to B.S. 4504.

Gate Valves

Upto to 40mm	ductile iron bodies, replaceable seat, bronze or stainless steel trim, union bonnet pattern and screwed by B.S. 21.

Non return valves

Upto to 40mm	bronze swing check screwed to B.S. 21.

50mm to 150mm ductile iron bodies, replaceable seat, bronze or stainless steel trim, union bonnet pattern and flanged to B.S. 4504.

Sight Glasses

Bronze/Gunmetal bodies, single window combined sight-check valves may be used only where installed safe from Mechanical damage.

Steam Traps

For line draining Inverted bucket steam trap (stainless steel trim).

For equipment Ball float steam trap to correct pressure range or equal, unless otherwise specified on the drawings. (Stainless steel trim).

Air vents

Thermostatic vent depending on pressure.

Pressure Reducing Valves

Diaphragm pilot operated reducing valve. Stainless steel trim, phosphor bronze diaphragm, correctly sized for floor rate and with high turn-down accuracy and tight shut-off.

Strainers

Up to 50mm Malleable or galvanised iron body, stainless steel screen and screwed connections to B.S. 21

65mm and above Galvanised iron or S.G. iron body, stainless steel screen and fanged connections

3.16.16 Cold and warm 45^{0}C Water Reticulation

a) Piping
Piping - Steel

Up to 150mm Galvanised steel piping to B.S. 1387, medium class, screwed and socketed.

Above 150mm B.S. 3601/22 or API equivalent, 4.5mm wall thickness with plain ends for welding. To be hot dip galvanised after fabricating.

Piping - Polypylene

Up to 25 mm 1 500 kpa rated. Extruded from polypropylene - ethylene grade and shall be heat and U.V. stabilised to B.S. 4991 or ISOR 160.

32mm and above 600 kpa rated for cold water and 900 kpa for warm water. Extruded from propylene acetylene and shall be heat and U.V. stabilised to B.S. 4991 or ISOR 160.

b) Fittings

Fittings -Steel

Up to 100mm	Fusion welded and of exactly the same material as the polypropylene piping.
Above 125mm	butt welded or fusion welded and of exactly the same material as the polypropylene piping.

Fittings -Polyprolene

Up to 150mm	Galvanised malleable iron fitting to SABS 509.
Above 125mm	flanged to B.S. 4504. Fabricated or forged steel.

c) Flanges

Flanges - Steel

50mm to 150mm	B.S. 4504 screwed and galvanised.
Above 125 mm	Butt welded or fusion welded and of exactly the same material as the polyprolene piping.

Flanges - Polypropylene

Full face polypropylene or polypropylene stub flanges with mild steel backing rings drilled to B.S. 4504.

d) Gaskets

6mm rubber insertion.

e) Valves

Globe

Upto to 40mm	bronze body, bronze or stainless steel trim, replaceable seating, and screwed to B.S. 21.
65 and above	galvanised iron body, bronze or stainless steel trim, replaceable seating flanged to B.S. 4504.

Gate

Upto to 40mm	bronze body, bronze or stainless steel trim, replaceable seating, and screwed to B.S. 21.
65mm and above	galvanised iron body, bronze or stainless steel trim, replaceable seating flanged to B.S. 4504.

Check-valves

Upto to 40mm	bronze body, bronze or stainless steel trim, replaceable seating, and screwed to B.S. 21.

65 and above galvanised iron body, bronze or stainless steel trim, replaceable seating flanged to B.S. 4504.

Ball valves

Upto to 50mm chrome plated brass, teflon seat rings screwed to B.S. 21, with fixed operating handle.

Restrictor Valves

Ball stop with crew driver operation.

f) Strainers

Upto to 50mm Malleable iron bodies, stainless steel screen and screwed connections to B.S. 21.

65 and above galvanised iron or S.C. iron bodies, stainless steel screen and flanged connections.

1.17.4 Hot water (85^0C)

a) Piping

Piping - Steel

Stainless steel type 304 L to A.S.T.M specification A312. Wall thickness 2mm minimum longitudinally welded. NOTE All welds made in the pipe during manufacture shall be suitably cold worked to relive stresses and normalize crystal structure in order to prevent stress corrosion occurring while the pipe is in service at 85^0C. All joints in run and to fittings to be welded, using a suitable inert gas technique.

Piping - Polypropylene

Upto to 25mm 1,500 kpa rated. Extruded from polypropylene - ethylene grade and shall be U.V. stabilised, to B.S. 4991 or ISOR 160.

32mm and above 1,500 kpa rated. Extruded from polypropylene - ethylene grade and shall be U.V. stabilised, to B.S. 4991 or ISOR 160.

Piping - Copper

Shall comply with B.S. 2051

b) Fittings

Fittings - Steel

Stainless steel type 304L welded.

Fittings - Polypropylene

Upto to 100mm	Fusion welded of exactly the same material and pressure rating as the polypropylene piping.
125mm and above	Flanged and of exactly the same pressure rating and material as the polypropylene piping.

Fittings - copper

Upto to 50mm	Capillary to B.S. 864 or screwed to B.S. 21. Above 50mm flanged, brazed or bronze welded.

c) Flanges

Flanges - Steel

Stainless steel type 304L flat face - slip-on, to B.S. 4504.

Flanges - Polypropylene

Full face polypropylene or polypropylene stub flanges with mild steel backing rings drilling to B.S. 4504.

Flanges - copper

Bronze or gunmetal brazed or welded to pipe, B.S. 4504. Brass bolts, nuts and washers to be used.

d) Gaskets

6mm Rubber insertion.

e) Valves

Globe (throttling valve only)

Up to 40mm bronze body, bronze or stainless steel trim, replaceable seating and screwed to B.S. 21.

50mm and above Galvanised iron body, bronze or stainless steel trim, replaceable seating and screwed to B.S. 4505.

Gate

Up to 40mm bronze body, bronze or stainless steel trim, replaceable seating and screwed to B.S. 21.

50mm and above Galvanised iron body, bronze or stainless steel trim, replaceable seating and screwed to B.S. 4505.

Valves

Up to 40mm bronze body, bronze or stainless steel trim, replaceable seating and screwed to B.S. 21.

50mm and above Galvanised iron body, bronze or stainless steel trim, replaceable seating and screwed to B.S. 4505.

Check Valves

Up to 40mm bronze body, bronze or stainless steel trim, replaceable seating and screwed to B.S. 21.

50mm and above Galvanised iron body, bronze or stainless steel trim, replaceable seating and screwed to B.S. 4505.

Ball Valves

Up to 40mm chrome plated brass, teflon seat rings, screwed to B.S. 21 with fixed operating handle.

Restrictor Valves

Ballstop with screwdriver option.

Finish - Machined brass unless specified otherwise.

f) Strainers

Up to 50mm Malleable iron body, stainless steel screen and screwed connections to B.S. 21 65mm and above malleable iron body, stainless steel screen and flanged connections

1.17.5 Hot water (85^0C)

a) Piping

Piping - Steel

Upto 150mm Steel piping (Black) to B.S. 1387 medium class plain ends for welding.

Above 150mm Steel piping to B.S. 3601/22 or API Equivalent 4, 5 mm wall thickness plain ends for welding.

Piping - Polypropylene

Upto to 100mm 1,500 kpa rated. Extruded from polypropylene - ethylene grade and shall be U.V. stabilised, to B.S. 4991 or ISOR 160.

b) Fittings

Fittings - Steel

Butt-weld fittings to B.S. 1640.

Fittings - Polypropylene

Upto to 100mm	Fusion welded of exactly the same material and pressure rating as the polypropylene piping.
125mm and above	Butt welded or fusion welded and of exactly the same pressure rating and material as the polypropylene piping.

c) Flanges

Flanges - Steel

B.S. 4504 wrought steel, flat faced, slip on.

Flanges - Polypropylene

Full face polypropylene or polypropylene stub flanges with mild steel backing rings drilling to B.S. 4504.

d) Valves

Up to 50mm	ball valves with bronze body, hard chromed bronze ball, teflon seats, screwed, to B.S. 21. Alternatively forged steel body, stainless steel ball.
65mm and above	globe valves with galvanised iron body, bronze seating rising spindle, flanged to B.S. 4504.

Check Valves

Non-slam double swing check valves with galvanised iron body, bronze flaps and neoprene seat, fitted between flanges.

Traps

15mm	Automatic trap with internal strainer, or approved equal.
20mm	Angle strainer fitted before trap or approved equal. All traps to have balance pipe.

Filter, Regulator, Lubricator Sets

8 mm	Complete with pressure gauge and manual operated drains on filter unit.
10, 15, & 25mm	Complete with pressure gauge and manual operated drains on filter unit.

Filter and Regulator

As for filter, regulator and lubricator sets but without lubricator.

e) Moisture separators

Up to 40mm	Vertical type screwed inlet and outlet to B.S. 21 complete with drain trap.

32mm and above Horizontal type flanged connections, complete with drain trap.

1.18.6 Chilled Water Pipework

a) Piping

upto 80 mm B.S. 1307 medium class, screwed and socketed.

100mm to 150mm B.S. 1387 medium class. Plain ends prepared for welding.

Above 150 mm B.S. 3601/22 or API equivalent with wall thickness 5 mm minimum. Plain ends prepared for welding.

b) Fittings

Steel butt-weld fittings to B.S. 1640 or equal, wall thickness not less than pipe thickness or screwed malleable iron fittings as applicable.

c) Flanges B.S. 4504

d) Gaskets Rubber insertion

e) Valves
Cocks - Balancing Valves

Upto to 50mm bronze body, bronze or stainless steel trim, replaceable seating and screwed to B.S. 21.

65mm and above Galvanised iron body, outside screw and yoke, bolted bonnet, replaceable seating, rising stem incorporation back seal, bronze or stainless steel trim, and flanged to B.S. 4504.

Gate

Upto to 50mm bronze body, bronze or stainless steel trim, replaceable seating and screwed to B.S. 21.

65mm and above Galvanised iron body, outside screw and yoke, bolted bonnet, replaceable seating, rising stem incorporation back seal, bronze or stainless steel trim, and flanged to B.S. 4504.

Check Valves

Upto to 50mm bronze body, bronze or stainless steel trim, replaceable seating and screwed to B.S. 21.

65mm and above Galvanised iron body, bronze seating, swing-check, flanged to B.S. 4504

f) Strainers

All strainers to be installed as follows:

Upto 50mm diameter screwed to B.S. 21. 50mm and over flanged to B.S. 4504.

Screwed ends Bronze body, stainless steel screen.

Flanged ends Galvanised iron body, stainless steel screen.

1.18.7 Condenser Water Pipework

a) Piping

upto 80 mm	B.S. 1307 medium class, screwed and socketed.- galvanised.
100mm to 150mm	B.S. 1387 medium class. Flanged ends - galvanised after manufacture.
Above 150 mm	B.S. 3601/22 or API equivalent with wall thickness 5 mm minimum, flagged ends - galvanised after manufacture.

b) Fittings

up to 80 mm	Galvanised malleable iron fittings to B.S. 143 screwed to B.S. 21.
Above 80 mm	Flanged to suit.

c) Flanges

up to 80 mm	B.S. 4504 screwed and galvanised.
Above 80 mm	B.S. 4504 slip on. Pipe and Flange galvanised after manufacture.

d) Gaskets Rubber insertion

e) Valves

Valves shall be all as specified for chilled water, 17.18.6 e.

f) Strainers

Strainers shall be all as specified for chilled water 17.18.6 e.

PART D

GENERAL SPECIFICATION FOR PLASTICS SYSTEM

4 PART D - GENERAL SPECIFICATION FOR PLASTICS SYSTEMS

4.1 Soil and Waste Systems

UPVC Soil System

5.1.1 The pipes and fittings shall comply in all respects with the requirements of British Standard BS 4514: 2001 and shall, where appropriate, bear the British Standard Kitemark.

5.1.2 Pipes shall be supplied in plain ended lengths.

5.1.3 The minimum acceptable wall thickness of pipe fittings and shall be:-

Nominal ins	Size mm	Pipe mm	Fittings mm
3	82	3.20	3.2
4	110	3.20	3.2
6	160	3.30	3.5

5.1.4 The method of jointing to be employed shall be that of solvent welding using the manufacturer's approved cement. Seal ring fittings shall be used where necessary to accommodate thermal movement, or the sockets of standard fittings shall be converted to seal ring joints by the addition of a seal ring adaptor.

5.1.5 The grade UPVC used for the pipe shall have a minimum softening point of 82^0C when tested by the vicat method as described in British Standard 2782:1976, Method 102A.

5.1.6 The grade of UPVC used for the fittings shall have a minimum softening point of 79^0C when tested by the Vicat method described in British Standard 2782:2004, Method 102A.

5.1.7 The pipe and fittings shall be colour grey, to British Standard 5252: 10.A.07, black, or for water closet connections, white.

5.1.8 The rubber seals for seal ring joints shall be of a section that gives more than one point of contact with the pipe and shall be to the material requirements of British Standard 2494:1986. Water closet connections shall be to the same British standard.

5.1.9 Waste boss connections when fitted to pipes shall consist of two parts with inner and outer flanges, solvent welded as a complete unit with inbuilt gradients for the waste pipes of $1\ 1/4^0$. Where it is not possible to gain access to the bore of the soil pipe, self-locking bosses with integral clamping action may be used provided that the mating surfaces are suitable for and used with solvent weld cement.

5.1.10 Alternative waste boss connections may be made using unequal junctions conforming to British Standard 4514:2001 with solvent weld joints conforming to British Standard 4514:2001.

5.1.11 When used internally holderbats shall be made of mild steel protected from corrosion by galvanised or plastic coating. They shall have two-position fixing suitable for either acting as a pipe support but allowing thermal movement or as a clamp fit on a fitting creating a fixed

point. For optimum fit to pipe supports PVC packing pieces may be used. PVC holderbats may be used for external use.

5.1.12 Access shall be provided where necessary either by means of an integrally moulded door in an access fitting with an externally fitted rubber seal and secured with two galvanised bolts and nuts or alternatively by a two-piece clamp type door fitted into the pipe run.

4.2 MUPVC WASTE SYSTEM

5.2.1 The pipe and fittings shall comply in all respects with the requirements of British Standard 5255:1989.

5.2.2 Pipes shall be supplied in plain ended lengths.

5.2.3 The minimum acceptable wall thickness of pipe and fittings shall be:-

Nominal Size ins	Size mm	Pipe and Fittings Wall Thickness mm
1 1/4	32	1.8
1 1/2	38	1.9
2	50	2.0

5.2.4 The method of jointing to be employed shall be that of solvent welding using the manufacturer's approved cement. Seal ring joints shall be introduced where it is necessary to accommodate expansion.

5.2.5 The grade UPVC used for the pipe shall have a minimum softening point of 94^0 when tested by the Vicat method as described in British Standard 2782:2004, Method 102A.

5.2.6 The grade of UPVC used for the fittings shall have a minimum softening point of 80^0C when tested by the Vicat method as described in British Standard 2782:2004, Method 102A.

5.2.7 The pipe and fittings shall be colour grey, to British Standard 5252: 1976 10.A.07, black or white.

5.2.8 The rubber seal rings shall be of a section that gives more than one point of contact with the pipe and shall be to the material requirement of British Standard 2494:1990.

5.2.9 Traps shall be moulded from white polypropylene and shall have a universal compression outlet. The fittings shall comply in all respects to British Standard BDEN 274 where applicable, and shall bear the British Standard Kitemark. Traps of configurations not covered by the British Standard shall comply with the performance specification of the standard.

4.3 SOIL AND WASTE SYSTEMS - WORKMANSHIP

5.3.1 The installation, method of jointing and fixing shall comply in all respects to the manufacturer's site work instructions.

5.3.2 Maximum intervals between pipe supports shall be:-

Nominal Size ins	mm	Horizontal m	Vertical m
1 1/4	32	0.5	1.2
1 1/2	38	0.5	1.2
2	50	0.9	1.2
3	82	0.9	1.8
4	110	0.9	1.8
6	160	1.0	1.8

5.3.3 Pipes shall be fixed in straight runs and all horizontal runs shall be laid to gradients in accordance with British Standard 5572:1994 Code of Practice for Sanitary Pipework, and in any event not less than 18mm/m unless otherwise instructed.

5.3.4 Expansion joints shall be provided at a maximum of 4 metre centres for soil, 2 metre centres for waste and between fixed points over 1 metre centres.

5.3.5 The work shall be inspected and tested during installation at agreed stages.
All work which will be concealed shall be tested before it is finally enclosed.

A final test shall be made upon completion of soundness and performance in accordance with British Standard 5572:1994 Code of Practice for Sanitary Pipework.

4.4 Rainwater Systems:

5.4.0 UPVC Half Round Rainwater System Pipe and Gutter

5.4.1 Gutters shall be true half round section 110mm outside diameter complying in all respects with the requirements of British Standard BS EN 1462:2004

5.4.2 Gutters shall be supplied in plain ended lengths.

5.4.3 The minimum acceptable wall thickness of gutter shall be 2.20mm

5.4.4 Rainwater pipes shall be circular in section, 65mm nominal diameter complying in all respects to British Standard BS EN 1462:2004.

5.4.5 Rainwater pipes shall be supplied in plain ended lengths.

5.4.6 The minimum acceptable wall thickness of rainwater pipe shall be 1.80mm.

5.4.7 Pipe support brackets must be adequate to screen expansion gaps.

5.4.8 The grade of UPVC used for gutter and pipe shall have a minimum softening point of 75^0C when tested by the Vicat method as described in British Standard 2782:2004, Method 102A.

5.4.9 The pipe and gutter shall be colour grey, to British Standard 5252: 10.A.07, black or white.

4.5 UPVC Square Rainwater System Pipe and Gutter

5.5.1 Gutters shall be rectilinear section 116mm wide maximum.

5.5.2 Gutters shall be supplied in plain ended lengths.

5.5.3 The minimum acceptable wall thickness of gutters shall be 2.20mm

5.5.4 Rainwater pipes shall be square in section, 58mm internal dimension.

5.5.5 Rainwater pipes shall be supplied in plain ended lengths.

5.5.6 The minimum acceptable wall thickness of rainwater pipes shall be 1.80mm.

5.5.7 Pipe support brackets must be adequate to screen expansion gaps.

5.5.8 The grade of UPVC used for gutter and pipe shall have a minimum softening point of 75^0C when tested by the vicat method as described in British Standard 2782:2004, Method 102A.

5.5.9 The pipe and gutter shall be colour grey, to British Standard 5252: 1976 10.A.07, black or white.

4.6 UPVC Rainwater Fittings

1.6.1 All fittings shall comply with the relevant requirements of British Standard BS EN 1462:2004

1.6.2 All gutters, pipe and fittings shall be colour grey to British Standard 5252:1976 10.A.07, black or white.

1.6.3 Gutter connecting fittings shall have integrally moulded seal retaining cavities housing a rubber seal or hallow section.

1.6.4 Gutter connecting fittings shall incorporate provision for fixing to fascia boards, rafters or brickwork such that the fixing screws shall not be in contact with the inner surface of the gutter and shall have provision for expansion of the gutter clearly marked in the fitting.

1.6.5 The grade of UPVC used for fittings shall have a minimum softening point of 75^0C when tested by the Vicat method 102A as described in British Standard 2782:2004, Method 102A.

4.7 Workmanship

5.7.1 All rainwater systems shall be installed in accordance with the manufacturer's site work instructions.

5.7.2 Gutters shall be supported on support brackets at one metre centres. In areas of heavy snow load, brackets shall be provided at 800mm centres.

5.7.3 Gutters shall be installed to accommodate the thermal movement.

5.7.4 Expansion joints shall be provided at maximum 4 metre centres.

5.7.5 Screws for fixing shall be round headed No.10 and long enough to make full use of the thickness of a traditional 25mm nominal softwood fascia. They shall have a rust-proofed finish. When fixing to other fascia, fastenings of equivalent holdings power shall be used.

4.8 BURIED DRAIN SYSTEM:

5.8.0 UPVC Buried Drain System

1.8.1 The pipes and fittings shall comply in all respects with the requirements of British Standard 4660:2000 and shall, where appropriate, bear the British Kitemark.

1.8.2 Pipes shall be supplied in plain ended lengths.

1.8.3 The minimum acceptable wall thickness of pipe and fittings shall be:-

Nominal Size	Pipe	Branch Junction Only		All Other Fittings	
		Socket	Body	Socket	Body
ins	mm	mm	mm	mm	mm
4	110	3.2	3.5	3.8	3.2	3.4
6	160	4.1	4.3	4.7	4.3	4.7

1.8.4 The method of jointing to be employed shall be lip-seal socketed fittings jointing to other materials shall be made in the manner specified by the manufacturer.

1.8.5 The grade of UPVC used for the pipe shall have a minimum softening point of 82^0C when tested by the Vicar method as described in British Standard 2782:2004, Method 102A.

1.8.6 The grade of UPVC used for the fittings shall have a minimum softening point of 79^0C when tested by the vicat method as described in British Standard 2782:2004, Method 102A.

1.8.7 The pipe and fittings shall be colour golden brown approximating to British Standard 381C:1971 No.414. The seal retaining caps shall be black polypropylene.

1.8.8. The rubber of lip seal joints shall be to the material requirement of British Standard 2494:1986.

1.8.9 Holderbats shall be made of mild steel protected from corrosion by galvanising or plastic coating. They shall have a two position fixing suitable for either acting as pipe support but allowing thermal movement or as clamp fit on a fitting creating a fixed point. For optimum fit to pipe supports PVC packing pieces may be used.

1.8.10 The base of soil and bent stack connection to the buried drain shall be made with a bend of minimum centre line radius of 250mm.

1.8.11 Minor changes of direction where permitted shall be made with a variable bend that has a constant effective length.

4.9 BURIED DRAIN SYSTEM - WORKMANSHIP

1.9.1 The installation, method of jointing and fixing shall comply in all respects to the manufacturer's sitework instructions.

1.9.2 Excavation of Trenches

Trenches shall be excavated to a sufficient depth to allow a 100mm minimum bed below the underside of the pipe. Trench width shall be not less than the outer diameter of the pipe plus 300mm and not wider than necessary.

1.9.3 Trench Invert

The base of the trench shall be such that even support is given to the pipe for its full length. Soft spots shall be removed and replaced with compacted or granular material. High spots and rock shall be removed to allow a full 100mm bed depth.

1.9.4 Pipe Bed

The bed shall be composed of granular material to the specification called for in clause 1.9.7 and shall cover the full trench width and length and be boned to gradient.

1.9.5 Laying and Jointing

Pipes and fittings shall be laid true to gradient in straight lines and jointed in accordance with manufacturer's instructions. All pegs used for alignment and other purposes must be removed after use and before side filling. All joints shall be watertight.

Pipes barrels shall be in continuous contact with the trench when laid.

1.9.6 Side Filling

The side filling of pipes shall be composed of hard granular material which shall be to the requirements of clause 1.9.7

Side filling must be placed equally on both sides of the pipes and compacted, so as to buttress the pipes against the trench walls. Side filling shall continue up to pipe crown level as a minimum and above this level if required by the Engineer.

1.9.7 Back Filling

The first 300mm of backfill above crown level shall be taken from selected trench spoil all passing 25mm sieve. It shall be placed in two 150mm layers each firmly, tamped. Above the 300mm level mechanical filling and compacting may be used.

Where cover is less than 450mm the pipe shall be covered with 75mm of selected material laid to support a concrete tile or slab indicating the presence of a service.

1.9.8 Granular Material for Bed and Sidefill

All material for bed and sidefill shall be hard and granular passing 20mm sieve and shall contain not more than 5 per cent fines passing 3mm sieve.

The material may be composed of crushed stone, clinker, quarry scalping, ballast, gravel, shingle or all-in aggregate to British Standard 882:1965.

The material shall have a compaction factor of 0.3 or less.

4.10 COLD WATER SYSTEMS:

5.10.0 UPVC Cold Water System

5.10.1 Pipe shall comply in all respects with the requirements of British Standard 3505:1986.

Fittings shall comply in all respects with the requirements of British Standard 4346 Part 1:1969.

5.10.2 Pipes shall be supplied in plain ended lengths.

5.10.3 The minimum acceptable wall thickness of pipe and fittings shall be:-

Nominal Size ins	Pipe and Fittings mm
3/8	1.5
1/2	1.7
3/4	1.9
1	2.2
1 1/4	2.7
1 1/2	3.1
2	3.9
3	5.7
4	7.3

1.10.4 The method of jointing to be employed shall be that of solvent welding using the manufacturer's approved cement, which shall comply with the requirements of British Standard 4346 Part 3. 1982.

5.10.5 The grade UPVC used for pipes shall have a minimum softening point of 75^0C and for the fittings a minimum softening point of 72^0C when tested by the Vicat method as described in British Standard 2782:2004, Method 102A.

5.10.6 The pipe and fittings shall be coloured dark grey.

5.11.0 Workmanship

1.11.1 The installation method of jointing and fixing shall comply in all respects to the manufacturer's site work instructions.

5.11.2 At 20^0C the maximum intervals between pipe supports shall be:-

Nominal Size ins	Horizontal m	Vertical m
3/8	0.75	Up to twice the permitted horizontal spacing of support centres shall be accepted provided the pipe is well protected within a structure.
1/2	0.84	
3/4	0.94	
1	1.07	
1 1/4	1.14	
1 1/2	1.28	
2	1.44	
3	1.72	
4	1.90	

5.11.3 Pipes passing through walls or floors shall be sleeved to allow unrestricted movement.

5.11.4 The work shall be inspected and tested during installation at agreed stages.

All work which will be concealed shall be tested before it is finally enclosed.

A final test shall be made upon completion for soundness and performance to the satisfaction of the Local Water Authority.

PART E

5 PART E - PARTICULAR SPECIFICATION FOR THE FIRE FIGHTING SERVICES

5.1 PARTICULAR SPECIFICATION FOR THE FIRE FIGHTING SERVICES

5.1.1 General

The particular specification details the requirements for the supply, installation and commissioning of the hosereel installation. The hosereel installation shall comply in all respects to the requirements set out in European Standards BS EN694 for hosereels and tested, approved and CE marked according to En671 – 1 or other International Standards. The system shall comprise of a pumped system for hosereels on all floors.

The Contractor shall include for all appurtenances and appliances not necessarily called for in this specification or shown on the contract drawings but which are necessary for the completion and satisfactory functioning of the works.

No claims for extra payment shall be accepted from the Contractor because of his non-compliance with the above requirements.

If in the opinion of the Contractor there is a difference between the requirements of the specification and the contract drawings, he shall clarify these differences with the Engineer before tendering.

5.1.2 Scope of Works

The Contractor shall supply/deliver, erect, test and commission all the automatic fire fighting hosereel installation which is called for in this Specification and shown on the Contract Drawings listed in the Drawing Schedule.

5.1.3 Pipework

The pipework for the hosereel installation shall be galvanised wrought steel tubing `Medium' Grade Class `B' to B.S. EN 10255:2004 malleable iron fittings to B.S. 21.

5.1.4 Pipe Fittings

The pipe fittings shall be wrought steel pipe fittings welded or seamless fittings conforming to B.S. EN 10241:2000 or malleable iron fittings to B.S. 143 and 1256:2000.

All changes in direction will be with standard bends or long radius fittings. No elbows permitted.

5.1.5 Flanges

The flanges shall comply with en 1092 – 1:2002. All flanges shall comply to a nominal pressure rating of 16 bar (PN 16) and shall be of either galvanised iron or steel.

5.1.6 Gaskets

The gaskets for use with flanges to en1092-1:2002 shall comply with en 1514-2:1997 for pressure up to and not exceeding 64 bar.

5.1.7 Non-Return Valves

The non-return valves up to and including 80mm diameter shall be to EN 12334:2001 with flanges to B.S. EN 1092-1:2002 (PN 16).

The valves shall be of galvanised iron construction with gunmetal seat and bronze hinge pin.

5.1.8 Gate Valves

The gate valves up to and including 80mm diameter shall be non-rising stem and wedge disc to (B.S. 5154: 1991) with screwed threads to B.S. 21 taper thread or flanged to B.S. EN 1092:-1:2002

5.1.9 Sleeves

Where pipework passes through walls, floors or ceilings, a sleeve shall be provided one diameter larger than the diameter of the pipe, the space between to be packed with mineral wool, to the Engineer's approval.

5.1.10 Floor and Ceiling Plates

Where pipes passes through walls, floors or ceilings, floor, wall and ceiling plates shall be secured around the pipe. The plates shall be of stainless steel construction and will serve no other purpose than to present a neat finish, to the exposed installation.

5.1.11 Hosereel

The hosereels to the installation shall consist of recessed automatic hosereels.

All the above hosereels shall comply with European Standards BS EN694, tested, approved and CE marked to EN671 – 1 or other International Standards.

The hosereels shall be supplied and installed complete with first-aid non-kinking hose 30 metres long, with nylon spray/jet/shut-off nozzle inlet to the reel are to be supplied.

The orifice to the nozzle shall not be less than 4.8mm to maintain a minimum flow of 0.4 L/S to the jet.

The hosereels shall be installed at 1.5mm centre above the finished floor level in locations shown on Contract Drawings.

5.1.12 Earthing

Earthing installation shall be electrically earthed by a direct earth connection. The installation of the earthing to be carried out by the Electrical Contractor.

5.1.13 Hosereel Pump Set

The Hosereel pump set shall incorporate a pressure monitoring device having two independently adjustable contacts arranged to close on falling pressure. Contact No.1 is set to close on fall in pressure due to opening of Hosereel valve or similar. Operation of this switch initiates the full automatic sequence set, including remote alarm and indication.

5.1.14 BasePlate

Fabricated steel with support for control panel and pipework, together with four lifting eye bolts for ease of installation.

5.1.15 Valves/Pipework

Each set consists of identical pumps with isolating valves on each pump suction and isolating and non-return valves on each pump discharge. The delivery line from the pump is fitted with a pressure switch, test cock/vent, delivery pressure gauge, and a further isolating valve for routine testing.

Suction and discharge manifolds terminate in flanges drilled to BS4504 PN16. The pipework is fabricated steel.

5.1.16 Membrane Pressure Vessel

A membrane pressure vessel has been integrated into the system to provide a positive charge, thus preventing pump operation as a result of any minor system leakage.

Control Panel

As described.

Electrics

The set, being pre-wired eliminates the need for wiring on site, except for the connection of an electrical power source (3 phase, 3 wire supply) to the control panel.

Testing

The complete unit to be manufactured, tested and delivered as a packaged unit, finished in hard gloss red paint.

5.1.17 Finish Painting

Upon completion of testing and commissioning of the hosereel installation the pipework shall be primed and finish painted with 2 No. coats of paint to the Architect's requirements.

5.1.18 Testing and Commissioning

The hosereel installation is to be flushed out before testing to ensure that no builder's debris has entered the system. The installation is to be then tested to one and a half times the working pressure of the installation to the approval of the Engineer. Simulated fault condition of the pumping equipment, is to be carried out before acceptance of the system by the Engineer and Architect.

5.1.19 Instruction Period

The Contractor shall allow in his contract sum for instructing of the use of the equipment to the Client's maintenance staff. The period of instructions may be within the contract period but may also be required after the contract period has expired.

The period of time required shall be stipulated by the Client but will not exceed seven days in which time the Client's staff shall be instructed in the operation and maintenance of the equipment.

5.2 PARTICULAR SPECIFICATION FOR PORTABLE FIRE EXTINGUISHERS

5.2.1 General

The particular specification details the requirements for the supply and installation and commissioning of the Portable Fire Extinguishers which shall conform to European Standards BS EN 3 or other International Standards. The Contractor shall include for all appurtenances and appliances not necessarily called for in this specification or shown on the Contract Drawings but which are necessary for the completion and satisfactory functioning of the works.

If in the opinion of the Contractor there is a difference between the requirements of the specification and the Contract Drawings, he shall clarify these differences with the Engineer before tendering.

5.2.2 Water/Co_2 Extinguishers

The portable 9-litre water filled CO_2 cartridge operated portable fire extinguishers shall comply with the requirements of B.S. EN3 or other International Standards. Unless manufactured with stainless steel, bodies shall have all internal surfaces completely coated with either a lead tin, lead alloy or zinc applied by hot dipping. There shall be no visibly uncoated areas.

The extinguishers shall be clearly marked with the following:-

a) Method of operation

b) The works "WATER TYPE" (GAS PRESSURE) in prominent letters

c) Name and address of the manufacturer or responsible vendor

d) The nominal charge of the liquid in letters

e) The liquid level to which the extinguisher is to be charged

f) The year of manufacture

g) A declaration to the effect that the extinguisher has been tested to a pressure of 24.1 bars.

h) Instructions for periodical checking and panel for signing when checked, dates and initials.

5.2.3 Portable Carbon Dioxide Fire Extinguishers

The portable carbon dioxide fire extinguishers shall comply with B.S. EN3 or other International Standards.

The body of the extinguishers shall be a seamless steel cylinder manufactured to one of the following Standards, B.S. 401, B.S. 1288 or other International Standards.

The filling ratio shall comply with B.S. 5355 with valves fittings for compressed gas cylinders to B.S. 341. Where a hose is fitted it shall be flexible and have a minimum working pressure of 206.85 bar, the hose is not to be under internal pressure until the extinguisher is operated.

The nozzle shall be manufactured of brass gunmetal, aluminium or stainless steel and may be fitted with a suitable valve for temporarily stopping the discharge if such means are not incorporated in the operating head.

The discharge born shall be so as to direct the discharge and limit the entrainment of air. It shall be construed of electrically non-conductive material.

The following and markings shall be applied to the extinguishers:

a) The words 6 Kg. carbon dioxide fire extinguishers and to include the appropriate nominal gas content.

b) Method of operation.

c) The words "Re-charge immediately after use".

d) Instructions for periodical checking and panel with space for date and initials.

e) The number of the Standard B.S. EN 3 or other International Standards.

f) The manufacturer's name or identification markings.

5.2.4 Dry Powder Portable Fire Extinguishers

The portable dry powder fire extinguishers shall comply with B.S. EN 3 or other International Standards. The body shall be constructed of steel not less than the requirements of B.S. 1449 or aluminium to B.S. 1470: and shall be suitably protected against corrosion.

The dry powder charge shall be non-toxic and retain its free flowing properties under the normal storage conditions. Any pressurizing agent used as an expellant shall be in dry state; in particular compressed air.

The discharge tube and gas tube if either is fitted shall be made of steel, brass, copper or other not less suitable material. Where a hose is provided it shall not exceed 1,060mm and shall be acid and alkali resistant. Provision shall be made for securing the nozzle when not in use.

The extinguisher shall be clearly marked with the following information;

a) The words "Dry Powder Fire Extinguisher".

b) Method of operation in prominent letters.

c) The working pressure and the weight of the powder charge in kilogrammes.

d) Manufacturer's name or identification mark.

e) The words "RECHARGE AFTER USE" if rechargeable type.

f) Instructions to regularly check the weight of the pressure container (gas cartridge) or inspect the pressure indicator on stored pressure types when fitted, and remedy any loss indicated by either and to have panel for dates and initials.

g) The year of manufacture.

h) The pressure to which the extinguisher was tested.

i) The number of this British Standard to B.S. EN3 or other International Standards.

j) When appropriate complete instructions for charging the extinguisher shall be clearly marked on the extinguisher or otherwise be supplied with the refill.

5.2.5 Foam Fire Extinguisher

The portable foam extinguisher shall comply with the requirements of B.S. EN3 or other International Standards. The body shall be constructed from 16 s.w.g. steel to B.S. 1449, polythene lined to give protection against internal corrosion while the neck ring shall be in steel to B.S. 980 and welded internally to the body.

The gas cartridge shall be a standard fitting 75 capacity $C0_2$ gas cartridge, plastic coated and also complying with B.S. 5423. The discharge hose shall be made from polyester reinforced flexible P.V.C. and nozzle in moulded A.B.S. Provision shall be made for securing the nozzle when not in use.

The extinguisher shall be clearly marked with the following information:-

a) The words “FOAM FIRE EXTINGUISHER”.

b) Method of operation in prominent letters.

c) The working pressure and the quantity of charge in litres.

d) Manufacturer’s name or identification.

e) The words “RECHARGE AFTER USE” if rechargeable type.

f) Instructions for periodical checking and panel for dates and initials.

g) The number of this British Standard B.S. EN3 or other International Standards.

5.2.6 Fire Blanket

The fire blanket shall be made from 3-ply composite material consisting of two layers of glass fibre fabric sandwiching an inner layer of fire retardant film to measure 2000 x 2000mm and shall be fitted with special tapes folded so as to offer instantaneous single action release blanket from storing jacket.

10.2.6.A Painting & Finishing

The contractor shall paint or cause to be painted all the service pipework in the respective colour coding as specified to B.S. 1710 and elsewhere in this specifications.

PART F

GENERAL TECHNICAL SPECIFICATION - COMMISSIONING

6 PART F - GENERAL TECHNICAL SPECIFICATION - COMMISSIONING

6.1 General

Before any commissioning work takes place, the Contractor shall submit a set of schematic commissioning drawings showing duct runs, and other equipment, air flows, water flows and controls. These drawings to be accompanied by the method proposed for commissioning of the plant, as by the method proposed for commissioning of the plant, as well as the number of people involved, their names and experience. The Engineer's approval on the above item is essential before any commissioning takes place.

6.2 Maintenance Manuals

The Contractor shall provide, before any commissioning works starts, three copies of the maintenance and operating manuals for the plant supplied. These manuals shall be sewn and bound in book form with hard plastic covers to withstand constant use, and shall be properly indexed to facilitate quick references. Prior to the submission of the three copies mentioned above the Contractor shall submit one draft copy of the maintenance and operating manuals for approval. The works shall not be considered to be completed for the purposes of taking over until such manuals have been supplied to the Engineer, and subsequent equipment test results have been included in them.

The manuals shall include:-

a) A list of recommended servicing tools and specialist plant.
b) A list of recommended spares necessary for a period of 2 years operation.
c) Exploded drawings or spares lists from which every item of every place of plant can be positively identified of each item of plant.
d) A list of giving the name and address of the manufacturer of each item of plant.
f) A copy of all test certificates obtained with the plant.
g) A list of recommended lubricants.
h) A preventive maintenance programme for all plant.
i) Operating instructions for each item of plant.
j) Performance data, equipment tests and characteristic curves.

6.3 Initial Testing and Plant Commissioning

7.3.1 Initial Testing

a) Pressure Testing - Piping

All pipework system shall be pressure tested by filling with water and raising the pressure to 1.5 times working pressure.

They shall then be left for a period of at least one hour during which all joints must remain water-tight. Any fault found during the pressure test shall be remedied and the test reapplied until the same is dealt with completely.

The pipework shall be tested in sections to suit the construction programme and all services in concealed locations shall be tested before they are finally concealed. No insulation shall be applied before tests have been carried out.

The Contractor shall provide all test equipment and all additional items such as toes, valves, drain fittings, etc, which are necessary to enable the systems to be treated in sections. Each test shall be witnessed by the Engineer or his nominated agent and also a signed certificate of approval shall be obtained.

b) Drawing and Cleaning

On completion of the pressure test on a section of pipework the water used for testing shall be drained away as quickly as possible to remove as much dirt and dross as possible. After completion for a pipework circuit the circuit shall be flushed through to remove all pipe scale, dress and similar material.

c) Pressure Testing - Ducting

See section on ducting

d) Insulation Tests

All electrical wiring and controls integral with the plant supplied shall be subjected to insulation tests. All instrument and other equipment required for the tests shall be provided by the Contractor.

e) Drives

All drives shall be run and tested for direction rotation and correspondence of alignment.

7.3.2 **Plant**

The Contractor shall check over and test and satisfy himself that all items of plant are correctly assembled and aligned before start-up. This work is to be carried out by skilled commissioning Engineers who are completely familiar with the plant involved.

The Engineer shall witness plant commissioning as required by him and the contractor must advise the Engineer prior to any commissioning work taking place.

On completion of the plant commissioning the Contractor shall provide written confirmation to the Engineer that he has completed all commissioning work to the Engineer that he has completed all commissioning work and is satisfied that the time items of plant are operating satisfactorily.

7.3.3 **Test of Completion**

On completion of the Contractor's initial testing and commissioning as specified above, the plant shall be put into normal operation and the final adjustment of the plant shall be made. Thereafter the Tests on completion shall be carried out to ensure that the plant will fulfil the function for which it has been designed. These tents shall extent for a period of at least four weeks and shall include the following:

a) Simulated tests for all alarm and safely cut out equipment.
b) Simulated tests on automatic controls.
c) Capacity tests to ensure that the plant supplied will handle the quantities specified.

The Contractor shall utilise the Engineer's manual Equipment performance and capacity.

The Contractor shall at his own cost render all assistance and supply all labour, appliances and any other materials, as may be required to carry out these tests. All instruments shall be accurately calibrated before the tests begin.

On completion of the whole of the tests and when the Contractor is satisfied that the entire plant is operating satisfactorily and will fulfil the function for which it has been designed, he shall submit to the engineer triplicate copies of all tests records and charts together with reports on all the tests called for in this specification. The Engineer shall reserve the right to ask for previous tests in order to prove that the operation of the plant is satisfactory and in accordance with the specification and drawings,

The Contractor shall be responsible for the proper operation and running maintenance of the plant throughout the period of the tests. The Contractor shall provide full time experienced commissioning Engineers and artisan staff during the entire testing period.

At the commencement of and during the whole of the testing period the Contractor shall be required to have stored on site all essential spares and tools considered necessary to enable repair work of defective parts to be carried out immediately in the event of a breakdown.

The operation and Maintenance manual shall be completed and handed over to the Engineer before the start of any commissioning work and in any case, prior to the issuing by the engineer of the taking-over certificates. The period of maintenance shall be deemed to have started upon the date of issuing of the taking-over certificate.

6.4 **Operator Training Period**

The Operator Training Period on the whole of the works or on any part thereof shall commence at the date to be fixed after the issue of the taking over certificate and mutually agreed with the Engineer.

This period shall continue for a period sufficient to ensure that the operations are full conversant with the functions they are to perform, but shall not exceed a period of 5 days.

The Contractor shall provide full-time instructions during the entire operator training period, who shall be fully experienced in the class of work and shall be capable of training the operating and maintenance staff in the duties they are to perform.

6.5 Period of Maintenance (Defect Liability)

The expression period of maintenance shall mean a period of 12 months from the date of taking over in accordance with Clause 3.3. Hereof.

7 BILLS OF QUANTITIES

7.1 GENERAL NOTES TO TENDERERS

1. The Bills of Quantities form part of the contract documents and are to be read in conjunction with the contract drawings and general specifications of materials and works.

2. The prices quoted shall be deemed to include for all obligations under the sub-contract including but not limited to supply of materials, labour, delivery to site, storage on site, installation, testing, commissioning (**excluding 16% VAT**).

3. All prices omitted from any item, section or part of the Bills of Quantities shall be deemed to have been included to another item, section or part thereof.

4. The brief description of the items given in the Bills of Quantities are for the purpose of establishing a standard to which the sub-contractor shall adhere. Otherwise alternative brands of **equal** and **approved** quality will be accepted.

5. Should the sub-contractor install any material not specified here in before receiving **written approva**l from the Project Manager, the sub-contractor shall remove the material in question and, **at his own cost**, install the proper material.

6. The grand total of prices in the price summary page must be carried forward to the **volume 1**.

7. The Bills of Quantities are divided generally into three sections: -

a. Contractual Requirement – Bill 1

The sub-contractor shall study the conditions and make provision to cover their cost in this Bill. The number of contractual items to be priced by the Tenderer have been limited to tangible items such as site office, temporary works and others. However, the Tenderer is free to include and price any other items he deems necessary taking into consideration conditions he is likely to encounter on site.

b. Installation Items – Other Bills

The brief description of the items in these Bills of Quantities should in no way modify or supersede the detailed descriptions in the contract Drawings, conditions of contract in volume 1 and specifications. The unit of measurements and observations are as per those described in the contract documents.

c. (c) Summary

The summary contains tabulation of the separate parts of the Bills of Quantities carried forward with provisional sum, and any prime cost sums included. The sub-contract shall insert his totals and enter his grand total tender sum in the space provided below the summary.

This grand total tender sum shall be carried forward to main summary of volume 1 of the main works.

PROPOSED LABOR WARD AT THE NAIROBI HOSPITAL

PLUMBING, DRAINAGE & SANITARY FITTINGS

BILLS OF QUANTITIES

SECTION D.W. (I) TITLE: PRELIMINARIES & CONTRACTUAL REQUIREMENTS

Item	Description	Unit	Qty	Rate	KShs.
	PRELIMINARIES & CONTRACTUAL REQUIREMENTS				
A.	Preparation of working drawings, printing and distribution.	Sum			-
					-
B.	Preparation of 'As Installed Drawings", printing and distribution as specified. Drawings to include:				-
	(a) Blue Prints - 4 sets of each.	Sum			-
	(b) AutoCAD on Flash Drive (5 GB) – 2 No.	Sum			-
	(c) Operational Instructions, manuals and test certificates	Sum			-
					-
C	Allow for any other preliminary stated in the conditions of contract	Sum			-
D	Any other item necessary to complete the installations in this section (please state)	Sum		-	``
	Carried to Main Summary Page				-

SECTION D.W. 2: INTERNAL WATER SUPPLY

Item	Description	Unit	Qty	Rate	Cost KShs.
	INTERNAL WATER SUPPLY				
2.1	**INTERNAL COLD WATER SUPPLY -**				
	To supply and install PPR tubing and fittings as described and shown on the drawings.				
	Tenderers must allow for jointings, clippings, couplings ,reducers etc. necessary for the proper and satisfactory functioning of the installation when pricing.				
	The following in PPR or approved equivalent.				
A	50mm dia tubing.	LM	0		-
B	40mm dia tubing.	LM	0		-
C	32mm dia ditto	LM	72		-
D	25mm tubing	LM	36		-
E	20mm dia ditto	LM	36		-
	Extra over tubing for:-				-
F	50 mm dia bend with male/female threads	No.	0		-
G	40 mm dia bend with male/female threads	No.	0		-
H	32mm dia ditto	No.	6		-
I	25mm dia ditto	No.	8		-
J	20mm dia ditto	No.	8		-
K	50 mm dia tee	No.	0		-
L	40 mm dia tee	No.	0		-
M	32mm dia ditto	No.	6		-
N	25mm dia ditto	No.	12		-
O	20mm dia ditto	No.	12		-
	Brass work				-
P	50mm dia non-rising stem solid wedge gate valve as peglars or equal and approved with connections to PPR tubing .	No	0		-
Q	32 mm dia ditto	No	2		-
R	25 mm dia ditto	No	10		-
Carried to sub-collection page					-

SECTION D.W. 2: INTERNAL WATER SUPPLY

Item	Description	Unit	Qty	Rate	Cost KShs.
2.2	**INTERNAL HOT WATER SUPPLY -** **To supply and install CPVC tubing and fittings as described and shown on the drawings.** **ers must allow for jointings, clippings, couplings ,reducers etc. necessary for the proper and satisfactory functioning of the installation when pricing.** **All pipe runs to be insulated using closed cell Polyethylene pipe insulation with aluminium foil cover as Jumbolag or an approved equivalent.** **The following in CPVC specificically suitable for Hot water upto 95 C to engineer's approval.**				
A	50mm dia tubing.	LM	0		-
B	40mm dia tubing.	LM	0		-
C	32mm dia ditto	LM	72		-
D	25mm tubing	LM	106		-
E	20mm dia ditto	LM	48		-
	Extra over tubing for:-				-
F	50 mm dia bend with male/female threads	No.	0		-
G	40 mm dia bend with male/female threads	No.	0		-
H	32mm dia ditto	No.	12		-
I	25mm dia ditto	No.	16		-
J	20mm dia ditto	No.	16		-
K	50 mm dia tee	No.	0		-
L	40 mm dia tee	No.	0		-
M	32mm dia ditto	No.	6		-
N	25mm dia ditto	No.	24		-
O	20mm dia ditto	No.	24		-
	Brass work				-
P	50mm dia non-rising stem solid wedge gate valve as peglars or equal and approved with connections to PPR tubing .	No	0		-
Q	32 mm dia ditto	No	2		-
R	25 mm dia ditto	No	9		-
Carried to sub-collection page					-

SECTION D.W. 2: INTERNAL WATER SUPPLY

Item	Description	Unit	Qty	Rate	Cost KShs.
	SUB-COLLECTION PAGE				
2.1	Internal Cold Water Supply				-
2.2	Internal hot water supply				-
	SUB-TOTAL				-
	Carried to Main Collection Page				-

SECTION: D.W. 3 SANITARY FITTINGS

Item	Description	Unit	Qty	Rate	Cost KShs.
3.1	**SANITARY FITTINGS - (page 1)**				
	Supply, assemble and install the following sanitary fittings including all the necessary joints to service, overflow, waste pipes and jointing materials, mortices, plugs, screws, bolts, nuts, gaskets etc and making good as described and shown on the drawings:-				
	Water Closet				
A	"Duravit-D-Code" WC consisting of Wall Hung WC Pan 54 cm complete with Soft Close Toilet Seat and Cover Ref:#253509, #006739, and all neccesary accessories for proper functioning of the installation.	No.	7		-
B	Geberit delta Concealed cistern complete with mounting accessories. Cistern to be of dual flush 6/4 litres with actuation push buttons to manufacturers details/ Architects approval.	No.	7		-
C	"Duravit Karree" wall toilet roll holder with cover. Item No. 0099551000	No.	7		-
D	Coat hook in Satin aluminium finish (Ref No. SAF 4166) as manufactured by Insta-office safco.	No.	7		-
E	Wall mounted toilet brush holder and brush of approved colour as Ideal Standard or approved equivalent	No.	7		-
F	Chrome plated Arabic shower fixed next to the water closet complete with chrome plated wall bracket as Cobra, scholsser angle valve or equal and approved.	No.	7		-
J	Mediclinic Hidgedown support Bar with internal toilet roller holder in white **Ref:BG0800**	No.	7		-
K	Mediclinic Straight Grab Rail **Ref:BR0600**	No.	21		-
	Wash Hand Basin & Accessories				-
G	Vanity top wash basin as Duravit – D-Code germshield antibacteria in white ref # 033754 with centre tap hole, size 545 x 435mm complete with all accessories	No.	12		-
H	Semi Pedestal wash basin as Duravit – D-Code germshield antibacteria in white ref # 231055 with centre tap hole, size 545 x 435mm complete with semi pedestal ref # 085717 and all neccesary accessories	No.	3		-
I	Hangrohe - Focus : Electronic Basin Mixer Tap with 230 V Main connection (Ref: #31174000) complete with all accessories to engineer's approval.	No.	15		-
J	Chrome plated 1¼" basin waste complete with flange, shank, chain & plug.	No.	15		-
K	Chrome plated 1¼" bottle trap with 75 mm deep seal and 200 mm long tail pipe, cap-nut and wall flange complete with cap-nut, wall flange, plug, chain and angle regulating valves.	No.	15		-
sub-total carried to sub-collection					-

SECTION: D.W. 3: SANITARY FITTINGS

Item	Description	Unit	Qty	Rate	Cost KShs.
3.2	**SANITARY FITTINGS - (Page 2)**				
	Paper Towel Dispenser				-
A	"Mediclinic PR0783" paper towel dispenser capacity 600 tissues stainless steel satin finish complete with fixing screws. (Code No. PR0783).	No.	15		-
B	White epoxy steel 12 litres capacity Electronic pedal operated receptacle and bins as mediclinics Ref No. PP1312, or equal and approved equivalent	No.	15		-
	Soap Dispenser				-
C	Mediclinics DJ0030 in White epoxy finish, with Mediclinics lock system, refill window, Anti-dripping and anti-corrosion valve, Capacity: 1.1 litre glued/screwed to wall liquid soap dispenser complete with initial charge, key and mounting brackets.	No.	15		-
	Hand Drier				-
D	"Mediclinic M96" Push Button Hand drier with 4 mm thick white melamine one-piece cover, complete with fixing accessories, power connection (in concealed conduit) to a local electrical isolator.	No.	2		-
					-
	Shower				-
B	Shower Set as "Hangrohe Radiance " Complete with 4-way diviter, handshower on rail, and all neccesary accessories for proper functioning of the installation. Overhead shower to be square as "Hangrohe Radiance E 300 1jet EcoSmart 9 l/min"or equal and approved.	no.	6		-
C	Fold-down shower seat for persons with disabilities as Mediclinics or approved equivalent	no.	6		-
D	Stainless steel soap basket with chrome finish as Tapis to engineers approval	no.	6		-
E	20mm dia x 600mm long single towel rail complete with end brackets with concealed screws as Mediclinics	no.	6		-
F	Stainless steel ring type tumbler holder as Mediclinics	no.	6		-
Carried to sub-collection					-

SECTION: D.W. 3: SANITARY FITTINGS

Item	Description	Unit	Qty	Rate	Cost KShs.
3.3	**SANITARY FITTINGS - Page 3**				
	Angle valves				-
A	Schlosser Germany: Angle Valve : 1/2x3/8in: CP #1710	no.	30		-
	Mirrors				-
B	3mm Mirror from plain bevelled glass plates size 800X600 wide with dome headed C.P screws and approved back paddling	No.	15		-
C	Ditto but 800x2000mm	No.	0		-
D	Ditto but 800x1800mm	No.	0		-
	Hand Sanitizer				
E	Anti-bacterial hand sanitizer dispenser. Dispenser to be battery-operated with with LED lights for low battery and low product indication. Dispenser to be as Mediclinics or approved equivalent.	No.	2		-
	Sluice Sink				
A	Stainless Steel combined disposal hopper with flush-hopper, concealed cistern, flush valve, and with single bowl s/s sink for rinsing, with drainer. Sink to be fitted with hot and cold water elbow action mixer tap as "Talis" or "Hansgrohe". Hopper to be complete with all piping, fittings and acessories and to be as Twyford PS8106SS.	No.	1		-
F	Wide Groove Stainless steel single bowl signle drainer kitchen sink as manufactured by Franke a, finished in bright machine polish and to incorporate sound deadening pads. Size 1200 x 500mm wide. The sink top shall be pierced for tap hole(s) and for a 40mm waste hole, outlet and overflow.Fittings to include for chrome plated chain waste 40mm dia. with overflow slots and 1 No. stainless steel bottle trap 40mm dia. with S trap outlet.	No	0		-
H	Swivel Kneck Kitchenette Sink as Grohe or approved equivalent. Tap to be chrome plated. Kitchen tap to architects approval	No.	0		-
I	Allow for careful removal of all existing sanitary fittings and handover to the client. Rate to include cart away of materials that will not required.	item	1		-
	Carried to sub-collection page				-

SECTION: D.W.3: SANITARY FITTINGS

Item	Description	Unit	Qty	Rate	Cost KShs.
	SUB-COLLECTION PAGE				
3.1	Sanitary fittings - page 1				-
3.2	Sanitary fittings - page 2				-
3.3	Sanitary fittings - page 3				-
	SUB-TOTAL				-
	Carried to Main Collection Page				-

SECTION D.W. 4: SOIL & WASTE DRAINAGE

Item	Description	Unit	Qty	Rate	Cost Kshs.
4.1	**SOIL AND WASTE DRAINAGE - PIPEWORK** **Supply and install the following drainage UPVC and PVC pipe system as described and shown on the drawings** **All pipes and fittings in this installation shall upvc and pvc to BS 5572:1978 and B.S.5750 as manufactured by "Key Terrain" or equal and approved. All jointings and fixings shall be in accordance with the manufacturers instructions and as described.** **Tenderers must allow for jointings, clippings, couplings, holders bats, plugging, reducers, spacers etc. necessary for the proper functioning of the installation when pricing**				
A	150 mm dia Grey pipe	LM	0		-
B	100 mm dia Brown pipe	LM	100		-
C	100 mm dia Grey pipe	LM	120		-
D	50 mm dia pipe	LM	60		-
E	40 mm dia pipe	LM	60		-
					-
	Extra over pipe for:-				-
F	150mm dia sweep bend	No.	0		-
G	100mm dia sweep bend	No.	32		-
H	50mm dia 45^{o} sweep bend	No.	12		-
I	50mm dia 91^{o} sweep bend	No.	12		-
J	40mm dia ditto	No.	6		-
K	100mm dia access sweep bend	No.	16		-
L	100mm dia long radius bend	No.	16		-
M	40mm rodding eye	No.	8		-
N	100mm dia ditto	No.	8		-
O	50mm dia ditto	No.	4		-
P	100mm dia WC connector	No.	7		-
Q	110mm dia. weathering slate	No.	0		-
R	100 mm diameter Light Grey Weathering Apron	No.	0		-
S	100mm dia vent cowl	No.	4		-
T	Floor traps complete with stainless steel floor trap covers (AISI 316) to engineers approval.	No.	14		-
					-
U	Allow for connection to existing drainage line	item	1		-
Carried to sub-collection					0.00

SECTION D.W.4.0: SOIL & WASTE DRAINAGE

Item	Description	Unit	Qty	Rate	Cost KShs.
	SOIL AND WASTE DRAINAGE				
A	Excavate trench in murram ground from ground depth not exceeding 2000 mm average 1200 mm including bedding pipe in bed class "B" for 100 mm dia pipe	LM	100		-
B	Allow for keeping the works free from water and mud by bailing, pumping or any other method	Item	1		-
C	Allow for connecting to the existing inspection chambers	Item	1		-
D	Allow for materials for the construction of a standard inspection chamber including excavation and make good depth not exceeding 900mm average 600mm. Chamber walls in 150mm block work with water proof cement render and formed channels bend.	No.	12		-
E	Medium duty cast iron inspection chamber cover with frame size: 600 x 450mm including bedding the frame in concrete and bitumen sand air seal.	No.	12		-
F	Ditto but heavy duty cover.	No.	0		-
G	Allow for materials for the construction of a standard inspection gulley trap complete with gulley trap covers to engineers approval	No.	12		-
	Carried to sub-collection				0.00

SECTION D.W. 4: SOIL & WASTE DRAINAGE

Item	Description	Unit	Qty	Rate	Cost KShs.
	SUB-COLLECTION PAGE				
4.1	Soil & Waste Drainage - Pipework				-
4.2	Soil & Waste Drainage - Cont				-
	SUB-TOTAL				-
	Carried to Main Collection Page				-

SECTION D.W. 5 : FIREFIGHTING SERVICES

Item	Description	Unit	Qty	Rate	Cost KShs.
	FIRE FIGHTING SERVICES				
5.1	**PORTABLE FIRE EXTINGUISHERS**				
A	9Kg dry powder multi-purpose fire Class A, B and C as manufactured by Angus Fire Armour ABC multipurpose model AP9K or equal and approved. complete with:- - charge and fixing bracket - pictorial instructions - colour coding to BS 7863 - discharge horn and hose. - pressure indicator	No.	1		-
B	5 kg Carbon Dioxide Steel Stored pressure gas fire extinguishers conforming to BS EN 5423 complete with:- - charge and fixing bracket - pictorial instructions - colour coding to BS 7863 - discharge horn and hose. - pressure indicator	No.	1		- -
C	1210 x 1210mm Fire Blankets in woven fibre-glass material to be installed in Kitchen	No.	0		-
	Carried to sub-collection page				-

SECTION D.W. 5 : FIREFIGHTING SERVICES

Item	Description	Unit	Qty	Rate	KShs.
	SUB-COLLECTION PAGE				
5.1	Portable extinguishers				-
	SUB-TOTAL				-
	Carried to Main Collection Page				-

MAIN COLLECTION PAGE

Item	Description				Price (KShs.)
	PROPOSED LABOUR WARD AT THE NAIROBI HOSPITAL **PLUMBING, DRAINAGE & FIREFIGHTING** **MAIN COLLECTION PAGE**				
I	Preliminaries				-
2	Internal Water Supply				-
3	Sanitary fittings				-
4	Soil & Waste Drainage				-
5	Firefighting Services				-
PC 1	**Allow a PC sum of Ksh. 1.5 million for Medical grade Birthing tub.**				**1,500,000.00**
	Sub-Total (Inclusive of VAT)				
	TOTAL FOR P,D,FF CARRIED TO MAIN SUMMARY PAGE				**-**

8 TECHNICAL SCHEDULE AND APPENDICES

8.1 TECHNICAL SCHEDULE

The tenderer must complete in full the technical schedule. Apart from the information required in the technical schedule, the tenderer **MUST SUBMIT** comprehensive manufacturer's technical brochures and performance details for all items listed in this schedule (fill forms attached).

ITEM No.	Description	Manufacturer	Country of origin	Remarks (Catalogue No. etc.)
A	Plumbing Pipework			
B	Drainage Pipework			
C	Sanitary fittings			

8.2 DOCUMENTATION REQUIREMENTS

Document	With Bid	Before Manufacture	During FAT	Upon Delivery
Preliminary general arrangement drawing (with dimensions)	YES			
QA / QC Plan in accordance with ISO 9001:2008		YES		
General arrangement drawing (with dimensions)		YES		
Schematics/Line diagrams for construction	N/A	YES	N/A	N/A
Recommended Spares List	N/A	N/A	N/A	YES
Routine Test Reports / Certificates			YES	
Type Test Reports / Certificates	N/A	N/A	YES	N/A
Commissioning Procedure	N/A	N/A	N/A	YES
As-built General arrangement drawing			YES	
As-built Schematics			YES	
Site Test Reports / Certificates				YES
Special Test Reports / Certificates	N/A	N/A	YES	NO

APPENDICES

9.1 Appendix I: Tender Evaluation Criteria

TENDER EVALUATION CRITERIA

TECHNICAL & FINANCIAL EVALUATION

SEC	REQUIREMENT SUMMARY	CRITERIA	TARGET SCORE	BIDDER'S SCORE
1	**TECHNICAL EVALUATION**			
a	Performance	Maximum of 10 as evaluated by Eng.	**10**	
b	Warranty	Maximum of 10 as per below schedule 1 year and below ---> Score of 2 1-3 years ---> Score of 6 3-10 years ---> Score of 10	**10**	
c	Product Life	Maximum of 10 as per below schedule 5-10 years ---> Score of 2 10-15 years ---> Score of 5 15 years and above ---> Score of 10	**10**	
d	Spare parts/Consumables and their availability. Local Back-up (maintenance)		**5**	
e	Technical data provided (brochures, technical specs, manuals, drawings etc)		**10**	
g	Understanding of the tender document		**5**	
3	**COSTS**			
a				
a	Price of the bid relative to the other bidders	Maximum of 25 as per below schedule Outside of 20% Range of Engineer's Estimate/Market Rate ---> Score of 0 Lowest ---> Score of 25 Second Lowest ---> Score of 20 Third Lowest ---> Score of 15 Fourth Lowest ---> Score of 10 Fifth Lowest ---> Score of 5	**25**	
b	Unit Rate Schedule (Appendix V below)	Maximum of 25 as per below schedule Lowest ---> Score of 25 Second Lowest ---> Score of 20 Third Lowest ---> Score of 15 Fourth Lowest ---> Score of 10 Fifth Lowest ---> Score of 5	**25**	
TOTAL SCORE			**100**	

The evaluation criteria provide that the bidder who scores **highest** points is technically responsive therefore, qualifies for recommendation of award of the contract unless otherwise stated.

9.2 Appendix II; Statement of Compliance

Technical Schedules shall be submitted by tenderers to facilitate and enable the Engineer to evaluate tenders but only when the fittings and accessories upon which the tenderer has based his tender sum differs in manufacture, type or performance from the description contained within this specification.

Tenderers shall submit separate leaflets and catalogues giving technical and physical details for all fittings and accessories described in the Technical Schedule at the time of tendering.

Completion of Technical Schedule shall not relieve the Contractor from complying with the requirements of the Specification except as may be approved by the Engineer.

…….. **(Signed)**

…….. **(Date)**

9.3 Appendix III; Exchange Rate Fluctuations

Adjustment will be made to the price of imported materials to compensate for variations in the foreign exchange rate. For this purpose, the tenderer is required to state the exchange rate in Kenya Shillings for the currency of the Country of origin of imported materials as applied to the actual remittance effecting payment to manufacturers of the materials.

Exchange Rate: …….

Signed (as in Tender) ……

Date ……

9.4 Appendix IV; System Warranties

The tenderer shall outline the warranties for all systems installed on this site as specified elsewhere.

These shall include but not limited, to the following:

- Pipework & Accessories
- Sanitary fittings

- Etc.

9.5 Appendix V; Schedule of Unit Rates

The tenderers shall provide a schedule of unit rates (under Tables (a) and (b) below) that shall be used to build up rates for variation items not specified in the bill of quantity.

This section, and the terms filled herein shall form part of the contract, and shall be considered locked for the duration of the project.

Rates filled herein shall be evaluated as part of the tender evaluation process. Attention is drawn to the tender evaluation criteria included in this tender package.

The sub-contractor shall disclose the cost of the material offered by the supplier, including or manufacturer or any other sources to the Engineer used to build up the rates in respect to schedule of table (a) and table (b) below. The engineer can reject the disclosed sources where the conflict of interest seems to prevail.

Table (a) and Table (b) shall be deemed to be exhaustive in capturing all cost components and the percentages filled herein shall be considered to be locked for the duration of the contract.

9.5.1 Locally Available Items

Unit rates for items that can be procured locally shall be generated according to table (a) below. Table (a) consists of the below items:

- Material cost – This is the supplier's unit cost for the item, i.e. the cost at the shop/supplier.
- Labor – This is to include all transportation, security, hoisting, installation, tools and consumables, testing, commissioning, costs, etc. The tenderer is to provide his/her labor cost as a percentage of material cost.
- Overheads and Profit – This is to capture all contractor's overheads, margins, profit, etc. The tenderer is to provide his/her overheads and profit as a percentage of material cost.
- Further to this, tenderers are expected to list all other cost carriers not deemed to have been captured in the table below, as a percentage of material cost.

9.5.1.1 Table (a): Locally Available Items.

Material Cost Kshs. (a)	Labour (as a percentage of material cost) (b)	Overheads and Profit (as a percentage of material cost) (c)	List any other component as necessary (as a percentage of material cost) (e)	Total Installed Cost of item Kshs. (VAT exclusive) (a+b+c+d)

9.5.2 Imported Items

Unit rates for items that will require importation shall be generated according to table (b) below. Table (b) consists of the below items:

- Material cost – This is the supplier's unit cost for the item as landed and cleared in Kenya. It includes FOB price, Carriage Insurance & Freight, Inspection Charges, Duty, Port Levies, Clearance Charges and VAT

- Labor – This is to include cost for transportation from port to site, security, hoisting, installation, tools and consumables, testing, commissioning and associated costs, etc. The tenderer is to provide his/her labor cost as a percentage of material cost.
- Overheads and Profit – This is to capture all contractor's overheads, margins, profit, etc. The tenderer is to provide his/her overheads and profit as a percentage of material cost.
- Further to this, tenderers are expected to list all other cost carriers not deemed to have been captured in the table below, as a percentage of material cost.

9.5.2.1 Table (b): Imported Items.

Material Cost Kshs. (a)	Labour (as a percentage of material cost) (b)	Overheads and Profit (as a percentage of material cost) (c)	List any other component as necessary (as a percentage of material cost) (e)	Total Installed Cost of item Kshs. (VAT exclusive) (a+b+c+d)

…….. **(Signed)**

…….. **(Date)**

…….. **(Official Stamp)**

9.6 Appendix VI; Day Work Terms for Labour

(To Be Completed By Tenderer)

Description of Artisan	**Cost Per Hour**
Supervisor	…….
Grade A Plumber	…….
Grade B Plumber	…….
Grade C Plumber	…….
Labour	…….
Apprentices	…….

9.7 Appendix VII; Technical Schedule

TECHNICAL SCHEDULE

The tenderer must complete in full the technical schedule. Apart from the information required in the technical schedule, the tenderer **MUST SUBMIT** comprehensive manufacturer's technical schedules details for all items listed in this schedule (fill forms attached).

Description	Manufacturer	Country of origin	Remarks (Catalogue No. etc.)
• Pipework & Accessories • Sanitary fittings			

PART A

GENERAL MECHANICAL SPECIFICATION

1 PART B - GENERAL MECHANICAL SPECIFICATION

1.1 General

This section specifies the general requirements for plant, equipment and materials forming part of the Sub-Contract Works and shall apply except where specifically stated elsewhere in the Specification or on the Contract Drawings.

1.2 Quality of Materials

All plant, equipment and materials supplied as part of the Sub-Contract Works shall be new and of first-class commercial quality, shall be free from defects and imperfections and where indicated shall be of grades and classifications designated herein.

All products or materials not manufactured by the Sub-Contractor shall be the products of reputable manufacturers and so far as if they had been manufactured by the Sub-Contractor.

Materials and apparatus required for the complete installation as called for by the Specification and Contract Drawings shall be supplied by the Sub-Contractor unless mention is made otherwise.

Materials and apparatus supplied by others for installation and connection by the Sub-Contractor shall be carefully examined on receipt and stored. Should any defects be noted, the Sub-Contractor shall immediately notify the Engineer.

Defective equipment or that damaged in the course of installation or tests shall be replaced or repaired to the approval of the Engineer.

1.3 Regulations and Standards

The Sub-Contract Works shall comply with the current editions of the following:-

(a) The Kenya Government Regulations.

(b) The United Kingdom Institution of Electrical Engineering Regulations for the electrical equipment of buildings.

(c) The United Kingdom Chartered Institution of Building Services' Guides.

(d) The Kenya Bureau of Standards Specifications.

(e) British Standards and Codes of Practice as published by the British Standards Institution.

(f) The Local Council By-laws.

(g) The electricity Supply Authority By-laws.

(h) The Kenya Building Regulations.

1.4 Electrical Requirements

Plant and equipment supplied under this Sub-Contract shall be complete with all necessary motor starters, control boards, and other control apparatus. Where control panels incorporating several starters are supplied they shall be complete with a main isolator.

The supply power up to and including local isolators will be provided and installed by the Electrical Sub-Contractor. All other wiring shall be as described in the Particular Specification.

The sub-contractor shall supply three copies of all schematic, cabling and wiring diagrams for the Engineer's approval.

The starting current of all electric motors and equipment shall not exceed the maximum permissible starting currents described in the Kenya Power and Lighting Company Ltd's By-laws.

All electrical plant and equipment supplied by the Sub-Contractor shall be rated for the supply voltage and frequency obtained in Kenya, that is 415 volts, 50HZ, 3-phase or 240 volts, 50HZ, 1-phase as specified in the particular specification.

Any equipment that is not rated for the above voltage and frequencies may be rejected by the Engineer.

1.5 Transport and Storage

All plant and equipment shall, during transportation be suitably packed, crated and protected to minimise the possibility of damage, and to prevent corrosion or other deterioration.
On arrival at site all plant and equipment shall be examined and any damage to parts and protective priming coats made good before storage or installation.

Adequate measures shall be taken by the Sub-Contractor to ensure that plant and equipment do not suffer any deterioration during storage.

Prior to installation all piping, plant and equipment shall be thoroughly cleaned.
If, in the opinion of the Engineer any equipment has deteriorated or been damaged to such an extent that it is not suitable for installation, the Sub-Contractor shall replace this equipment at his own cost.

1.6 Site Supervision

The Sub-Contractor shall ensure that there is an English-speaking supervisor on the site at all times during normal working hours.

1.7 Installation

Installation of all special plant and equipment shall be carried out by the Sub-Contractor under adequate supervision form skilled staff provided by the plant and equipment manufacturer or his appointed agent, in accordance with the best standards of modern practice to the relevant regulations and standards described under clause 2.3 of this section.

1.8 Testing

1.8.1 General

All testing shall be carried out to the entire satisfaction of the Engineer.

The following sub-clause are intended to define the Sub Contractor's responsibilities with respect to testing and inspection.

1.8.2 Materials Tests

All materials for plant and equipment to be installed under this sub-contract shall be tested, unless otherwise directed, in accordance with the relevant B.S. Specification concerned.

For materials where no B.S Specification exists tests are to be made in accordance with the best modern commercial methods to the approval of the Engineer having regard to the particular type and application of materials concerned.

The Sub-Contractor shall prepare specimens and performance tests and analyses to demonstrate conformance of the various materials with the applicable standards.

If stock material, which has not been specifically manufactured for the plant and equipment specified is used, then the sub-contractor shall submit satisfactory evidence to the Engineer that such materials conform to the requirements stated herein in which case test of material may be partially or completed waived. Certified mill test reports of plates, piping and other materials shall be deemed acceptable.

1.8.3 Manufactured Plant and Equipment - Works Tests

The rights of the Engineer relating to the inspection, examination and testing of plant and equipment during manufacture shall be applicable to the Insurance Companies or Inspection Authorities so nominated by the Engineer.

The sub-contractor shall give two weeks' notice to the Engineer of the manufacturer's intention to carry out work tests and inspection.

The Engineer or his representative shall be entitled to witness such tests and inspections. The costs of such tests and inspections shall be borne by the Sub-Contractor.

Six copies of all test and inspection certificates and performance graphs shall be submitted to the Engineer for his approval as soon as possible after the completion of such tests and inspections.

Plant and equipment which is shipped before the relevant test certificate has been approved by the Engineer shall be shipped at the Sub-Contractor's own risk and should the test and inspection certificate not be approved, new tests may be ordered by the Engineer at the Sub-Contractor's expense.

1.8.4 Pressure Testing

All pipework installation shall be pressure tested in accordance with the requirements of the various sections of this Specification. The installation may be tested in sections to suit the progress of the works but all tests must be carried out before the work is buried or concealed behind building finishes. All tests must be witnessed by the Engineer or his representative, and the Sub-Contractor shall give 48 hours' notice to the Engineer of his intention to carry out such tests.

Any pipework that is buried or concealed before witnessed pressure tests have been carried out shall be exposed at the expense of the Sub-Contractor and the specified tests shall then be applied.

The Sub-Contractor shall prepare test certificates for signature by the Engineer and shall keep a progressive and up-to-date record of the sections of the work that have been tested.

1.9 Colour Coding

Unless stated otherwise in the Particular Specification all pipework shall be colour coded in accordance with the latest edition of B.S.1710.

1.10 Welding

1.10.1 Preparation

Joints to be made by welding shall be accurately cut to size with edges sheared, flame cut or machined to suit and the required type of joint. The prepared surfaces shall be free from all visible defects such as laminations, surface imperfections due to shearing or flame cutting operation, etc., and shall be free from rust scale, grease and other foreign matter.

1.10.2 Method

All welding shall be carried out by the electric arc process using covered electrodes in accordance with B.S. 639.

Gas welding may be employed in certain circumstances providing that prior approval is obtained from the Engineer.

1.10.3 Welding Codes and Construction

All welded joints shall be carried out in accordance with the following specification:-

a) Pipe Welding

All pipe welds shall be carried out in accordance with the requirements of B.S. 806.

b) General Welding

All welding of mild steel components other than pipework shall comply with the general requirements of B.S.5135:1974.

1.10.4 Welder's Qualifications

Any welder employed on this sub-contract shall have passed the trade test as laid down by the Government of Kenya.

Trade engineer may require to see the appropriate certificate obtained by any welder and should it be proved that the welder does not have the necessary qualifications the Engineer may instruct the Sub-Contractor to replace him by a qualified welder.

PART B

GENERAL MECHANICAL VENTILATION AND AIR CONDITIONING SPECIFICATION

2 PART C - GENERAL MECHANICAL VENTILATION AND AIR CONDITIONING SPECIFICATION

2.1 GENERAL

This section specifies the general requirements for mechanical ventilation and air conditioning plant, equipment and materials forming part of the Sub-Contract works and shall apply except where specifically stated elsewhere in this Specification or on the Contract Drawings.

2.2 INSTALLATION

Installation of all ductwork, plant and equipment shall be carried out under adequate supervision from skilled staff in the relevant codes and standards specified herein.

The Sub-Contractor shall be responsible for ensuring that sufficient provision is made to prevent the transmission of vibration from equipment to the supporting structure. In the case of fans, this shall be done by rot and vermin-proof flexible connections and anti-vibration mountings of an approved type.

The Sub-Contractor shall ensure that all ducting systems are provided with sufficient access hatches complete with covers, for maintenance purposes.

Dampers and other user equipment shall be installed with adequate access for operation and maintenance. Where dampers and other operational equipment are unavoidably installed beyond normal reach and in such a position as too be difficult to reach from a short step ladder, extension spindles shall be provided.

The variety and type of supports for ducts, and fans shall be kept to a minimum and their design shall be such as to facilitate quick and secure fixing to metal, concrete, brickwork and wood.

Where the design of the structure is in reinforced concrete, supports shall be secured to the structure by means of redheads, rawbolts or other approved means.

Where the Sub-Contractor proposes to secure his supports by other means than to the main structural concrete, he shall consult with the Engineer before proceeding.

2.3 TESTING AND INSPECTION

2.3.1 Site Test

The Sub-Contractor shall supply all instruments and equipment necessary to carry out Site Tests and shall arrange with other Sub-Contractors for the testing of associated equipment which may affect the performance of the plant installed under these Sub-Contract Works.

2.3.2 Site Tests- Fans

All fans shall be charged with a suitable lubricant and shall be tested upon completion of the ancilliary system erection to ascertain that the performance of each fan complies with the requirements of the Specification.

2.4 Completion of Works - Balancing and Commissioning

Following the Site Tests and prior to handover, mechanical ventilation or air conditioning systems shall be balanced by means of grilles, dampers and other special controls installed, so as to give the required air flow rates and where applicable the desired temperatures, pressures and humidity conditions in all areas served by the said systems.

The complete system shall be balanced and commissioned as a whole. Sectional balancing and commissioning on any one part of the system where this excludes final complete system balancing and commissioning, shall not be accepted.

Test volumes within ducts shall be within + or - 5% of the design volumes, and volumes at grilles and diffusers shall be within + or - 10% of the design volumes.

When the system has been balanced to the satisfaction of the Engineer, it shall be run under complete automatic control for 72 hours continuous operation to ascertain any faults in operation before acceptance and handover. Any faults discovered during this time shall be corrected and a further test or tests of 72 hours duration shall be carried out to ensure satisfactory operation, all at the expense of the Sub-Contractor.

2.5 Ductwork

The Sub-Contractor shall supply, deliver and erect all ductwork as shown on the Contract Drawings.

All ductwork shall be manufactured in accordance with the Heating and Ventilation Contractors Association (H.V.C.A.) Specification DW/121, current edition except where stated otherwise.

Ductwork shall be manufactured from galvanised mild steel sheet unless otherwise specified. All external ductwork shall be manufactured from black mild steel sheet and galvanised after manufacture. All seams shall be of lock form type. All ductwork systems shall be complete with all necessary dampers, bends, tees, tapers, transformation and special pieces.

Where removal is required for access or maintenance, ducting shall be provided with steel angle flange joints suitably painted and protected.

Only bends type 1 - 7 inclusive as detailed in the H.V.C.A. Specification will be permitted.

Only duct connections type 42 - 44 inclusive 53 and 54 as detailed in the H.V.C.A. Specification will be permitted. All joints shall be fixed as to be suitable for the direction of the air flow.

All positions of plant and ductwork shall be checked on site before detailed manufacturing drawings are prepared and ductwork manufacture commenced.

Transformation and paper pieces shall, wherever possible, be constructed so that the included angle does not exceed 30 degrees C.

All flanged joints shall be sealed by the use of asbestos string, compressed between the flanges, and where slip joints occur, these shall be sealed by "Prestik" or other similar suitable jointing compound and adhesive tape 40mm wide. Exposed sheet metal edges shall be painted with galvanize before sealing.

Dampers shall be of aerofoil section and manufactured from galvanised mild steel sheet. Damper blades shall not exceed 150mm in width and the edges of the blades shall be sealed with a 3mm thick felt or rubber seal to minimise leakage. Operating quadrants shall be provided with locknuts and the quadrant shall be clearly marked with `Open' and

`Closed' positions. Multileaf damper blades shall be operated by one arm through a linkage external to the duct.

The Sub-Contractor shall provide sufficient access doors and handholds in the ductwork for the purpose of maintenance and inspection. Access doors shall be of the hinged type and door openings in the ductwork shall be adequately stiffened and made airtight with purpose made rubber gaskets around the door perimeter.

All supports and brackets shall be wire brushed and painted one coat of red oxide paint prior to and after erection. All nuts and bolts shall be sheradized. The fastening of electrical cables to ductwork will not be permitted.

Where ductwork has insulation incorporating an external vapour seal, the ductwork shall be insulated from the support by a rot-proof softwood, hardwood or other suitable closed cell insulator of not less than 25mm greater thickness than the insulation to be applied so that the vapour seal may be bonded to the face of the timber, all as detailed in Clause 6.4 of the H.V.C.A. Specification DW/121, latest edition.

Where ductwork passes through floors and walls, etc., galvanised sheet sleeves or builders work timber frames shall be provided. The space between duct and sleeve or frame shall be paced with asbestos rope or mastic to prevent air movement or noise transmission from one space to another. Ducts must not come into direct contact with the building fabric.

Hangers and brackets shall be manufactured from rolled mild steel angle or channel sections and shall generally be of the drop rod hanger or cantilever type. The hangers shall be spaced to ensure adequate support and where practicable shall be fitted at each ductwork joint.

The Sub-Contractor shall supply and install, where called for, louvred inlets and outlets with insect-proofed screens. The louvres shall be constructed throughout from extruded aluminium sections and shall have a lacquered or anodised finish to prevent corrosion. The louvres shall be weather-proof and have a free area of not less than 50%.

The Sub-Contractor shall ensure that wherever fans or similar equipment are connected to the ductwork system, the connections are made with a heavy duty rot and vermin-proof neoprene, or similar material, flexible connection to prevent vibration transmission to the ductwork or building fabric. Flexible connections shall be secured by a pre-drilled mating flange, or when fixing to a spigot, the spigot should be beaded and a jubilee clip or split flat iron ring should be used.

The Sub-Contractor shall provide test holes in all branch ducts and in the main duct on the discharge of the fan. The holes shall be suitably spaced in accordance with B.S. 848, shall be situated on a straight length of ductwork and where possible, not less than 2 metres downstream or any bends or damper. After the completion of testing the Sub-Contractor shall provide and fix properly metal or plastic plugs to all test holes. The use of rubber or cork bungs will not be permitted.

2.6 INSULATION

2.6.1 General Description

All heated, cooled and recirculated air ductwork shall be insulated.

Insulation shall be of 25mm thick expanded polystyrene sheet, or spray applied polyurethane foam to a uniform thickness of 25mm. Polystyrene shall be fixed so that the edges butt closely without gap and insulation shall overlap at corners by the thickness of the insulation. The sheet shall be fixed by means of a suitable adhesive and plastic impingement pines attached to the ductwork.

2.6.2 Ductwork in Plant Rooms

The insulation described in Clause 5.1 above shall be finished by the application of a 15mm thick layer of hard setting plastic compound trowelled to a smooth finish. All corners shall be protected by setting in a 1mm thick aluminium angle strip into the hard setting finish. Insulation shall be bevelled to angle of 45 degrees at all connecting flanges, access hatches and all other places where operation or maintenance is likely to cause the breaking of the insulation.

The insulation shall then be given a vapour sealing by the application of two coats of anti-condensation paint.

2.6.3 Ductwork External to Plant Rooms

The insulation described in Clause 5.1 above shall be finished by the application of two coats of bitumastic.

2.6.4 Finish Painting

Upon completion of the installation and after all tests have been carried out too the satisfaction of the Engineer the plant, equipment, supports etc., shall be examined and all priming coats damaged during erection made good.

Any plant or equipment, ductwork, etc., which is to be insulated, shall have had the priming paint protection made good before the application of the insulation.

PART C

3 GENERAL TECHNICAL SPECIFICATION

3.1 PART C - GENERAL TECHNICAL SPECIFICATION

3.1.1 Materials and Workmanship

All materials shall be of adequate quality for the duty specified and the workmanship shall be in accordance with the best accepted modern practice. Unless otherwise stated the Mechanical Contractor shall be obliged to comply with the requirements of the latest edition of the relevant Bureau of Standards Specification where applicable. Failing this, the latest edition of the relevant Britain Standard Specification shall provide the required standard. If the Mechanical Contractor desires to use any other standard specification or code of practice, it shall be referred to the Engineer for approval.

3.1.2 Structural Steelwork

The structural steel used in the Mechanical Contract shall be mild steel to B.S. 15. Black bolts and nuts shall be in accordance with B.S. 916. Black metal washers shall be in accordance with B.S. 916.

High Strength friction grips, bolts, nuts and washers shall be in accordance with B.S. 3139, Part 1, and their application shall conform to B.S. 3139, Part 1, and their application shall conform to B.S. 3294, Part 1 torque wrenches or impact tools where used be recalibrated before each shift.

All fabrication and erection procedures shall be in accordance with B.S. 449 as amended, Part 5. Before commencing the fixing of the steelwork the erector shall check the seating for line, level and bolt setting, and any errors which cannot be accommodated by the steelwork erector shall be reported to the Engineer.

3.1.3 Steel Fabrication and Baseplates

The manufacture of all fabricated items of plant shall be generally in accordance with B.S. 449 as amended, Part 5.

The fabrication and manufacture of the plant and equipment shall be completed in the Mechanical Contractor's workshops before delivery to site. No fabrication of complete units shall take place on site, sitework shall be confined to only such minor alterations and adjustments as are found to be necessary during erection. If major alterations are found necessary the items of plant covered shall be returned to the Mechanical Contractor's workshop for modification on replacement and shall be tested and checked before re-delivery to site.

Drive baseplates shall be robustly constructed and adequately stiffened to prevent twisting and distortion. The ration of the base length to its height shall not be more than 10:1.

All surfaces shall be free from recesses and cavities to prevent the accumulation of dirt and/or waste material, and shall be designed to facilitate ease of cleaning and maintenance.

Where driving units are directly coupled to the driven component all mounting surfaces shall be accurately machined to ensure alignment. After final assembly and testing, the individual items of plant shall be accurately dowelled in position on the baseplate to prevent misalignment during installation or during operation.

The Mechanical Contractor shall include in the design for any measures required to counter the effects of vibration which might be caused by operation of equipment.

3.1.4 Stainless Steel

All items fabricated in stainless steel shall be in the grade specified and detailed designs shall be compatible with fabrication techniques. The designs of articles to be pressed or welded shall be discussed with the fabricator before manufacture. All stainless steel items shall have a 'half-moon' finish to the satisfaction of the Engineer. Edges shall be finished by either welding on 12mm stainless steel round bar in the same grade as the article or by turning down to an acceptable radius.

3.1.5 Welding

3.1.5.1 Welding

Welding shall be carried out in accordance with the BC Code of Practice for welding No.044 Parts 1, 2, 3, & 4.

3.1.5.2 Freedom from Surface Defects

All welded fillets or butt joints shall be ground smooth and shall be free from porosity, cavities and entrapped slag. All welds shall conform to the requirements of B.S. 1856.

Welds which are to be hot dip zinc coated shall be neatly formed and the surfaces shall be acceptable and free from cracks in the welds or heat affected zone, from overlap undercuts, porosity, entrapped slag and spatter in or associated with the welds. The welds shall seal completely the edges of all overlapping or contacting surfaces.

3.1.5.3 Smoothness of joints where Weld is re-commenced or Terminated

The joints in the weld run where welding has been recommenced or terminated shall be smooth and shall show no pronounced hump or crater in the weld surface.

3.1.5.4 Shape of Profile

The profile of the weld shall be uniform, of appropriately equal leg length and free form overlap at the toes of the weld. Unless otherwise specified the surface shall be either flat or slightly convex in the case of welds and with a reinforcement of not more than 3 mm in the case of butt welds.

3.1.5.5 Uniformity of Surface

The weld face shall be uniform in appearance through its length.

3.1.5.6 Electrodes

Electrodes shall be of an approved type for the material being used and shall be kept in a dry condition. All electrodes shall conform to the latest issue of B.S. 693 'Electrodes for Manual Metal Arch Welding of Mild Steel and Medium High Tensiles Steel'.

3.1.6 Qualification of Welders

Welding on or off the site shall be carried out only by welders qualified to the approval of the Engineer. Each welder to be used on the Mechanical Contract Works will be required to carry to test welds to the approval of the Engineer and in the presence of the Engineer's Representative. Only welders whose test welds have been passed by the Engineer shall be employed on the Mechanical Contract Works and then only for the class of welding for which they have been tested. Initial testing of welders and such periodical tests as may be required by the Engineer shall be carried out at the Mechanical Contractor's expense using materials supplied by the Mechanical Contractor.

3.1.7 HOT DIP (Galvanised Zinc Coatings)

3.1.7.1 General

All hot dip zinc coatings shall conform to the requirements of the latest issue of specification 'Hot-Dip (Galvanised Zinc coatings' with particular reference to the following.

Tubular constructions shall be provided vent holes in appropriate locations to prevent internal pressure build-up during the hot zinc bath shall be referred to the galvaniser who shall state his requirements for the vent holes desired. Welding flux shall be chipped away, all welds shall be wire brushed, ground or grit or shot blasted if necessary before hot zinc coating.

The surfaces to be hot-dip coated shall be free from paint, oil, grease, and similar impurities. Identification numbers of individual pieces shall be clearly stamped on surfaces of members prior to hot-zinc coating, numbers painted or welded on the surfaces of these members shall be unacceptable.

Exposed surfaces, except welds when necessary, need not be grit or shot blasted, but the engineer shall decide to call for grit or shot-blasting in cases of unsuitable surface finish on material for hot-dip zinc coating. The Engineer shall have the right to inspect all steel components before galvanising, and shall have the right to reject or ask for remedial treatment of any material which is considered unsuitable. This applies particularly to welds, burrs, and surfaces having visible surface defects.

Globular extra heavy deposits for zinc which interfere with the intended use of the material shall not be acceptable. Excessively protuberant lumps and nodules shall be removed by hot wiping or skilful application of mechanical means provided that a sufficient minimum thickness of unbroken zinc coating remains after such treatment. Flows on small parts and working surfaces shall be repaired only by stripping, dressing and re-dipping.

3.1.7.2 Threads

The galvanising on threads or bolts shall be such as to fit a gauge made by overtapping a nut to the following increased limits of size to 7H tolerances:

	Bolt Sizes	M6	M8	M10		M12	M16	M24
Overcut,mm	To be Agreed	To be Agreed	0,33	0,33	0,38	0,38	0,38	

For threaded articles less than 10mm diameter mechanical plating will be acceptable instead of hot dip zinc coating (galvanising).

Nuts shall be capable of being spun over the full length of the thread by hand ungalvanised internal threads shall be coated immediately after cutting, before they are allowed to rust, with preventive compound of type agreed between the supplier and the Engineer.

3.1.7.3 Bolts

Bolts to be galvanised shall be standard black bolts manufactured according to B.S 916 (and having threads produced to medium class tolerances G8). Any bolt which has been subjected to cold forming (heading) operation during manufacture shall be stree-relieved at a temperature between 600^0C for a minimum period of 20 minutes and subsequently cooled in air.

3.1.7.4 Protection of Coating (Passivation)

Immediately after withdrawal from the bath of molten zinc, galvanised material shall be quenched in water containing approximately 1% of sodium dichromat slightly acidified with sulphuric acid. Other bath compositions may be used provided that they contain recognised passivating agents unless otherwise specified.

Alternatively by agreement between the galvaniser and the Engineer, protection may be applied by other means, such as, for instance, a lacquer containing chromate salts.

3.1.7.5 White Rust (White Storage Stain)

All galvanised material shall be free from gross deposits of white rust. If material has been affected by white rust, the deposit may be removed, by means of non-metallic brushes and provided that the thickness of zinc coating in the affected area meets the requirements of the specification the material can be accepted.

No galvanised material shall be used for erection unless such material:-

a) has been zinc coated under the KBS certification scheme, and this is indicated by the diamond standardisation mark, which should appear on all labels, delivery notes, and other similar documents relating to such material. Such documents should also indicate the name of the galvaniser concerned.

Structural material should also bear a paint mark applied by the galvaniser to indicate standardisation mark quality. The Engineer may call for certificates from the galvaniser indicating that each consignment of material complies with the specification and was galvanised under the certification mark scheme: or

b) The galvanised material has been inspected, and each consignment is accompanied by an inspector's certificate indicating that the material is acceptable and complies with the requirements. Structural material should also bear a paint mark applied by the inspector to indicate that the material has been inspected and accepted. Bolts, nuts and other material of small size should be in a bag or container containing a label bearing the inspector's stamp.

3.1.7.6 Castings

Because of the corrosion-inducing conditions, and in order to obtain satisfactory mechanical properties of tensile, shear and yield strengths, resistance to impact and transverse loads and hardness properties, all ferrous castings other than those included in the proprietary 'bought out' items of equipment shall comply with the specification hereunder. If the Contractor wishes to offer alternative materials, he shall submit comprehensive details of such alternatives and obtain the prior written approval of the Engineer before proceeding with manufacture.

Material:	Pearlitic Nodular Structure.
Mechanical Properties:	Ultimate Tensile Strength - 725 mpa Elongation - 2% Hardness - 240 to 300 brinell (after normalizing)
Inoculation:	All castings shall be inoculated with 3% copper.
Heat Treatment:	To provide the optimum physical properties consistent with the pearlitic nodular structure of the material, and to provide a hardness within the range 207 to 235 brinell.

Test Certificates: The contractor shall submit to the Engineer all test certificates of analysis including all relevant details of the micro-structure and mechanical properties. The number of tests to be performed and for which certificates of analysis are required shall depend on the respective casting and shall be a greed in writing with the Engineer.

3.1.8 VEE-BELT DRIVES

All vee-belt drives shall conform to B.S. 1440: 1962 - "Endless V-belt drives" and shall be as specified below:

a) Application

Unless otherwise specified or agreed to by the Engineer, Vee-Belt drives shall only be used in applications of constant and slightly varying load conditions. Belt speeds shall not exceed 900 metres per minute, unless otherwise agreed. For reasons of spares interchangeability and maintenance, standard stock vee-belts shall be used.

b) Pulleys

The belt pulleys shall be manufactured from a close-grained cast iron and shall be accurately balanced. The belt grooves shall be properly machined to the correct groove angle and depth.

All sharp corners at the top of the groove shall be removed and the groove sides shall be polished smooth to avoid excessive belt wear. The grooves of mating pulleys shall accurately match each other, particularly regarding width, angle and alignment.

c) Adjustment

Adjustment inward, i.e. towards the driven pulley, shall be provided to ensure sufficient movement of the driving pulley to enable the vee-belts to be fitted by hand, without the use of a lever of any king to force the belts over the pulleys.

The outward adjustment shall provide for correct belt tensioning to ensure that slipping does not occur. All belt tensions shall be re-checked within 24hours and again within a week to start-up to ensure that the initial slack, if any, is taken up.

d) Speed Ratio

Speed ratios greater than 7:1 shall not be acceptable unless otherwise agreed by the Engineer.

3.1.9 Bearings

3.1.9.1 Anti-Friction

Anti-friction bearings shall include all bearings which provide rolling contact between one or more sets of hardened steel balls or rollers located between hardened steel rings or raceways. Anti-friction bearings shall be of approved manufacture.

To facilitate maintenance, spares interchangeability and standardisation, anti-friction bearings of standard designs and manufacture shall be employed. All anti-friction bearings shall be provided with greasing facilities in accordance with the manufacturer's requirements.

3.1.9.2 Bushed Bearings

Only where specifically stated and in cases of low velocities and light loads in moisture-free conditions will bushed bearings be accepted. All bushed bearing shall be made of an approved friction quality and shall be capable of withstanding severe usage.

All bushed bearings shall be provided with lubrication facilities to ensure adequate lubrication and shall be properly grooved to distribute the lubricant uniformly over the bearing surface. Grooves shall not be cut into the journal, but always into the surrounding bush. The edges of all chamfers and grooves shall be rounded to avoid sharp corners and to facilitate the introduction of the oil or grease.

3.1.9.3 Self-Lubricating or Oil-less Bearings

Self-lubricating or oil-less bearings shall only be used on application of light loads and low velocities in moisture-free and low humidity conditions and where bearings are of difficult access and likely to be neglected during servicing. The types of bearing metal composition used shall have frictional and wear resistant properties akin to those of grease lubricated bushed bearings.

3.1.9.4 Keys and Key Ways

All keys and Keyways and taper pins shall conform to B.S. 46: Part 1, 1958.

3.1.9.5 Limits and Fits

Limits and tolerances for shafts and hoes shall conform to B.S.3614.

3.1.10 General Machinery Protection

3.1.10.1 Coupling and Shaft Guards

All high speed couplings, projecting shaft ends and every dangerous moving part of machinery shall be protected by a guard manufactured from not less than 1.6mm mild steel plate. The guards shall be neatly formed and securely fixed in position.

3.1.10.2 Belt Guards

All belt or rope drives shall be adequately protected by a belt guard.

The guard shall be manufactured from wire mesh or open type expanded metal, securely braced and stiffened with suitable rolled steel sections and bolted in position. Guard supports shall not short-circuit vibration isolators on form. Provision must be made for test openings to permit RPM reading of fan and motor without the removal of the belt guard.

3.1.10.3 Painting

All guards shall be finished in a light orange colour to B.S. 381C in accordance with Clause 2.8.4 Class 'C'.

3.1.10.4 EQUIPMENT BASES

Unless stated elsewhere in this specification, inertia base formers for machinery shall be provided to the Main Contractor for casting, by the Contractor for casting, by the Contractor. The bases shall consist of reinforced concrete cast into sheet metal formers at least 150mm deep.

The formers shall comply with the standard set by Mason Industries, for both size and construction. Bases shall be mounted on properly selected spring isolators incorporating noise isolation pads.

Either free-standing stable steel spring or caged spring with snubber may be used. Spring isolators shall be provided with levelling bolts. Noise isolation pads shall be large enough to prevent excessive rocking of equipment during start up and normal operation. Bases and supports shall be arranged to give a clearance of approximately 25mm between the underside of the bases and the floor. Bases shall be large enough to accommodate motors and the equipment they drive.

3.1.10.5 Identification and Labelling

All plant and equipment items, including items such as dampers, pumps, etc, shall be labelled in a clearly visible position with the item name and, in the case of duplicate items, a number. Plant labels shall correspond with labels on starters, isolators, etc.

Labels shall be of sandwich thermosetting plastic with black lettering on a white background. Lettering shall be at least 6mm high and labels shall be in keeping with the size of equipment and legibility with regard to position.

3.1.11 Painting

3.1.11.1 Painting Materials

All paint shall be non-toxic, driers and the like, and other materials shall conform with the requirements of the relevant British Standard Specification. All paints shall be of the best quality and of approved brand and manufacture. All materials shall be used in strict accordance with the manufacturer's instructions and otherwise in strict accordance with the best standard practice. Undercoats of paintwork and primers shall be as supplied by the manufacturer of the paint begin used for the finishing coat. If necessary, paint shall be strained free from skins and similar impurities immediately before application. Priming coats shall be applied over the whole surface and well brushed in order to obtain the maximum penetration. All materials shall be delivered to the job in their original unopened containers with the manufacturer's name and description of contents thereon and no adulteration will be allowed.

3.1.11.2 Colours

Samples of the final colours required shall be submitted for approval before painting the work in hand and the work shall then be finished to the colour or colours as approved. Each coat of paint shall be a distinctive colour working up to the finished colour as approved.

3.1.11.3 External Painting

External painting shall not be undertaken during rainy, damp, frosty or other inclement weather or where such weather is reasonably to be expected within the next 24 hours.

3.1.11.4 Internal Painting

Before internal painter's work is commenced all floors shall be swept clean, and dirt and rubbish removed, and the rooms left practically free from dust; dust-free conditions being maintained during the progress of the work. No sweeping or dusting shall be done whilst the painting is in progress.

Unless otherwise stated, no paint shall be applied within 50mm of areas which are to be welded. Welds and adjacent parent metal shall be de-slagged, inspected and approved and area shall be abrasive-blasted or ground, and all contaminants shall be removed

prior to painting. Wire brushing of the weld shall only be allowed if the paint specification calls for wire-brushing. The weld area shall then be flushed with fresh water and allowed to dry before receiving the full paint system.

Areas where the paint coating has been damaged during transportation erection or by any means whatever, shall be repaired as follows:

Damaged areas or rust spots shall be removed by means of a wire brush or emery paper and the surrounding paint which is still intact shall be feathered for a distance of 20mm beyond the damaged area. Spot priming shall consist of all the coats previously applied and shall overlap the undamaged area by 20mm. Surfaces which are to rest on concrete or other floors or which will be inaccessible after erection shall receive full specified paint system before erection or assembly. Unless otherwise specified, steel embedded with concrete shall not be painted except to within 50mm below the concrete/air interface.

Mating or contact surfaces shall be protected from corrosion by ensuring that the two surfaces brought into contact with each other shall be prepared and primed in accordance with the specification. The primed surfaces shall be brought together while the paint is still wet. Surfaces which are to be friction-bolted shall be prepared in accordance with the specification (i.e. blast-cleaned or wire-brushed) but shall receive no paint coating. All sharp edges shall receive the specified dry film thickness of paint.

Where the shop coat has been allowed to age for a few months before painting, it shall be lightly sanded or rubbed with steel wool and scrubbed with clean water suing a bristle brush. Before painting galvanised iron surfaces, they shall be treated with galvanised Iron Cleaner" or equal and approved cleaner, used in strict accordance with the manufacturer's instructions. Where a temporary protective coating has been applied to prevent wet storage stain, the surface shall be thoroughly scrubbed down by means of a bristle brush and the approved cleaner until all the temporary protection has been removed. The treated surfaces shall then be thoroughly washed down with clean water and the surfaces allowed to dry before painting.

All galvanised sheeting shall be painted on the ground before erection. This will also ensure that overlaps are well protected. Where it is impracticable to apply the coating system before erection, prior consent to paint after erection shall be obtained form the Engineer.

Paint dry-film thickness shall be measured using a non-destructive thickness gauge such as the MIKROTEST or equivalent.

3.1.11.5 Inspection of Surfaces

All surfaces to be painted shall be carefully inspected by the Contractor who shall satisfy himself that the surfaces are in a perfect state to take the paintwork specified. No claim will be entertained arising from defective work due to not strictly insisting on receiving from defective work due to not strictly insisting on receiving from other trades, surfaces in a proper condition, fit to receive the type of paint specified. All surfaces shall be perfectly clean, free from dust, dirt, grease, blotches, and other blemishes before painting, staining or application of any coat.

All surfaces shall be properly prepared before painting or staining. Each coat of paint, except the last, shall be rubbed down with a fine glass paper before the next coat is applied.

Unless otherwise directed, the last coat of paint or finishing shall be done when all other work in the Contract is completed and the premises free from all rubbish and dirt. On completion, all painter's work shall be touched up where necessary and any defects made good. All paint and stain spots shall be removed and all surfaces left in a perfect condition.

3.1.11.6 Iron and Steel Surfaces

The contractor shall ensure that primed steelwork which is to be delivered to site is stacked on bearers and is clear of the ground. Wherever possible channels, angles, and other equipment and material shall be stacked so that water cannot collect on the steel.

Iron and steel surfaces shall be scrapped or shot blasted to produce a clean surface before painting. Paint shall not be applied over any surface containing traces of grit, grease, oil and the like, loose rust, loose millscale or corrosion products and foreign matter of any kind.

All air used for blast-cleaning or spraying shall be free from all traces of water and oil. When blast-cleaned, a satisfactory blast profile (i.e. anchor pattern) shall be achieved. If the abrasive used for blast-cleaning is sand, it shall be free of clay. All metal surfaces to which paint is to be applied shall be moisture dry. Paint surfaces which are to be over-coated shall be hard-dry before over-coating, unless otherwise specified.

3.1.11.7 Painting of Steel Surfaces with Polyurethane System

This system is based on a polyurethane which is cured with an Aliphatic Di-Isocyanate. No polyurethane products which are cured with Aromatic Di-Isocyanate curing agents will be acceptable. This system shall be used as specified in highly corrosive conditions and where a high quality finish is required.

a) In Fabricator's Premises

i) Surface Preparation. All steel surfaces shall be abrasive blast-cleaned to a near-white finish and shall be free from oil and grease and any corrosive contaminants.

ii) Priming. Within 4 hours of blast-cleaning, one coat of an approved zinc chromate epoxy primer shall be applied to give a minimum dry film thickness of 38 micrometers.

iii) Undercoat. One coat of an approved undercoat compatible with both the primer and the finishing coat to give a minimum dry film thickness of 50 micrometers

b) On Site Painting

After erection the following procedures shall be adopted:-

i) Damaged areas shall be repaired as per clause 15.4 above, and spot priming shall comprise all the shop coats.

ii) Undercoat. Unless the undercoat has already been applied it shall be applied before erection as described in Sub-Clause (a) iii) above.

iii) Finishing. Two finishing coats of approved polyurethane enamel in the specified colour shall be applied to give a minimum dry film thickness of 25 micrometers per coat. The two coats shall be distributable in colour and the second coat shall be applied within 24 hours of the first. The total Minimum dry film thickness for the complete paint system shall be 138 micrometers.

3.1.11.8 Painting of Steel Surfaces with Alkyd System

This system shall be used as specified on columns, roof trusses, steel window frames and door jambs, pipes, pumps and equipment in areas where corrosion is mild and a decorative appearance is required.

i) Surface.

Where a decorative rather than corrosive resistant finish is required, steel surfaces may be specified to be mechanically or hand wirebrushed to remove loose rust millscale.

Where a more corrosive resistant finish than the above is specified, all steel surfaces shall be abrasive blast-cleaned to a near white finish. The abrasive shall be free from oil and grease and corrosive contaminants such as chlorides and the like.

ii) Etch Priming. (Applicable to abravise-blasted surfaces only).

Within 24 hours of cleaning, apply one coat of an approved single pact within 4 hours of cleaning, apply one coat of an approved single pack zinc chromate etch primer to give a dry film thickness of not less than 20 micrometers.

iii) Priming. (For abrasive - blasted surfaces).

Apply one coat of an approved zinc chromate primer (green) to give a dry film thickness of not less than 38 micrometers.

For wire brushed surfaces to the clean steel apply one coat, by rush or roller, of an approved red lead primer to give a dry film thickness of not less than 38 micrometers.

b) **On-Site Painting of Steelwork**

i) Damaged Areas

Before and after erection damaged areas shall be repainted as for Clause 15.4 above, and spot priming shall comprise all the shop coats.

ii) Undercoat

Apply one coat of an approved undercoat to give a minimum dry film thickness of 38 micrometers. The undercoat may be tinted to a shade just lighter than the finishing colour using approved stainers.

iii) Finishing

Apply at least one coat of an approved high gloss enamel in the specified colour, to give a minimum dry film thickness of 25 micrometers.

The total dry film thickness for the complete system shall not be less than 100 micrometers for wire-brushed surfaces, and 120 micrometers. The total dry film thickness for the complete system shall not be less than 100 micrometers for wire-brush surfaces and 120 micrometers for abrasive-blasted surfaces.

Note: Where window frames, door jambs and the like have been painted in the fabricator's yard with red oxide primer, this shall be rubbed down and primed in accordance with Clause 15.7 (a) III.

c) **Painting of Motors, Gear Boxes and other Equipment**

i) Surface Preparation

The surfaces to be painted shall be completely free from oil, grease, rust and foreign matter of any kind.

ii) Priming

One coat of an approved epoxy primer shall be applied to form a uniform coat and to fill all porosities in the castings. After 24 hours the primer shall be wet sanded to produce a uniform smooth surface.

iii) Undercoat

One coat of suitable undercoat tinted to a shade just lighter than the finishing colour with suitable staining agent, which is compatible with the paints, shall be applied.

iv) Finishing

One coat of approved high gloss enamel in the specified colour shall be applied. N.B. Flanged faces shall receive the full specified coating.

d) **Painting of Pipes**

i) Surface Preparation

The surfaces shall be wire brushed to remove loose rust and loose millscale.

ii) Priming

An approved one coat primer shall be applied.

iii) Undercoat

Undercoat shall be specified in Clause 15.8.

iv) Finishing

The finishing coat shall be as specified in Clause 15.8 (c) (iv). The total dry film thickness for the coating system shall not be less than 90 micrometers. N.B. Flanged faces shall receive the full specified coating.

3.1.11.9 Painting of Galvanised Surfaces with Alkyd System

This paint system shall be used as specified for painting of side sheeting, ducting and plenum walls, underside of roof sheeting and the outside surfaces of rain water gutters where a decorative effect is required. It shall only be used where the corrosive conditions are mild.

i) Surface Preparation

The surfaces shall be prepared in the manner as described in Clause 15.4 above.

ii) Priming

To the cleaned surfaces apply one coat of an approved Calcium Plumbate primer.

iii) Undercoat

Apply one coat of approved high gloss enamel in the specified colour. The total paint dry film thickness for the system shall not be less than 100 micrometers.

3.1.11.10 Painting of Equipment and Steelwork with Epoxy System

i) Surface Preparation

a) **Equipment**

Where the equipment is specified to be painted after installation it shall be delivered to site unpainted. The surfaces to be painted shall be completely free from oil, grease, rust and all other foreign matter. If possible, castings shall be fettled prior to priming.

b) **Supports and Steelwork**

All surfaces shall be abrasive blast-cleaned. The abrasive shall be free from oil, grease, and corrosive contaminants such as chlorides and the like.

ii) Priming

Apply one coat of approved epoxy primer to form a uniform coat, and to fill all porosities in the casting. After 24 hours the primer shall be wet sanded to produce a uniform, smooth surfaces.

iii) Finishing

Apply two coats of an approved Epoxy Enamel in the specified colour, the second coat to be applied within 24 hours of the fist. N.B. Flanged faces shall receive the full specified coating system.

3.1.11.11 Painting of Galvanised Surfaces with Epoxy System

This paint system shall be used for painting of galvanised surfaces in highly corrosive conditions.

i) Surface Preparation

These surfaces shall be prepared in the manner as described in Clause 15.4 above.

ii) Priming

To the cleaned surfaces apply one coat of approved Epoxy Zinc Chromate Primer.

iii) Finishing

Apply two coats of approved epoxy enamel. The second finishing coat shall be applied within 24 hours after the application of the fist finishing coat, and shall be distinguishable in colour from the first. The total minimum dry film thickness for the paint system shall be 88mm.

3.1.11.12 Painting of Chequer Plate of Egg-Crate Flooring and Supporting

Frames with Epoxy Tar System

This paint system shall be abrasive blasted or acid pickled and passiveated.

i) Surface Preparation

Surfaces shall be abrasive or acid and passivated.

ii) Finishing

Three coats of approved epoxy Tar shall be applied. Consecutive coats shall be in distinguishing colours.

3.1.11.13 Painting of Galvanised Surfaces with Epoxy Tar System

This paint system shall be used for the painting of internal surfaces of galvanised gutters.

i) Surface Preparation shall be described in Clause 15.4

ii) Finishing

To the cleaned surfaces apply one coat of approved Calcium Plumbate Primer.

iii) Undercoat

Apply one coat of suitable undercoat tinted to a shade just lighter than the finishing colour with a suitable tinting agent which shall be compatible with the paint.

iv) Finishing

The Contractor shall apply two coats of approved Epoxy Tar. The second coat shall be applied within 24 hours of the first coat. The total paint dry film thickness shall be not less than 200 micrometers.

3.1.11.14 Painting of Steelwork with Chlorinated Rubber System

This system shall be used in areas where the steelwork is exposed to occasional corrosive conditions.

a) In Fabricator's Yard

i) Surface Preparation

Abrasive blast-clean all steel surfaces. The abrasive shall be free from oil, grease and any corrosive contaminants.

ii) Priming

One coat of approved chlorinated rubber undercoat shall be applied to give minimum dry film thickness of 75 micrometers.

iii) Undercoat

One coat of approved chlorinated Rubber Undercoat shall be applied to give a minimum dry film thickness of 75 micrometers.

b) **On-Site Painting**

After erection, the following procedure shall be adopted:-

i) Damaged areas shall be repaired as described in clause 15, 4 above and spot priming shall comprise all the shop coats.

ii) Finishing

One coat of approved chlorinated rubber enamel shall be applied in the specified colour, to give a dry film thickness of not less than 25mm.

3.1.11.15 Painting of Galvanised Surfaces with Micaceous Iron Oxide Pigmented Alkyd System

Unless the Engineer has given his written consent, the galvanised sheets shall be primed on the ground before erection.

i) Surface Preparation. The surfaces shall be prepared in the manner as described in Clause 1.15.4.

ii) Priming To the clean surfaces apply one coat of an approved calcium plumbate primer.

iii) Undercoat. Apply one coat of an approved Alkyd micaceous Iron Oxide structural paint.

iv) Finishing. Apply one coat of an approved Alkyd micaceous Iron Oxide structural paint in colour as specified.

(v) Damaged Areas These shall be repaired in a manner as described in clause 1.15.4

The total paint dry film thickness shall not be less than 114 micrometers.

3.1.11.16 Specialised Painter

All painting shall be carried out by a painting specialist employed by the contractor.

3.1.12 Protection of Unpainted Surfaces

Bright Machined Parts

All bright machined parts shall have a protective treatment applied by the manufacturer before despatch and this treatment shall be kept intact up to the time of handover unless it has been removed for installation. If the surface is exposed after installation a further protective coating shall be applied in accordance with the manufacturer's requirements.

3.1.13 Piping and Fittings

3.1.13.1 Materials

Pipework shall be run as shown on the contract drawings. All piping used in the construction of the works shall be straight, cleanly finished, round in cross-section, free from cracks, surface flows, laminations and other defects and free from scale.

3.1.13.2 Neatness

All pipe runs shall be arranged to present a neat appearance with where practicable shall be parallel both with one another and with the building structure, paying due regard however to the grading and venting requirements. All vertical pipes shall be plumb.

Pipes shall be bent round piers and all other projections and recesses and all offsets due to varying thicknesses of plaster, walls, floors and ceilings and other structural works were such changes in direction of piping are indicated on the drawings or not. Details of the skirting heights, sill heights and floor finishes shall be determined before any work is commenced. No pipework offsets shall be allowed on piping.

3.1.13.3 Prevention of Dirt Entering Pipes, valves etc.

All pipes, fittings, valves, etc. shall be guaranteed to be free from corrosion and internal obstruction. Pipes and fittings showing signs of corrosion shall not be fitted.

The open ends of all pipework and valves shall be protected. Wrought-iron screwed caps or plugs or plastic covers only shall be used to cover open ends. Wood, rag or paper plugs shall be used. Pipework delivered for use on the Contract Works shall be stored clear off the ground on suitable racks or stands and with the ends protected as described above.

3.1.13.4 Pipe Cutting and Cleaning

All cuts from Standard lengths of pipe shall have all burrs and swarf removed, the ends shall be trimmed square and the pipe shall be thoroughly cleaned both internally and externally before erection.

3.1.13.5 Accessibility

All valves, drains and supports shall be positioned so as to facilitate maintenance. Grouping of valves, drains union's flanges etc. shall be preferred to scatted siting. Joints shall not be formed in the thickness of walls, floors or ceilings. All pipework, valves fittings and equipment forming the piping installation shall be erected so that it can be dismantled and be readily accessible for repair and replacement.

Readily accessible means that the flange, union, etc, can be reached and worked upon either in the open or else by removal of a purpose made duct cover, manhole or similar cover. The fitting is not accessible if as fixed it cannot be manipulated.

Where pipework is to be installed in an inaccessible position it shall be welded or brazed. Unions or flanges shall be provided as equipment to facilitate dismantling. Care shall be taken to ensure that pipe flanges, valves etc. are staggered relative to similar projections or adjacent pipes and obstructions such as bemas columns and pipe supports, where necessary.

3.1.13.6 Grading of Pipework

All pipework shall be installed with continuous gradients to allow for drainage and for venting air. The rise or fall of piping in the direction of flow shall be as laid out in the schedule below (unless noted otherwise on the drawings or instructed by the Engineer.

Service	Rise or Fall	Minimum Gradient mm per meter
Water	Rise (preferred)	2
Steam	fall	4
Condensate	fall	4
Compressed Air	fall	8

3.1.13.7 Pipes laid in Ground

Pipes laid in the ground shall be assembled with care and shall be well bedded in to ensure that pipework and fittings shall not be damaged by movement of the ground. (Steel pipes shall either be supplied with factory applied bitumen/fibreglass wrapping and joints site-wrapped with bitumen tape, or the entire pipeline shall be primed with Densopaste, protected with Denso tape applied with a 55% overlay and protected with PVC wrapping securely fixed).

Excavation in ground and backfilling of trenches with sealed backfill shall be by others unless specified otherwise.

3.1.13.8 Pipes Joints

a) Types of Joints

Joints shall be screwed, welded or flanged as specified for each particular service elsewhere in this specification. Joints shall comply with relevant KBS or BS specification. All flanges shall be at 90^0 to the centre line of the pipe and the holes shall straddle the centre line.

b) Screwed Joints

Pipes for screwed joints shall be provided with taper threads to B.S. 21 Part 1. Steel pipes shall be carefully reamed out before the plain end is threaded. Threads shall be right, clean and free of burrs prior to installation. Before making a joint, the male screw thread shall be wrapped with Polytetrafluoroethene (PTFE) tape. Alternative jointing compounds shall not be used without the express approval of the Engineer.

Should a screwed joint prove defective under test or in operation, the joint shall be broken and remade, caulking will be permitted.

c) Flanged Joints - Steel Pipes

All flanges, bolts, nuts and washers shall be manufactured from mild or stainless steel to B.S. 4504 Part 2 "Table of Piped Flanges (for land use)" to the table appropriate to the pressure specified. Bolt holes in flanges shall be drilled, not punched, and spot faced for nuts.

Pipes not galvanised shall be provided with flanges crewed or welded for nominal bores of 80mm and below and with welded flanges for larger sizes. Galvanised pipes shall be provided with galvanised screwed flanges for nominal bores 80mm and below and with welded flanges for larger sizes. For galvanised piping all welding shall be carried out before galvanising.

Welded flanges shall be of the machine-faced, slip-on pattern with neck secured by welding both at the neck and bore of the flange to pipe, with the pipe finishing 3mm inside the bore. Care shall be taken not to distort the machined face. The

use of alternative flanging to the ASA standards throughout the installation will be considered upon application.

d) Flanged joints - Polypropylene Pipe

Flanges on polyprolene pipes shall be of the full face type up to and including 100mm NB, and the stub flange type with mild steel backing ring for sizes 125mm NB and above, these shall also be used on sizes below 100 mm NB upon the Engineer's request.

All drilling in flanges and backing rings shall be to B.S. 4504 Part 2 "Table of Pipe Flanges" (for land use) and the holes shall be drilled, not punched, and spot faced.

Thickness of flanges and backing rings shall be as specified for each service and the material for the flanges and stub flanges shall be identical to that of the pipe. The use of the alternative flanging to ASA standards throughout the installation will be considered upon application.

e) Gaskets and Bolts

The joint between flanges shall be made up with a joint ring graphite faced on both sides. Joint strings shall be suitable for the pipeline pressure and temperature duty and shall be identified for duty for which they are suitable. Joint rings shall be cut from sheets on site.

Bolts heads and nuts shall be hexagonal in form and washers shall be fitted beneath bolt heads and nuts. The lengths of bolts shall be such that not less than one thread nor more than 5mm of bolt protrudes through each nut when the joint is pulled up. All bolts and nuts shall be corrosion resistant.

f) Welded Joints - General

Welding technique, edge preparing and welding rods or electrodes shall be selected to be suitable in all respects for the materials and duty of the pipeline, and comply with the applicable British Standards.

Each approved welder will be assigned a reference number which shall be stamped on each weld carried out by him. During the progress of the site work ultrasonic or radiographic examination or welds may be carried out by an independent authority at the expense of the Employer Welds found to be defective shall be cut out and the pipe made good, all the contractor at his own expense, and the new welds retested at the contractor's expense.

The Contractor shall cut out and prepare for mechanical testing in the presence of the Engineer, welded joints selected by the Engineer. Cutting out and preparing of test pieces and the making good of pipelines shall be at the contractor's expenses. The total number of such tests will not exceed one per cent of welded joints except that welds found to be defective shall not form part of this total.

Should a significant proportion of the tested welds of a particular welder prove to be defective due to faulty workmanship, all welds carried out by the particular welder shall be cut out and the pipeline made good by another welder whose work has proved satisfactory.

When the general hydraulic test of the completed systems is carried out, each weld shall be lightly hammered during the time pressure is maintained. If any leaks occur at welds, the portion of weld near the leak shall be removed by cutting

or grinding and welded. Repairs shall not be attempted by caulking or fusion of surrounding metal.

g) Welded Joints - Steel Pipes

Oxy-acetylene welding shall generally be carried out in accordance with the "Recommended practise of oxy-acetylene welds in mild steel pipelines" publishing by the Heating and Ventilation Contractors Association. Metal arc welding shall be in accordance with Technical Memorandum T.3 issued by the British Welding Research Association.

The contractor shall obtain from the manufacturers tests certificates representative of welding rods and electrodes used and in accordance with B.S. 1453 or B.S. 639 respectively.

All welded joints, whether produced by oxy-acetylene flame or metal are processes shall be of prime quality. The butts shall be slightly convex with regular ripples and no undercutting, washing away or surface cavities shall be present. Notches at the root into the pipe bore in excess of 1.5mm will be accepted and the external reinforcement shall run out smoothly to the pipe surface on either side. All slag shall be removed after each run. Undercut edges, slag pockets, unsound metal and blowholes shall be chipped out as the work proceeds.

h) Welding - Polypropylene

The use of radial welding equipment for pipework joints shall be preferred. The butt machine used for the welding of polypropylene pipes shall be of a design approved by the Engineer. The machine is to carry out the butt welding of pipes from 100 mm NB up to and including 300 mm NB, must be capable of welding flanges and fittings onto the pipe, and be able to do angular butt welds for development of special bends.

The machine shall be capable of maintaining a welding force of 3500 N. The welding force to be maintained at each weld shall be 10N for each square centimetre of annular pipe surface, at a temperature of 250 plus of minus 10^0C, and therefore provision shall be made for the heating of both mating surfaces to a temperature of, and maintaining, 250 plus of minus 10^0C. All heating surfaces in contact with the piping material shall be Teflon coated.

i) Pipe Fittings

General

Fittings shall be to the standards specified elsewhere in this specification and shall be compatible in all respects with the materials and class of piping being installed. Where standard fittings are not available for the duty required, reductions on the run and to the branch shall be in all cases be made with reducing sockets. Reducing bushes and long screw connectors with backnuts shall not be used.

Bends shall preferably be of the long radius type except for the compressed air system and where space is restricted. In these cases short radius elbows may be used subject to the approval of the Engineer.

In general standard tees shall be used for all connections to pipes and headers. The welding on of sockets or branch pipes will be permitted only with the authority of the Engineer. Reducers shall be of the eccentric type, except on vertical pipelines where concentric reducers may be used. Transitions shall be swept and not abrupt. All connections to plant items shall be so arrange that the plat

can be easily disconnected. All steam, compressed air and water connections shall be made to the top of the line unless noted otherwise on the drawings.

3.1.13.9 Pipe Supports and Guides

a) General

All supports, brackets, hangers clips and other fixing accessories necessary to support all piping system from the building structure or concrete bearers shall be provided and fixed under this Contract. As far as practicable standard bought dip galvanised components shall be used. Samples of these components shall be submitted for approval prior to the placing of order.

Steam and other pipes for high temperature duties be supported on rollers and guided with rollers at changes of direction or other points where necessary to prevent pipes leaving the supports, or on hangers with spherical washers or suitably articulated to take up movement.

Brackets and supporting frames of rolled steel sections shall be fabricated in accordance with the best accepted practice to form true, rigid, neat structures. Makeshift, untidy or unstable supports will be acceptable. Woodscrews, pop-rivets, self-tapping screws, or other fastenings subject to loosening by vibration shall not be used in the fabrication or attachment of pipe supports or fixings. Spring washers, lock nuts or other locking devices shall be used on nuts. Contact between dissimilar metals shall be avoided. A pipe shall not be supported from another pipe unless approved by the Engineer or specifically called for the drawings. Where a common hanger is used for more than one pipe, provision shall be made to accommodate unequal expansion.

b) Fixing to Structure

Fixing to the building structure shall not be carried out in any manner other than that specifically approved by the Engineer for the particular area of the building and type of finish. Care shall be taken to avoid unnecessary damage to finishing.

Competent labour shall be employed to ensure that supports are correctly sized, spaced and set out prior to fixing. All work shall be made good to the Engineer's approval.

For fixing to brick and concrete, holes of correct size shall be neatly drilled using special purpose twist drills, and fixings made by rowl-bolts or equal or bolts of the grouted type approved by the Engineer. Shot fixings shall not be used nor shall fixings be made into mortar between bricks. Fixing to lightweight or hollow structures shall be by means of suitable screw anchors, toggle bolts or approved alternative.

c) Spacing of Supports

Spacing of supports for steel and copper pipes shall not exceed the centres given in the following table:

MAXIMUM SPACING OF SUPPORTS (M)

Nominal Bore of pipe (mm)	Steel Pipes		Copper Pipes	
	Horizontal	Vertical	Horizontal	Vertical

15	2.0	2.4	1.4	1.9
20	2.4	3.0	1.4	1.9
25	2.7	3.0	1.7	2.2
32	2.7	3.0	1.7	2.7
35	3.0	3.6	2.0	3.0
40	3.4	4.0	2.0	3.0
50	3.7	4.5	2.0	3.4
65	3.7	5.0	2.4	4.0
80	4.1	5.0	3.0	4.0
100	4.4	5.0	3.0	4.0
125	4.4	5.5	3.0	4.0
150	4.8	6.0	-	-
200	5.1	6.3	-	-
250	5.8	6.5	-	-
300 and over	6.1		-	-

Special supports shall be provided for all heavy items of pipeline equipment such as stainers, valves, etc.

d) Positions of Supports

Supports shall be positioned to reduce, as afar as possible, stress on joints, valves and items of equipment. Due to regard shall be given to the maintenance of accessibility and to the requirements of access to their services to be fixed in the area.
Vertical pipes shall be supported at the bottom of the riser, or at an intermediate anchor point, to allow for expansion and to carry the entire weight of the riser. Intermediate supports will act as guides. Branches from risers shall not act as supports for the riser.

e) Guides

Guides shall be provided and fixed to prevent pipes leaving their supports due to expansion compensating devices.

f) Anchor Points

Anchor points shall be provided to resist the axial stress transmitted by the flexure of expansion loops or bellows.

Anchors shall be provided complete for attachment to the structure and where applicable shall be bolted or welded to the structure or positioned accurately for grouting in by others.

On steel pipelines anchors shall consist of heavy mild steel saddles welded all round to the pipe surface and provided with exterior lugs for bolting to the building structure or thrust block. Saddles shall be not less than the thickness of the pipe to which they are welded and of width equal to its nominal bore. On polypropylene pipelines shall const of 3mm thick polypylene pads completely surrounding the pipe and then attached to the supporting steelwork with U Bolts. Alternatively, anchors may consist of slip on flanges welded to the pipe and not bolted or welded in the approved manner to rolled steel members attached to the structure.

In the case of copper pipes, anchors shall generally consist of two flanges-to-copper adaptors interposed into the pipe run at the anchor point. Mild steel sections

shall be bolted to either side of the flanged joint and attached to the building structure.

3.1.13.10 Provision for Expansion in Piping

Piping shall be installed in such a manner as to allow for thermal expansion. Where sufficient flexibility is not provided by changes of direction in the run, expansion loops or expansion compensators shall be provided. In general, fabricated expansion loops shall be used to allow 'nesting' of loops in adjacent pipes but purpose made expansion loops may be used if they are suitable for the pressure and expansion duty.

Expansion compensators shall be used only on Engineer's approval and then must be suitable for the working conditions and installed in full compliance with the manufacturer's recommendations regarding guiding, alignment and all other respects of erection and commissioning.

Care shall be taken that the compensators are not overstressed during pressure testing of pipelines, and if necessary, made-up spool-pieces of pipe shall be substituted during these tests.

All supports shall provide for the expansion movement in pipes. Hangers shall be free to 'swing' and rigid supports shall be of the roller type or pipes shall have 'slides' of rolled steel sections welded to them to permit free movement on supports without damage to the pipe or insulation.

3.1.13.11 Pipe Sleeves

a) General

Pipes shall not be build rigidly into walls, floors, ceilings, footings or under roads. Sleeves shall be provided under this contract, unless noted otherwise on the drawings, for building-in by others at all such locations.

The Contractor shall provide all sleeves in advance of building requirements and shall be responsible for ensuring that sleeves are properly positioned, aligned and built-in. Rectangular or circular openings will be provided by the builder in structural concrete slabs and it shall be the Contractor's responsibility to supply, position, align and secure sleeves, ready for casting in by the builder. Puddle flanges shall be provided for building-in where pipes pass through bound walls or below ground.

b) Sizes

Sleeves shall not be used as pipe supports and a free annular space of at least 6mm shall be allowed between a pipe and its covering, if any and its sleeve. In lad bearing walls or footings the annular space shall be of a minimum of 25mm. Where pipes change direction, sleeves shall be oversized to accommodate expansion movement of the pipe.

Sleeves shall extend through walls to within 5mm of the finished surface on both sides to allow for flush caulking over the sleeve with water proofing compound. Vertical sleeves shall be project 50mm above the finished floor level and end 5mm above the underside of the slab. Polystyrene or similar material spacer discs shall be provided to locate the sleeve during casting of concrete, so that when the discs are removed the caulking clearance is left.

c) Materials

Sleeves in load-bearing walls and under roads shall be of cast-iron. Other sleeves shall be of standard galvanised pipe cut to length. Sleeves shall properly cut, reamed and trimmed square. Sleeves for casting in the concrete shall be securely fixed to form work by the contractor before concrete is poured. The annular space between each pipe and sleeve shall be firmly caulked at each end with polysulphide or equal waterproof compound which does not set hard.

3.1.13.12 Ventilation and Draining of Pipework

a) General

Sufficient provision shall be made at high points of piping and equipment for ventilation and at low points for draining. Drains shall be provided on all major sections of pipework so that they can be drained without draining the entire system. Vents shall be adequate to ensure that airlocks cannot form in the system.

b) Manual Vents

Manually operated air release points shall be provided on all water piping to permit the initial charging of the system. Each point shall comprise an air bottle fitted on tope of the pipe and with a welded cap and 15mm discharge pipe run to a full way air-release valve at hand level and then to discharge at an agreed point. Pipes up to 40mm shall have air bottles of the same diameter as the pipe, air bottles for larger pipes shall be 40mm diameter. All air bottles shall be 300mm long.

c) Automatic Vents

Automatic vents shall be provided with lockshield isolating valves and 15mm discharge pipes run to approved positions. Automatic vents shall be as equal and approved. Steam mains shall be provided with thermostatically operated air vents at all high points in the system to allow for quick warming up of the system after a shutdown.

d) Drain Points

Steam lines shall be provided with steam trapped condensate drain points at all low points at least every 40 meters on long lines. Drain pockets of diameter equal to that of the steam pipe shall be provided on lines up to 100mm diameter and of diameter 50mm less than the pipe diameter for pipes above 100mm. The condensate line from the trap shall enter the top of the condensate in the header or main.

Water lines and equipment shall be drainable through 15mm lockshield isolating valves and discharge pipes run to approved positions. Compressed air lines shall have trapped automatic condensate drains at all low points in the system.

3.1.13.13 Valves and Strainers

a) General

Valves and strainers shall be of the types specified elsewhere in this specification, of best quality and suitable in all respects for the duties for which they are intended.

b) Valves

Except where loose key or lever operation is specified, all manual valves shall be provided with handweels. Closing shall be by clockwise rotation of the handwheel. All valves shall conform to the following design and materials specification:

Bronze	B.S. 1400 LG-2C or A.S.T.M.B. 62-63
Cast Iron	B.S. 1452 GR14C or A.S.T.M.A. 445-63T
Ductile Iron	B.S. 1504-161A or A.S.T.M.A. 216 Grade WCB.

Mixing, thermostatic and other automatic valves shall be of 'fail-safe' design and where practicable self-acting.

3.1.13.14 Pressure Reducing Valve Sets

Pressure reducing valves shall be as equal and approved. They shall be installed complete with separator, isolating valves, strainer, pressure gauges, by-pass and control valves, etc and a pressure relief valve mounted on the low pressure side, sized in accordance with accepted practice, to fully protect any equipment in the event of failure of the pressure reducing valve. The relief valve shall be set, and all gauges shall be in place before steam is allowed to pass through any P.R.V. set. The discharge pipe from the pressure relief valve shall be run to the nearest drain point approved by the Engineer.

3.1.13.15 Instruments and Gauges - Pipework

Where shown on the drawings pressure gauges and thermometers shall be provided.

Pressure gauges shall be of the dial type with minimum 100mm dials and scaled to 50% in excess of maximum anticipated pressure.

They shall be fitted with isolating valves, gauge cocks and syphon bends and installed on extension pipes extended to a convenient position and properly supported. Gauges shall be tested against a deadweight tester in the presence of the Engineer and shall be accurate to within 2% over the working range. Pressure gauges shall be calibrated in kpa. Blow off holes in gauges shall be aimed in a safe direction, away from the operator. Thermometers shall be of brass mercury-in-glass type at least 150mm long and installed in thermometer pockets so that they may be removed without draining the pipeline. Angle or staring pattern thermometers as appropriate shall be used. Calibration shall be in ^{0}C.

3.1.13.16 Identification and Labelling

a) Pipework

All pipework, both insulated and uninsulated shall have coloured identification band and direction arrows marked on in clearly visible positions at maximum spacings of 6 meters on all runs. This spacing shall be reduced if necessary to ensure that each pipe and branch-passing through any form of space is coded, each branch has at least one coding band and there shall be a coding band within one meter of each valve, plant connections and flange or union.

The colours to be used for banding and arrows shall be agreed with the Engineer but shall comply as far as is possible with B.S. Bands and arrows shall be neatly stencilled using paint system compatible with the surfaces to which they are to be applied. Bands will consist of a base colour band and identification bands of contrasting colours and each 50mm wide.

All insulated pipework other than stainless steel, copper galvanised and polypropylene, shall be painted over the entire length prior to insulating with an approved anti-corrosive inert bituminous based paint, suitable for use on steam pipework. All other pipework shall be pained and code banded, as indicated elsewhere in this specification. On bare polypropylene, identification and direction of flow arrows shall be made by the sue of coloured adhesive tape (of a type approved by the Engineer) banded around the pipe in accordance with the foregoing positions.

b) Equipment Items

All plant and equipment items shall be labelled in a clearly visible position with the items name and, in the case of duplicate items, a number. Plant labels shall correspond with designations on the drawings. Labels shall be of rear engraved and filled 'trefoiled'' of sandwich thermosetting plastic with black lettering on white background. Lettering size shall be at least 6mm.

c) Valves

Section isolating valves and valves in service areas shall be labelled to identify the zones they serve and with an abbreviated code to identify the service. A schedule of labels required will be provided by the Engineer.

Valve labels shall be sandwich thermosetting plastic with black lettering on a white background secured to the valve stem with a light chain. Sample labels shall be submitted for approval.

3.1.14 Pipework System Materials

3.1.14.1 General

All materials shall be suitable for the temperature rating of the system in which they are installed. These ratings are given in the detailed specification.

3.1.14.2 Steam Reticulation and Condensate Return

a) Piping

150 mm and below	B.S. 1387, heavy class seamless, plain ends prepared for welding.
Above 150 mm	B.S. 3601/22 or AP1 5.L Sch 20 with wall thickness 6,35mm min.

b) Fittings

Steel but-weld fittings to B.S. 1640 or equal, wall thickness not less than pipe thickness.

c) Flanges

B.S. 4504

d) Valves

Steam Isolating Valves

Upto to 40mm	globe valves with cast bronze or ductile iron bodies, replaceable seat, bronze or stainless steel trim, union bonnet pattern and screwed by B.S. 21.
50mm to 150mm	globe valves with cast bronze or ductile iron bodies, replaceable seat, bronze or stainless steel trim, union bonnet pattern and flanged to B.S. 4504.
200mm and above	globe valves with cast bronze or ductile iron bodies valves with cast iron or ductile iron bodies replaceable seat, bronze or stainless trim, rising spindle pattern and flanged to B.S. 4504.

Steam Regulating Valves

These valves shall be needle valves of materials specification similar to isolating globe valves.

Condensate Valves

Upto to 40mm	Cast bronze of ductile iron bodies, replaceable seat, bronze or stainless steel trim, union bonnet pattern and screwed by B.S. 21.
50mm to 150mm	Cast iron or ductile iron bodies, replaceable seat, bronze or stainless steel trim, union bonnet pattern and flanged to B.S. 4504.

Gate Valves

Upto to 40mm	ductile iron bodies, replaceable seat, bronze or stainless steel trim, union bonnet pattern and screwed by B.S. 21.

Non return valves

Upto to 40mm	bronze swing check screwed to B.S. 21.
50mm to 150mm	ductile iron bodies, replaceable seat, bronze or stainless steel trim, union bonnet pattern and flanged to B.S. 4504.

Sight Glasses

Bronze/Gunmetal bodies, single window combined sight-check valves may be used only where installed safe from Mechanical damage.

Steam Traps

For line draining	Inverted bucket steam trap (stainless steel trim).
For equipment	Ball float steam trap to correct pressure range or equal, unless otherwise specified on the drawings. (Stainless steel trim)

Air vents

Thermostatic vent depending on pressure.

Pressure Reducing Valves

Diaphragm pilot operated reducing valve. Stainless steel trim, phosphor bronze diaphragm, correctly sized for flor rate and with high turn-down accuracy and tight shut-off.

Strainers

Up to 50mm	Malleable or cast iron body, stainless steel screen and screwed connections to B.S. 21
65mm and above	Cast Iron or S.G. iron body, stainless steel screen and fanged connections

3.1.14.3 Cold and warm 45^{0}C Water Reticulation

a) Piping

Piping - Steel

Up to 150mm	Galvanised steel piping to B.S. 1387, medium class, screwed and socketed.
Above 150mm	B.S. 3601/22 or API equivalent, 4.5mm wall thickness with plain ends for welding. To be hot dip galvanised after fabricating.

Piping - Polypylene

Up to 25 mm	1 500 kpa rated. Extruded from polypropylene - ethylene grade and shall be heat and U.V. stabilised to B.S. 4991 or ISOR 160.
32mm and above	600 kpa rated for cold water and 900 kpa for warm water. Extruded from propylene acetylene and shall be heat and U.V. stabilised to B.S. 4991 or ISOR 160.

b) Fittings

Fittings -Steel

Up to 100mm	Fusion welded and of exactly the same material as the polypropylene piping.
Above 125mm	butt welded or fusion welded and of exactly the same material as the polypropylene piping.

Fittings -Polyprolene

Up to 150mm	Galvanised malleable iron fitting.
Above 125mm	flanged to B.S. 4504. Fabricated or forged steel.

c) Flanges

Flanges - Steel

50mm to 150mm	B.S. 4504 screwed and galvanised.
Above 125 mm	Butt welded or fusion welded and of exactly the same material as the polyprolene piping.

Flanges - Polypropylene

Full face polypropylene or polypropylene stub flanges with mild steel backing rings drilled to B.S. 4504.

d) Gaskets

6mm rubber insertion.

e) Valves

Globe

Up to 40mm	bronze body, bronze or stainless steel trim, replaceable seating, and screwed to B.S. 21.
65 and above	cast iron body, bronze or stainless steel trim, replaceable seating flanged to B.S. 4504.

Gate

Up to 40mm	bronze body, bronze or stainless steel trim, replaceable seating, and screwed to B.S. 21.
65mm and above	cast iron body, bronze or stainless steel trim, replaceable seating flanged to B.S. 4504.

Check-valves

Up to 40mm	bronze body, bronze or stainless steel trim, replaceable seating, and screwed to B.S. 21.
65 and above	cast iron body, bronze or stainless steel trim, replaceable seating flanged to B.S. 4504.

Ball valves

Up to 50mm	chrome plated brass, teflon seat rings screwed to B.S. 21, with fixed operating handle.

Restrictor Valves

Ball stop with c=screw driver operation as supplied by castle Brass or equal.

f) Strainers

Up to 50mm	Malleable iron bodies, stainless steel screen and screwed connections to B.S. 21.
65 and above	cast iron or S.C. iron bodies, stainless steel screen and flanged connections.

3.1.14.4 Hot water (85^0C)

a) Piping

Piping - Steel

Stainless steel type 304 L to A.S.T.M specification A312. Wall thickness 2mm minimum longitudinally welded. NOTE All welds made in the pipe during manufacture shall be suitably cold worked to relive stresses and normalize crystal structure in order to prevent stress corrosion occurring while the pipe is in service at 85^0C. All joints in run and to fittings to be welded, using a suitable inert gas technique.

Piping - Polypropylene

Up to 25mm	1,500 kpa rated. Extruded from polypropylene - ethylene grade and shall be U.V. stabilised, to B.S. 4991 or ISOR 160.
32mm and above	1,500 kpa rated. Extruded from polypropylene - ethylene grade and shall be U.V. stabilised, to B.S. 4991 or ISOR 160.

Piping - Copper

Type CU DHP complying with B.S. 2051

b) Fittings

Fittings - Steel

Stainless steel type 304L welded.

Fittings - Polypropylene

Up to 100mm	Fusion welded of exactly the same material and pressure rating as the polypropylene piping.
125mm and above	Flanged and of exactly the same pressure rating and material as the polypropylene piping.

Fittings - copper

Up to 50mm	Capillary to B.S. 864 or screwed to B.S. 21. Above 50mm flanged, brazed or bronze welded.

c) Flanges
Flanges - Steel

Stainless steel type 304L flat face - slip-on, to B.S. 4504.

Flanges - Polypropylene

Full face polypropylene or polypropylene stub flanges with mild steel backing rings drilling to B.S. 4504.

Flanges - copper

Bronze or gunmetal brazed or welded to pipe, B.S. 4504. Brass bolts, nuts and washers to be used.

d) Gaskets

6mm Rubber insertion.

e) Valves
Globe (throttling valve only)

Up to 40mm bronze body, bronze or stainless steel trim, replaceable seating and screwed to B.S. 21.

50mm and above Cast iron body, bronze or stainless steel trim, replaceable seating and screwed to B.S. 4505.

Gate

Up to 40mm bronze body, bronze or stainless steel trim, replaceable seating and screwed to B.S. 21.

50mm and above Cast iron body, bronze or stainless steel trim, replaceable seating and screwed to B.S. 4505.

Valves

Up to 40mm bronze body, bronze or stainless steel trim, replaceable seating and screwed to B.S. 21.

50mm and above Cast iron body, bronze or stainless steel trim, replaceable seating and screwed to B.S. 4505.

Check Valves

Up to 40mm bronze body, bronze or stainless steel trim, replaceable seating and screwed to B.S. 21.

50mm and above Cast iron body, bronze or stainless steel trim, replaceable seating and screwed to B.S. 4505.

Ball Valves

Up to 40mm chrome plated brass, teflon seat rings, screwed to B.S. 21 with fixed operating handle.

Restrictor Valves

Ballstop with screwdriver option.

Finish - Machined brass unless specified otherwise.

f) Strainers

Up to 50mm Malleable iron body, stainless steel screen and screwed connections to B.S. 21 65mm and above malleable iron body, stainless steel screen and flanged connections

3.1.14.5 Hot water (85^0C)

a) Piping

Piping - Steel

Up to 150mm Steel piping (Black) to B.S. 1387 medium class plain ends for welding.

Above 150mm Steel piping to B.S. 3601/22 or API Equivalent 4, 5 mm wall thickness plain ends for welding.

Piping - Polypropylene

Up to 100mm 1,500 kpa rated. Extruded from polypropylene - ethylene grade and shall be U.V. stabilised, to B.S. 4991 or ISOR 160.

b) Fittings

Fittings - Steel

Butt-weld fittings to B.S. 1640.

Fittings - Polypropylene

Up to 100mm	Fusion welded of exactly the same material and pressure rating as the polypropylene piping.
125mm and above	Butt welded or fusion welded and of exactly the same pressure rating and material as the polypropylene piping.

c) Flanges

Flanges - Steel

B.S. 4504 wrought steel, flat faced, slip on.

Flanges - Polypropylene

Full face polypropylene or polypropylene stub flanges with mild steel backing rings drilling to B.S. 4504.

d) Valves

Up to 50mm	ball valves with bronze body, hard chromed bronze ball, teflon seats, screwed, to B.S. 21. Alternatively forged steel body, stainless steel ball.
65mm and above	globe valves with cast iron body, bronze seating rising spindle, flanged to B.S. 4504.

Check Valves

Non-slam double swing check valves with cast iron body, bronze flaps and neoprene seat, fitted between flanges.

Traps

15mm	Automatic trap with internal strainer, or approved equal.
20mm	Angle strainer fitted before trap or approved equal. All traps to have balance pipe.

Filter, Regulator, Lubricator Sets

8 mm	Complete with pressure gauge and manual operated drains on filter unit.
	10, 15, & 25mm complete with pressure gauge and manual operated drains on filter unit.

Filter and Regulator

As for filter, regulator and lubricator sets but without lubricator.

e) Moisture separators

Up to 40mm	Vertical type screwed inlet and outlet to B.S. 21 complete with drain trap.
32mm and above	Horizontal type flanged connections, complete with drain trap.

3.1.14.6 Chilled Water Pipework

a) Piping

upto 80 mm	B.S. 1307 medium class, screwed and socketed.
100mm to 150mm	B.S. 1387 medium class. Plain ends prepared for welding.
Above 150 mm	B.S. 3601/22 or API equivalent with wall thickness 5 mm minimum. Plain ends prepared for welding.

b) Fittings

Steel butt-weld fittings to B.S. 1640 or equal, wall thickness not less than pipe thickness or screwed malleable iron fittings as applicable.

c) Flanges B.S. 4504

d) Gaskets Rubber insertion

e) Valves
Cocks - Balancing Valves

Upto to 50mm	bronze body, bronze or stainless steel trim, replaceable seating and screwed to B.S. 21.
65mm and above	Cast iron body, outside screw and yoke, bolted bonnet, replaceable seating, rising stem incorporation back seal, bronze or stainless steel trim, and flanged to B.S. 4504.

Gate

Upto to 50mm	bronze body, bronze or stainless steel trim, replaceable seating and screwed to B.S. 21.
65mm and above	Cast iron body, outside screw and yoke, bolted bonnet, replaceable seating, rising stem incorporation back seal, bronze or stainless steel trim, and flanged to B.S. 4504.

Check Valves

Upto to 50mm	bronze body, bronze or stainless steel trim, replaceable seating and screwed to B.S. 21.
65mm and above	Cast iron body, bronze seating, swing-check, flanged to B.S. 4504

f) Strainers

All strainers to be installed as follows:

Up to 50mm diameter screwed to B.S. 21. 50mm and over flanged to B.S. 4504.

Screwed ends Bronze body, stainless steel screen.

Flanged ends Cast Iron body, stainless steel screen.

3.1.14.7 Condenser Water Pipework

a) Piping

upto 80 mm	B.S. 1307 medium class, screwed and socketed.- galvanised.
100mm to 150mm	B.S. 1387 medium class. Flanged ends - galvanised after manufacture.
Above 150 mm	B.S. 3601/22 or API equivalent with wall thickness 5 mm minimum, flagged ends - galvanised after manufacture.

b) Fittings

Up to 80 mm	Galvanised malleable iron fittings to B.S. 143 screwed to B.S. 21.
Above 80 mm	Flanged to suit.

c) Flanges

Up to 80 mm	B.S. 4504 screwed and galvanised.
Above 80 mm	B.S. 4504 slip on. Pipe and Flange galvanised after manufacture.

d) Gaskets Rubber insertion

e) Valves

Valves shall be all as specified for chilled water, 17.18.6 e.

f) Strainers

Strainers shall be all as specified for chilled water 17.18.6 e.

3.2 GENERAL TECHNICAL SPECIFICATION - COMMISSIONING

3.2.1 General

Before any commissioning work takes place, the sub-contractor shall submit a set of schematic commissioning drawings showing duct runs, and other equipment, air flows, water flows and controls. These drawings to be accompanied by the method proposed for commissioning of the plant, as by the method proposed for commissioning of the plant, as well as the number of people involved, their names and experience. The Engineer's approval on the above item is essential before any commissioning takes place.

3.2.2 Maintenance Manuals

The Sub-Contractor shall provide, before any commissioning work starts, three copies of the maintenance and operating manuals for the plant supplied. These manuals shall be sewn and bound in book form with hard plastic covers to withstand constant use; and shall be properly indexed to facilitate quick references. Prior to the submission of the three copies mentioned above the Sub-Contractor shall submit one draft copy of the maintenance and operating manuals for approval. The works shall not be considered to be completed for the purposes of taking over until such manuals have been supplied to the Engineer, and subsequent equipment test results have been included in them.

The manuals shall include:-

(a) A list of recommended servicing tools and specialist plant.

(b) A list of recommended spares necessary for a period of 2 years operation.

(c) Exploded drawings or spares lists from which every item of every place of plant can be positively identified of each item of plant.

(d) A list of giving the name and address of the manufacturer of each item of plant.

(e) A copy of all test certificates obtained with the plant.

(f) A list of recommended lubricants.

(g) A preventive maintenance programme for all plant.

(h) Operating instructions for each item of plant.

(i) Performance data, equipment tests and characteristics curves.

3.2.3 INITIAL TESTING AND PLANT COMMISSIONING

3.2.3.1 Initial Testing

(a) Pressure Testing - Piping

All pipework system shall be pressure tested by filling with water and raising the pressure to 1.5 times working pressure. They shall then be left for a period of at least one hour during which all joints must remain water-tight. Any fault found during the pressure test shall be remedied and the test reapplied until the same is dealt with completely.

The pipework shall be tested in sections to suit the construction programme and all services in concealed locations shall be tested before they are finally concealed. No insulation shall be applied before tests have been carried out.

The Sub-Contractor shall provide all test equipment and all additional items such as toes, valves, drain fittings, etc. which are necessary to enable the systems to be treated in sections. Each test shall be witnessed by the Engineer or his nominated agent and also a signed certificate of approval shall be obtained.

(b) Draining and Cleaning

On completion of the pressure test on a section of pipework the water used for testing shall be drained away as quickly as possible to remove as much dirt and dross as possible. After completion for a pipework circuit the circuit shall be flushed through to remove all pipe scale, dress and similar material.

(c) Pressure Testing - Ducting

See section on ducting.

(d) Insulation Tests

All electrical wiring and controls integral with the plant supplied shall be subjected to insulation tests. All instrument and other equipment required for the tests shall be provided by the sub-contractor.

(e) Drives

All drives shall be run and tested for direction rotation and correspondence of alignment.

3.2.3.2 Plant Commissioning

The Sub-Contractor shall check over and test and satisfy himself that all items of plant are correctly assembled and aligned before start-up. This work is to be carried out by skilled commissioning Engineers who are completely familiar with the plant involved.

The Engineer shall vitreous plant commissioning as required by him and the contractor must advise the Engineer prior to any commissioning work taking place.

On completion of the plant commissioning, the Contractor shall provide written confirmation to the Engineer that he has completed all commissioning work and is satisfied that the items of plant are operating satisfactorily.

3.2.3.3 Test of Completion

No completion of the Sub-Contractor's initial testing and commissioning as specified above, the plant shall be put into normal operation and the final adjustment of the plant shall be made. Thereafter the Tests on completion shall be carried out to ensure that the plant will fulfill the function for which it has been designed. These shall extend for a period of at least four weeks and shall include the following:

(a) Simulated tests for all alarm and safely cut out equipment.

(b) Simulated tests on automatic controls.

(c) Capacity tests to ensure that the plant supplied will handle the quantities specified.

The Engineer reserves the right to witness all tests.

The Sub-Contractor shall utilise the Engineer's manual Equipment performance and capacity.

The Sub-Contractor shall at his own cost render all assistance and supply all labour, appliances and any other materials, as may be required to carry out these tests. All instruments shall be accurately calibrated before the tests begin.

On completion of the whole of the tests and when the sub-contractor is satisfied that the entire plant is operating satisfactorily and will fulfil the function for which it has been designed, he shall submit to the Engineer triplicate copies of all tests records and charts together with reports on all the tests called for in this specification. The Engineer shall reserve the right to ask for previous tests in order to prove that the operation of the plant is satisfactory and in accordance with the specification and drawings.

The Sub-Contractor shall be responsible for the proper operation and running maintenance of the plant throughout the period of the tests. The Sub-Contractor shall provide full time experienced commissioning Engineers and artisan staff during the entire testing period.

At the commencement of and during the whole of the testing period the Sub-Contractor shall be required to have stored on site all essential spares and tools considered necessary to enable repair work of defective parts to be carried out immediately in the event of a breakdown.

The operation and maintenance manuals shall be completed and handed over to the Engineer before the start of any commissioning work and in any case, prior to the issuing by the Engineer of the taking-over certificates. The period of maintenance shall be deemed to have started upon the date of issuing of the taking-over certificate.

3.2.4 OPERATOR TRAINING PERIOD

The Operator Training Period on the whole of the works or on any part thereof shall commence at the date to be fixed after the issue of the taking over certificate and mutually agreed with the Engineer. This period shall continue for a period sufficient to ensure that the operations are fully conversant with the functions they are to perform, but shall not exceed a period of 5 days.

The Contractor shall provide full-time instructions during the entire operator training period who shall be fully experienced in the class of work and shall be capable of training the operating and maintenance staff in the duties they are to perform.

3.2.5 PERIOD OF MAINTENANCE (Defects Liability)

The expression period of maintenance shall mean a period of 12 months from the date of taking over in accordance with Clause 3.3 hereof.

PART D:
PARTICULAR SPECIFICATION

FOR

MECHANICAL VENTILATION, AIR CONDITIONING AND REFRIGERATION SERVICES

4 PART D - PARTICULAR SPECIFICATION

FOR

MECHANICAL VENTILATION, AIR CONDITIONING AND REFRIGERATION SERVICES

4.1 Particular Conditions

4.2 Location of Site

The site of the proposed Sub-Contract works shall be at The Nairobi Hospital along Argwings Kodhek Road.

4.3 Description of the Project

The project comprises of Conversion of Meeting Rooms on Third Floor of Anderson Centre to Doctors Clinics.

4.4 Commencement of Works

The Sub-Contractor in submitting his tender shall be deemed to have included for commencing any necessary work on site at such time as will comply with the Main Contractor's programme.

4.5 Climatic Conditions

The following climatic conditions apply at site of the works and all plant, equipment, apparatus, materials and installations shall be suitable for these conditions.

Where not otherwise stated, all rating of plant, equipment and apparatus shall be interpreted at site ratings and NOT sea level or other ratings.

Maximum temperature	31.5^0C
Minimum temperature	24^0C
Average Diurnal Range	11.7^0C
Relative humidity range	48-93%
Altitude	10.5m above sea level
Latitude	01 19’S
Longitude	36^0 49'E
Mean Rainfall	911mm per year.
Maximum Rainfall	1475mm

The Sub-Contractor shall be deemed to have taken account of the above details in his prices and his planning of the execution of the works.

4.6 Scope of the Sub-Contract Works

The Sub-Contract shall comprise the supply, delivery, erection, testing, commissioning and setting to work of mechanical ventilation and air conditioning systems detailed in this Specification and the accompanying Contract Drawings.

The Sub-Contract Works shall include for all appurtenances and appliances not particularly called for in this Specification or on the Contract Drawings but which are necessary for the completion and satisfactory functioning of the Sub-Contract Works.

No claims for extra payment shall be accepted from the Sub-Contractor due to his failure to adhere to the above requirements. It is deemed that if, in the opinion of the sub-contractor at the time of tendering, there existed a difference between the Specification and the Contract Drawings that the Sub-Contractor clarified this difference with the Engineer before tendering.

The works to be installed under the Sub-Contract shall comprise air conditioning but not restricted to mechanical ventilation systems, air conditioning and refrigeration systems as described and shown on the drawings.

4.7 Design Conditions

The air conditioning systems are designed to maintain 23^0C internal conditions with an external ambient temperature of 31.5^0C db.

4.8 Air Conditioning System

Natural ventilation shall be encouraged as much as possible with mechanical ventilation and air conditioning being adapted to suit specific operational requirements.

The proposed air conditioning shall vary from complex AHUs systems to fan coil units depending in room occupancy, sound levels, energy saving considerations and environmental impact shall be carefully considered at design stage. Care shall be taken to ensure fresh air replenishments and filtration to acceptable limits. In the conference and low level grilles shall be incorporated to handle foul smell and solid particles.

The air handling units and indoor fan coil units shall be chosen and designed to suit duty requirements for the areas served. Care shall be exercised to ensure uniform distribution of air to avoid direct draughts to the occupants and also avoiding hot and cold spots. Air freshness shall also be critically addressed in the designs. The rooms and especially the conference rooms etc. shall be maintained at positive pressure to preclude dust ingress.

Air discharge units (grilles) and ducts shall be designed to ensure silent operation with attenuation incorporated in the designs. This is to ensure a serene atmosphere required. Grille patterns and finishes shall be selected in close liaison with the Architect to ensure harmony with the interior décor.

Maintenance and environmental considerations shall be critically addressed to ensure that equipment incorporated in the works are maintainable. Only environmentally friendly units, with local representation and spare parts distribution and from reknown models with proven past performance shall be considered. Systems with ozone depleting C.F.C based refrigerants shall not be considered.

Extract systems for landlocked cloak and changing rooms will be proposed to enhance air flows and remove odours. Areas with good cross ventilation shall be kept under natural ventilation.

High precision Air conditioning units shall be proposed in sensitive ICT and equipment rooms with duty and standby units to ensure reliability and long equipment live. The cooling loads shall be worked out in liaison with specialist equipment suppliers to ensure right sizing and appropriate controls. The designs shall allow for reasonable future expansion. All the air conditioning shall be BMS compliant for ease of monitoring, scheduled maintenance and operation.

All advantages shall be exploited for maximum benefit while limitations shall be carefully analysed and mitigated in design.

4.9 Extract Fans

These shall be similar or equal to WOODS fans manufactured by Woods of Colchester of the United Kingdom. The fan to be standard length type with a casing that covers the overall length of the impeller and the motor.

4.10 Hoods

The hood shall be fabricated from 1.8mm thick Aluminium sheet steel, covering the entire Hood. 'Vokes' filters will be included each size 500 x 686 x 565mm. Hoodlights as PL bulkhead fittings, 18 Watts, or equal and approved.

The hood should be installed at a minimum height of 1900mm from the finished floor level. A 75 x 40mm grease drain channel will be incorporated in the hood inclusive of 8 No. drain plugs. Hoods designs shall be issued on approval from the Client.

5 PART D - BILLS OF QUANTITIES

CONTENTS

5.1 GENERAL NOTES TO TENDERERS

1. The Bills of Quantities form part of the contract documents and are to be read in conjunction with the contract drawings and general specifications of materials and works.

2. The prices quoted shall be deemed to include for all obligations under the sub-contract including but not limited to supply of materials, labour, delivery to site, storage on site, installation, testing, commissioning (**excluding 16% VAT**).

3. All prices omitted from any item, section or part of the Bills of Quantities shall be deemed to have been included to another item, section or part thereof.

4. The brief description of the items given in the Bills of Quantities are for the purpose of establishing a standard to which the sub-contractor shall adhere. Otherwise alternative brands of **equal** and **approved** quality will be accepted.

5. Should the sub-contractor install any material not specified here in before receiving **written approva**l from the Project Manager, the sub-contractor shall remove the material in question and, **at his own cost**, install the proper material.

6. The grand total of prices in the price summary page must be carried forward to the **volume 1**.

7. The Bills of Quantities are divided generally into three sections:-

a. Contractual Requirement – Bill 1

The sub-contractor shall study the conditions and make provision to cover their cost in this Bill. The number of contractual items to be priced by the Tenderer have been limited to tangible items such as site office, temporary works and others. However the Tenderer is free to include and price any other items he deems necessary taking into consideration conditions he is likely to encounter on site.

b. Installation Items – Other Bills

The brief description of the items in these Bills of Quantities should in no way modify or supersede the detailed descriptions in the contract Drawings, conditions of contract in volume 1 and specifications. The unit of measurements and observations are as per those described in the contract documents.

c. Summary

The summary contains tabulation of the separate parts of the Bills of Quantities carried forward with provisional sum, and any prime cost sums included. The sub-contract shall insert his totals and enter his grand total tender sum in the space provided below the summary.

This grand total tender sum shall be carried forward to main summary of volume 1 of the main works.

PROPOSED LABOUR WARD RENOVATIONS AT NAIROBI HOSPITAL

AIR CONDITIONING & MECHANICAL VENTILATION SYSTEM

BILLS OF QUANTITIES

SECTION D.W. (I) TITLE: PRELIMINARIES & CONTRACTUAL REQUIREMENTS

Item	Description	Unit	Qty	Rate	KShs.
	PRELIMINARIES & CONTRACTUAL REQUIREMENTS				
A.	Preparation of working drawings, printing and distribution.	Sum			-
					-
B.	Preparation of 'As Installed Drawings", printing and distribution as specified. Drawings to include:				-
	(a) Blue Prints - 4 sets of each.	Sum			-
	(b) AutoCAD on Flash Drive (5 GB) – 2 No.	Sum			-
	(c) Operational Instructions, manuals and test certificates	Sum			-
C	Allow for any other preliminary stated in the conditions of contract	Sum			-
D	Any other item necessary to complete the installations in this section (please state)	Sum			-
	Carried to Main Summary Page				-

SECTION D.W 1: LABOUR WARD- AIR CONDITIONING - OUTDOOR UNITS

Item	Description	Unit	Qty	Rate KShs.	Cost KShs.
1	**OUTDOOR UNITS**				
	VRV AIR CONDITIONING SYSTEM : CORPORATE CENTER FINANCE OFFICES				
	Supply, install, test and commission the following air conditioning units. The units must be wired for automatic resetting in case of power failures.				
	'VRV/VRF System as DAIKIN, LG, TOSHIBA or an approved equivalent", inverter heat pump type air conditioning system or equal and approved comprising outdoor/indoor units including supports and all safety devices of high pressure switch, fan motor driver overload protector, inverter overload protection over current relay and PCB fuse all as described here below. Indoor units to be complete with wired remote controllers.				
	The Outdoor Units.				
A	These shall be as "DAIKIN , TOSHIBA, LG ARUM100LTES" or an approved equivalent" VRV/VRF system to have heat recovery and to be a **3 PIPE SYSTEM** for provision of simultenous heeating and cooling. **Cooling Capacity:** 28kW **Heating capacity:** 28kW Dimensions (HxWxD in mm) approx. 1690x930x760),Weight approx.215Kg. The compressor to be of the hermetically sealed scroll type with power input 3ph, 380 – 415V, 50Hz supply. Compressor to be for use with CFC FREE refrigerant. (**Note that R22 and any other ozone depleting refrigerant will not be acceptable)**. The unit shall be complete with function unit to manufacturer's specification, safety devices including HPS, fan driver overload protector, over current relay, inverter overload protector, PC Board fuse,Building Management System (BMS) interface etc.	Set	1		-
B	Supply of 3 Phase Monitor / Voltage Surge Protection Device	No.	1		-
	Sub-total carried to next page				-

SECTION D.W 1: LABOUR WARD- AIR CONDITIONING - OUTDOOR UNITS

Item	Description	Unit	Qty	Rate KShs.	Cost KShs.
	bal b/f				-
	Main Line: Refrigerant Pipe Work				
C	Supply, deliver & install of refrigeration copper pipe work complete with 25mm Armoflex Rubber Insulation for suction/liquid line including all the fittings, 'Y' Joints, Distributors etc. size19.1 mm to 41.3 mm. Rate includes the provision of 150mm cable trays	LM	120		-
	Electrical Works				
D	Inter connecting Control / Network Cables (Sheilded) to Indoor Units and / to Outdoor Units	LM	40		-
E	Allow for power connection from an isolator located approx 1 meter from the outdoor unit. (Not provision of isolator by others)	Item	1		-
	Sub-total carried to Main Collection Page				-

SECTION D.W 2: LABOUR WARD- AIR CONDITIONING- INDOOR UNITS

Item	Description	Unit	Qty	Rate KShs.	Cost KShs.
2	**INDOOR UNITS** ***Direct expansion fan coil evaporating units as "Daikin VRV IV" or equal and approved complete with all necessary multiconnection piping kits including all refigerant piping and fittings and branch connectors/controllers, evaporator fan motor, Fresh air Kit consisting of filter duct and external air grille and louvre, wired remote controller,drain up kit, and wiring to the power distribution. All refrigerant piping to be complete with 25mm Armoflex rubber insulation and including all fittings, "Y" Joints, Distributors, Branch connectors, etc. Note: Indoor Unit to match outdoor unit (3 pipe type indoor units)***				
A	5.2kW (18,000 Btu/hr.) Ceiling Concealed Air Conditioning Unit as Daikin, LG, Toshiba, or an approved equivalent, Dimensions in mm (H x W x D) 900 x 190 x 700, power input of approx. 56 watts	No.	1		-
B	3.6kW (12,000 Btu/hr.) Ceiling Concealed Air Conditioning Unit as Daikin, LG, Toshiba, or an approved equivalent, Dimensions in mm (H x W x D) 900 x 190 x 700, power input of approx. 34 watts	No.	6		-
	Sub-total carried to Main-Collection Page				-

SECTION D.W 3: LABOUR WARD- AIR CONDITIONING - ACCESSORIES

Item	Description	Unit	Qty	Rate KShs.	Cost KShs.
3	**AIR CONDITIONING ACCESSORIES**				
	Refrigerant Pipe Work				
A	Supply, deliver & install of refrigeration copper pipe work complete with 25mm Armoflex Rubber Insulation for suction/liquid line including all the fittings, 'Y' Joints, Distributors etc. size 6.5mm to 35mm. Rate includes the provision of 150mm cable trays to approval	LM	210		-
	Electrical Works				
B	Inter connecting Control / Network Cables (Sheilded) to connect VRV Indoor Units and / to Outdoor Units	LM	70		-
	Drainage Pipework				
C	Supply and install of uPVC drain pipe work to connect indoor units to drainage outlets complete with all fittings support brackets etc.	Item	1		-
					-
	Ductwork				-
D	Galvanised iron sheet metal ducting (22 SWG) complete with Armacell 22mm insulation including transformation, tees, bends, plenum, etc. manufactured to DW/144 specification with sealed joints and hangers/supports complete with all necessary accessories.	SM	30		-
	Diffusers/ Grilles				
E	Supply and install of Square Diffusers 600x600mm (Supply / Return) with Volume Control Damper as Waterloo or equal and approved. Diffuser to be constructed from extruded aluminium sections and finished in matt paint (white) and to be complete with air-supply volume control damper and supply plenum box with 200mm or 300mm diameter opening to branch.	NO	16		-
F	1200mm long One-way linear slot diffuser with at least three slots (approx. width 150mm) and with fixing accessories for gypsum (dry wall) ceiling. Diffuser to be constructed from extruded aluminium sections and finished in matt paint (white) and to be complete with air-supply volume control damper and supply plenum box with 150mm diameter opening to branch.	NO	2		-
	Sub-total carried to Main -Collection Page				-

SECTION D.W 4: LABOUR WARD- MECHANICAL VENTILATION

Item	Description	Unit	Qty	Rate	Cost KShs.
4	**FANS, DUCTING & GRILLES - GENERAL AREAS**				
	Supply fan				
A	Supply, deliver and install Supply/Extract Fan as SystemAir Capacity 2000 Cu. M/Hr at 200 Pa, complete with necessary accessories. F. Fans to come complete with brackets for mounting externally to match existing brackets on lower floors.	No.	1		-
	Diffusers/ Grilles				
B	Supply and install of Square Diffusers 600x600mm (Supply / Return) with Volume Control Damper as Waterloo or equal and approved. Diffuser to be constructed from extruded aluminium sections and finished in matt paint (white) and to be complete with air-supply volume control damper and supply plenum box with 200mm or 300mm diameter opening to branch.	NO	4		-
	Fresh Air Supply Ducts				
C	Galvanised iron sheet metal ducting (22 SWG) including transformation, tees, bends, plenum, etc. manufactured to DW/144 specification with sealed joints and hangers/supports complete with all necessary accessories.	SM	30		-
D	***Flexible Ducts- Uninsulated***				
(i)	Supply of Un-Insulated Flexible Duct 300mm Dia	LM			-
(ii)	Supply of Un-Insulated Flexible Duct 200mm Dia	LM	4		-
(iii)	Supply of Un- Insulated Flexible Duct 150mm Dia	LM	0		-
E	Supply and install Discharge Louver with Insect Screen 400 x 300mm	No	1		-
	Sub-total carried to Main Collection Page				**-**

SECTION D.W 5: LABOUR WARD- TOILET/ SLUICE EXTRACTION SYSTEM

Item	Description	Unit	Qty	Rate KShs.	Cost KShs.
5	**FANS, DUCTING & GRILLES - TOILET/SLUICE EXTRACTION**				
	Toilet/Sluice Extract Fan				
A	Supply, deliver and install Extract Air Fan as Solar Palau Silent or approved equivalent. Power input 0.29 kW, Capacity 240m3/hr @ 100 Pa complete with all necessary accessories.	No	9		-
B	"Waterloo Air Products Plc" WR/6/PPM9010/LD Disc valves of 150mm dia: for Supply/Return Air complete with adjustable damper and fixing ring able to deliver at Noise level of <50 NC	No	18		-
C	Supply and install Discharge Louver with Insect Screen 300 x 200mm	No	9		-
					-
	Toilet extract duct				-
D	Galvanised iron sheet metal ducting (22 SWG) including transformation, tees, bends, plenum, etc. manufactured to DW/144 specification with sealed joints and hangers/supports complete with all necessary accessories.	SM	130		-
E	***Flexible Ducts***				
(i)	Supply of Un-Insulated Flexible Duct 300mm Dia	LM	0		-
(ii)	Supply of Un-Insulated Flexible Duct 200mm Dia	LM	0		-
(iii)	Supply of Un- Insulated Flexible Duct 150mm Dia	LM	18		-
	Sub-total carried to Main -Collection Page				-

SECTION D.W 6: LABOUR WARD- SERVER/UPS ROOM AIR CONDITIONING

Item	Description	Unit	Qty	Rate KShs.	Cost KShs.
6	**SERVER/ UPS ROOM**				
	Split AC Unit				
A	Supply, deliver and install Wall Mount Type Split A/C Unit as Daikin or Toshiba - 24,000 BTU/ Hr Cooling, Power input of 1.9 kW / 1 Ph complete with matching condensing Unit, wall mounted AC drainage pump, and all necessary accessories	No.	1		-
	Refrigerant Pipe Work				
B	Supply, deliver & install of refrigeration copper pipe work complete with 25mm Armoflex Rubber Insulation for suction/liquid line including all the fittings, 'Y' Joints, Distributors etc. size 6.5mm to 35mm. Rate includes the provision of 150mm cable trays to approval	LM	50		-
	Electrical Works				
C	Allow for Electrical Connection for Outdoor and Indoor Units from Local Isolators / D P Switches provided by others	Item	1		-
D	Inter connecting Control / Network Cables (Sheilded) to connect Indoor Units and / to Outdoor Units	LM	25		-
E	Supply of AVS 30 Amp Voltage Surge Protection Device	No.	1		-
	Drainage Pipework				
F	Supply and install of uPVC drain pipe work to connect indoor units to drainage outlets complete with all fittings support brackets etc.	Item	1		-
	Sub-total carried to main collection page				-

MAIN COLLECTION PAGE

Item	Description				Price (KShs.)
	PROPOSED LABOUR WARD AT NAIROBI HOSPITAL **AIR CONDITIONING & MECHANICAL VENTILATION** **MAIN COLLECTION PAGE**				
(i)	Preliminaries and General Conditions				-
1	Outdoor Units				-
2	Indoor Units				-
3	Air Conditioning Accessories				-
4	Mechanical ventilation				-
5	Toilet/ Sluice Extraction				-
6	Server/ UPS Room				-
	TOTAL (VAT Inclusive)				-
	Sub-total carried to Main Summary Page				-

6 TECHNICAL SCHEDULE AND APPENDICES

6.1 TECHNICAL SCHEDULE

The tenderer must complete in full the technical schedule. Apart from the information required in the technical schedule, the tenderer **MUST SUBMIT** comprehensive manufacturer's technical brochures and performance details for all items listed in this schedule (fill forms attached).

ITEM No.	Description	Manufacturer	Country of origin	Remarks (Catalogue No. etc.)
A	GMS Duct			
B	Diffusers			
C	Volume Control Dampers			
D	Air Conditioning Units			
E	Ductwork Insulation			
F	Cold Room Evaporator			
G	Cold Room Condenser			
H	Filter Drier			
I	Control Panel			
J	Refrigerant Pipes			
K	Refrigerant Gas			
L	Refrigeration Controls			

6.2 DOCUMENTATION REQUIREMENTS

Document	With Bid	Before Manufacture	During FAT	Upon Delivery
Preliminary general arrangement drawing (with dimensions)	YES			
QA / QC Plan in accordance with ISO 9001:2008		YES		
General arrangement drawing (with dimensions)		YES		
Schematics/Line diagrams for construction	N/A	YES	N/A	N/A
Recommended Spares List	N/A	N/A	N/A	YES
Routine Test Reports / Certificates			YES	
Type Test Reports / Certificates	N/A	N/A	YES	N/A
Commissioning Procedure	N/A	N/A	N/A	YES
As-built General arrangement drawing			YES	
As-built Schematics			YES	
Site Test Reports / Certificates				YES
Special Test Reports / Certificates	N/A	N/A	YES	NO

APPENDICES

7 APPENDICES

7.1 Appendix I: Tender Evaluation Criteria

TENDER EVALUATION CRITERIA

TECHNICAL & FINANCIAL EVALUATION

SEC	REQUIREMENT SUMMARY	CRITERIA	TARGET SCORE	BIDDER'S SCORE
1	**TECHNICAL EVALUATION**			
a	Performance	Maximum of 10 as evaluated by Eng.	**10**	
b	Warranty	Maximum of 10 as per below schedule 1 year and below ---> Score of 2 1-3 years ---> Score of 6 3-10 years ---> Score of 10	**10**	
c	Product Life	Maximum of 10 as per below schedule 5-10 years ---> Score of 2 10-15 years ---> Score of 5 15 years and above ---> Score of 10	**10**	
d	Spare parts/Consumables and their availability. Local Back-up (maintenance)		**5**	
e	Technical data provided (brochures, technical specs, manuals, drawings etc)		**10**	
g	Understanding of the tender document		**5**	
3	**COSTS**			
a				
a	Price of the bid relative to the other bidders	Maximum of 25 as per below schedule Outside of 20% Range of Engineer's Estimate/Market Rate ---> Score of 0 Lowest ---> Score of 25 Second Lowest ---> Score of 20 Third Lowest ---> Score of 15 Fourth Lowest ---> Score of 10 Fifth Lowest ---> Score of 5	**25**	
b	Unit Rate Schedule (Appendix V below)	Maximum of 25 as per below schedule Lowest ---> Score of 25 Second Lowest ---> Score of 20 Third Lowest ---> Score of 15 Fourth Lowest ---> Score of 10 Fifth Lowest ---> Score of 5	**25**	
TOTAL SCORE			**100**	

The evaluation criteria provide that the bidder who scores **highest** points is technically responsive therefore, qualifies for recommendation of award of the contract unless otherwise stated.

7.2 Appendix II; Statement of Compliance

Technical Schedules shall be submitted by tenderers to facilitate and enable the Engineer to evaluate tenders but only when the fittings and accessories upon which the tenderer has based his tender sum differs in manufacture, type or performance from the description contained within this specification.

Tenderers shall submit separate leaflets and catalogues giving technical and physical details for all fittings and accessories described in the Technical Schedule at the time of tendering.

Completion of Technical Schedule shall not relieve the Contractor from complying with the requirements of the Specification except as may be approved by the Engineer.

…….. **(Signed)**

…….. **(Date)**

7.3 Appendix III; Exchange Rate Fluctuations

Adjustment will be made to the price of imported materials to compensate for variations in the foreign exchange rate. For this purpose, the tenderer is required to state the exchange rate in Kenya Shillings for the currency of the Country of origin of imported materials as applied to the actual remittance effecting payment to manufacturers of the materials.

Exchange Rate: …….

Signed (as in Tender) …….

Date ……

7.4 Appendix IV; System Warranties

The tenderer shall outline the warranties for all systems installed on this site as specified elsewhere.

These shall include but not limited, to the following:

- Air Conditioning Units (Split, VRV or any other specified)
- Mechanical Ventilation fans
- Control Panels
- Copper pipework
- Refrigerant pipework insulation
- Etc.

7.5 Appendix V; Schedule of Unit Rates

The tenderers shall provide a schedule of unit rates (under Tables (a) and (b) below) that shall be used to build up rates for variation items not specified in the bill of quantity.

This section, and the terms filled herein shall form part of the contract, and shall be considered locked for the duration of the project.

Rates filled herein shall be evaluated as part of the tender evaluation process. Attention is drawn to the tender evaluation criteria included in this tender package.

The sub-contractor shall disclose the cost of the material offered by the supplier, including or manufacturer or any other sources to the Engineer used to build up the rates in respect to schedule of table (a) and table (b) below. The engineer can reject the disclosed sources where the conflict of interest seems to prevail.

Table (a) and Table (b) shall be deemed to be exhaustive in capturing all cost components and the percentages filled herein shall be considered to be locked for the duration of the contract.

7.5.1 Locally Available Items

Unit rates for items that can be procured locally shall be generated according to table (a) below. Table (a) consists of the below items:

- Material cost – This is the supplier's unit cost for the item, i.e. the cost at the shop/supplier.
- Labor – This is to include all transportation, security, hoisting, installation, tools and consumables, testing, commissioning, costs, etc. The tenderer is to provide his/her labor cost as a percentage of material cost.
- Overheads and Profit – This is to capture all contractor's overheads, margins, profit, etc. The tenderer is to provide his/her overheads and profit as a percentage of material cost.
- Further to this, tenderers are expected to list all other cost carriers not deemed to have been captured in the table below, as a percentage of material cost.

7.5.1.1 Table (a): Locally Available Items.

Material Cost Kshs. (a)	Labour (as a percentage of material cost) (b)	Overheads and Profit (as a percentage of material cost) (c)	List any other component as necessary (as a percentage of material cost) (e)	Total Installed Cost of item Kshs. (VAT exclusive) (a+b+c+d)

7.5.2 Imported Items

Unit rates for items that will require importation shall be generated according to table (b) below. Table (b) consists of the below items:

- Material cost – This is the supplier's unit cost for the item as landed and cleared in Kenya. It includes FOB price, Carriage Insurance & Freight, Inspection Charges, Duty, Port Levies, Clearance Charges and VAT

- Labor – This is to include cost for transportation from port to site, security, hoisting, installation, tools and consumables, testing, commissioning and associated costs, etc. The tenderer is to provide his/her labor cost as a percentage of material cost.
- Overheads and Profit – This is to capture all contractor's overheads, margins, profit, etc. The tenderer is to provide his/her overheads and profit as a percentage of material cost.
- Further to this, tenderers are expected to list all other cost carriers not deemed to have been captured in the table below, as a percentage of material cost.

7.5.2.1 Table (b): Imported Items.

Material Cost Kshs. (a)	Labour (as a percentage of material cost) (b)	Overheads and Profit (as a percentage of material cost) (c)	List any other component as necessary (as a percentage of material cost) (e)	Total Installed Cost of item Kshs. (VAT exclusive) (a+b+c+d)

…….. **(Signed)**

…….. **(Date)**

…….. **(Official Stamp)**

7.6 Appendix VI; Day Work Terms for Labour

(To Be Completed By Tenderer)

Description of Artisan	Cost Per Hour
Supervisor	……..
Grade A Plumber	……..
Grade B Plumber	……..
Grade C Plumber	……..
Labour	……..
Apprentices	……..

7.7 Appendix VII; Technical Schedule

TECHNICAL SCHEDULE

The tenderer must complete in full the technical schedule. Apart from the information required in the technical schedule, the tenderer **MUST SUBMIT** comprehensive manufacturer's technical schedules details for all items listed in this schedule (fill forms attached).

Description	Manufacturer	Country of origin	Remarks (Catalogue No. etc.)
• GMS Duct • Diffusers • Volume Control Dampers • Air Conditioning Units • Ductwork Insulation • Cold Room Evaporator • Cold Room Condenser • Filter Drier • Control Panel • Refrigerant Pipes • Refrigerant Gas • Refrigeration Controls			

1. PART A: GENERAL MECHANICAL SPECIFICATION

1.1. GENERAL

This section specifies the general requirements for plant, equipment and materials forming part of the Sub-Contract Works and shall apply except where specifically stated elsewhere in the Specification or on the Sub-Contract Drawings.

1.2. QUALITY OF MATERIALS

All plant, equipment and materials supplied as part of the Sub-Contract Works shall be new and of first-class commercial quality, shall be free from defects and imperfections and where indicated shall be of grades and classifications designated herein.

All products or materials not manufactured by the Sub-Contractor shall be the products of reputable manufacturers and so far, as if they had been manufactured by the Sub-Contractor.

Materials and apparatus required for the complete installation as called for by the Specification and Sub-Contract Drawings shall be supplied by the Sub-Contractor unless mention is made otherwise.

Materials and apparatus supplied by others for installation and connection by the Sub-Contractor shall be carefully examined on receipt and stored. Should any defects be noted, the Sub-Contractor shall immediately notify the Engineer.

Defective equipment or that damaged in the course of installation or tests shall be replaced or repaired to the approval of the Engineer.

Medical gas plant supplier/constructor shall be a qualified company with relevant references for this specific type of work.

1.3. REGULATIONS AND STANDARDS

The Sub-Contract Works shall comply with the current editions of the following: -

(a) The Kenya Government Regulations.
(b) The United Kingdom Institution of Electrical Engineering Regulations for the electrical equipment of buildings.
(c) The United Kingdom Chartered Institution of Building Services' Guides.
(d) The Kenya Bureau of Standards Specifications.
(e) British Standards and Codes of Practice as published by the British Standards Institution.
(f) The Local Council By-laws.
(g) The electricity Supply Authority By-laws.
(h) The Kenya Building Regulations.
(i) The BS EN ISO 7396-1:2016 Medical gas pipeline systems. Pipeline systems for compressed medical gases and vacuum

1.4. ELECTRICAL REQUIREMENTS

Plant and equipment supplied under this Sub-Contract shall be complete with all necessary motor starters, control boards, and other control apparatus. Where control panels incorporating several starters are supplied they shall be complete with a main isolator.

The supply power up to and including local isolators will be provided and installed by the Electrical Sub-Contractor. All other wiring shall be as described in the Particular Specification.

The Sub-Contractor shall supply three copies of all schematic, cabling and wiring diagrams for the Engineer's approval.

The starting current of all electric motors and equipment shall not exceed the maximum permissible starting currents described in the Kenya Power and Lighting Company Ltd.'s By-laws.

All electrical plant and equipment supplied by the Sub-Contractor shall be rated for the supply voltage and frequency obtained in Kenya, that is 415 volts, 50HZ, 3-phase or 240 volts, 50HZ, 1-phase as specified in the particular specification.

Any equipment that is not rated for the above voltage and frequencies may be rejected by the Engineer.

1.5. TRANSPORT AND STORAGE

All plant and equipment shall, during transportation be suitably packed, crated and protected to minimise the possibility of damage, and to prevent corrosion or other deterioration.

On arrival at site all plant and equipment shall be examined and any damage to parts and protective priming coats made good before storage or installation.

Adequate measures shall be taken by the Sub-Contractor to ensure that plant and equipment do not suffer any deterioration during storage.

Prior to installation all piping, plant and equipment shall be thoroughly cleaned.

If, in the opinion of the Engineer any equipment has deteriorated or been damaged to such an extent that it is not suitable for installation, the Sub-Contractor shall replace this equipment at his own cost.

1.6. SITE SUPERVISION

The Sub-Contractor shall ensure that there is an English-speaking supervisor on the site at all times during normal working hours.

1.7. INSTALLATION

Installation of all special plant and equipment shall be carried out by the Sub-Contractor under adequate supervision form skilled staff provided by the plant and equipment manufacturer or his appointed agent, in accordance with the best standards of modern practice to the relevant regulations and standards described under clause 2.3 of this section.

1.8. TESTING

1.8.1. General

All testing shall be carried out to the entire satisfaction of the Engineer.

The following sub-clause are intended to define the Sub-Contractor's responsibilities with respect to testing and inspection.

1.8.2. Materials Tests

All materials for plant and equipment to be installed under this Sub-Contract shall be tested, unless otherwise directed, in accordance with the relevant B.S. Specification concerned.

For materials where no B.S Specification exists tests are to be made in accordance with the best modern commercial methods to the approval of the Engineer having regard to the particular type and application of materials concerned.

The Sub-Contractor shall prepare specimens and performance tests and analyses to demonstrate conformance of the various materials with the applicable standards.

If stock material, which has not been specifically manufactured for the plant and equipment specified is used, then the Sub-Contractor shall submit satisfactory evidence to the Engineer that such materials conform to the requirements stated herein in which case test of material may be partially or completed waived. Certified mill test reports of plates, piping and other materials shall be deemed acceptable.

1.8.3. Manufactured Plant and Equipment - Works Tests

The rights of the Engineer relating to the inspection, examination and testing of plant and equipment during manufacture shall be applicable to the Insurance Companies or Inspection Authorities so nominated by the Engineer.

The Sub-Contractor shall give two weeks' notice to the Engineer of the manufacturer's intention to carry out work tests and inspection.

The Engineer or his representative shall be entitled to witness such tests and inspections. The costs of such tests and inspections shall be borne by the Sub-Contractor.

Six copies of all test and inspection certificates and performance graphs shall be submitted to the Engineer for his approval as soon as possible after the completion of such tests and inspections.

Plant and equipment which is shipped before the relevant test certificate has been approved by the Engineer shall be shipped at the Sub-Contractor's own risk and should the test and inspection certificate not be approved; new tests may be ordered by the Engineer at the Sub-Contractor's expense.

1.8.4. Pressure testing

All pipework installation shall be pressure tested in accordance with the requirements of the various sections of this Specification. The installation may be tested in sections to suit the progress of the works, but all tests must be carried out before the work is buried or concealed behind building finishes. All tests must be witnessed by the Engineer or his representative, and the Sub-Contractor shall give 48 hours' notice to the Engineer of his intention to carry out such tests.

Any pipework that is buried or concealed before witnessed pressure tests have been carried out shall be exposed at the expense of the Sub-Contractor and the specified tests shall then be applied.

The Sub-Contractor shall prepare test certificates for signature by the Engineer and shall keep a progressive and up-to-date record of the sections of the work that have been tested.

1.9. COLOUR CODING

Unless stated otherwise in the Particular Specification all pipework shall be colour coded in accordance with the latest edition of B.S.1710.

1.10. Welding

1.10.1. Preparation

Joints to be made by welding shall be accurately cut to size with edges sheared, flame cut or machined to suit and the required type of joint. The prepared surfaces shall be free from all visible defects such as laminations, surface imperfections due to shearing or flame cutting operation, etc., and shall be free from rust scale, grease and other foreign matter.

1.10.2. Method

All welding shall be carried out by the electric arc process using covered electrodes in accordance with B.S. 639.

Gas welding may be employed in certain circumstances providing that prior approval is obtained from the Engineer.

1.10.3. Welding Codes and Construction

All welded joints shall be carried out in accordance with the following specification: -

1.10.4. Pipe Welding

All pipe welds shall be carried out in accordance with the requirements of B.S. 806.

1.10.5. General Welding

All welding of mild steel components other than pipework shall comply with the general requirements of B.S.5135:1974.

1.10.6. Welder's Qualifications

Any welder employed on this Sub-Contract shall have passed the trade test as laid down by the Government of Kenya.

Trade engineer may require to see the appropriate certificate obtained by any welder and should it be proved that the welder does not have the necessary qualifications the Engineer may instruct the Sub-Contractor to replace him by a qualified welder.

1.11. GENERAL MECHANICAL SPECIFICATION

1.12. INTRODUCTION

This standard specification is intended to form part of the general specification to be included in the Standard Tender document as follows:

Part (1) General Conditions of contract.
(2) Preliminary clauses (supplementary to General Conditions)
(3) Technical specification(s)
(4) Schedules of works.
(5) Appendices to specifications.

The specification comprises standard clauses, which can be used to complete specifications for Medical Gases, Air and Vacuum installations in Hospitals. The clauses are so arranged that they can be selected to suit the requirements of individual schemes and guidance notes are included to assist in the selection and completion of the clauses. All the clauses may not apply. It may also be necessary to add clauses to suit particular requirements. These should be considered for future inclusion in the specification.

Dimensions and values are given in Metric S.I. units; Imperial equivalents are quoted in brackets. Where precision in equivalent values is not important, the nearest practical or rational equivalent in Metric or Imperial units is given.

Note; - This specification does not cover the requirements for Pathology Departments, Laboratories or Workshop. These departments must be treated separately and supplied from installations independent of Medical installations. Specifications will need to be drawn up based on appropriate sections of H.T.M. 02-01.

It is intended that design guidance for Medical installations is obtained from HTM-02-01 and that the requirements arrived at are written into the specification clauses.
REFERENCES

1.13. BRITISH STANDARDS INSTITUTION

BS 4	Structural steel sections.
BS21	Pipe Threads.
BS3643	I.S.O Metric screw Threads.
BS341	Valve Fittings for compressed Gas Cylinders.
BS1319	Medical Gas Cylinders and Anaesthetic Apparatus.
BS587	Motor Starters and controllers.
BS2613	The Electrical performance of Rotating Electrical Machinery.
BS2960	Dimensions of 3 phase Electric Motors.
BS3979	Dimensions of Electric Motors, Metric Series.
BS89	Direct Acting Electrical indicating instruments.
BS559	Light Gauge copper tube, imperial sizes-inch bores.
BS2871	Part 1. Copper tubes for water, gas and sanitation – Metric outside Diam's.
BS1172	Phosphorous Deoxidised Non-arsenical copper for General Purposes.
BS1845	Filler Metals for Brazing.
BS1723	Specification for Brazing.
BS487	Part 1: Fusion welded steel air receivers (for pressures not exceeding 5001b/sq.inch).
BS1123	Safety Valves, Gauges and fittings for air receivers and compressed air installations.
BS1780	Bourdon Tube pressure and vacuum gauges.
BS1701	Air Filters for air supply for compressors, etc.
BS 2831	Methods of air filters in filters used in air conditioning and general ventilation.
BS3928	Methods for sodium flame test for air filters.
BS4001	Care and maintenance of underwater breathing apparatus. Part 1 compressed air open circuit type. Part 2 standard diving equipment.
BS4275	Selection, use and maintenance of respiratory equipment.
BS 3970	Steam sterilizers.
BS4199	Surgical suction apparatus.

	Part 1 and 2 electrically operated surgical suction apparatus.
BS3636	Methods for proving Gas Tightness of vacuum or pressurised plants.
BS1710	Identification of pipelines.
BS4099	Colours and their meanings when used for indicator lights.
CP3009	Underground piping systems.
BS4957	Hospital Medical vacuum pipe line service.
HTM	Hospital Technical Memorandum

1.14. DHSS PUBLICATIONS

Hospital Technical Memorandum No. 02-01 Piped medical gases, medical compressed air and medical vacuum installations. Data sheet EE10.11/12 colour code identification for medical gas terminal units and pipe installations.

2. STANDARD SPECIFICATIONS

2.1. GENERAL

2.1.1. Extent of Contract.

The work shall include for supplying, installing, testing, commissioning, demonstrating and leaving in proper working order a piped centralised supply system for medical gases comprising as outlined in this specification. Tenders shall comply in all respects with the specification, but the contractor may offer alternatives provided that the differences and advantages are clearly detailed by him on the schedule of alternatives attached which shall be returned with the tender.

2.1.2. Specialist Contractors.

The work shall be tendered for by approved contractors only who are specialists in the installation of medical gas systems and who have permanently employed staff experienced in this type of work. At the time of tendering the contractor shall confirm in writing that he has suitable qualified personnel who would be employed on the project.

2.1.3. Contract Drawings.

The contract drawing to be read in conjunctions with this specification are as follows
Any discrepancies between the drawings and the specification shall be clarified with the Engineer before tendering.

2.1.4. As- Installed Drawings

During the course of construction, the contractor shall correct one copy of the contract drawings daily as the work proceeds, indicating any change made from the arrangement shown in the contract drawings.

This amended drawing shall remain on site, readily available for inspection, and the amendments must ultimately be transferred to a reproducible copy of the contract drawing.Automatic manifold assembly.

The manifolds for all the specified gases (and air) shall be as far as possible identical in construction and the following clauses refer to the assemblies any of the “gases”.

2.1.4.1. Manifold Headers

Each bank of cylinders shall be located beneath a high-pressure manifold header securely mounted control panel. The headers shall carry flexible spiral tail pipes on the underside for connecting to the cylinders and each tail pipe shall incorporate a renewable non-return valve on the manifold header to allow removal and replacement of the cylinder without interrupting the supply from others in the same bank.

2.1.4.2. Non-interchange ability of cylinder connections

The screwed connections of the tail pipes to the cylinder valves shall be designed such that cross connection of the pipe for any one gas cannot be made to any cylinders for the gases, the exception being oxygen and air which to BS. 341 part 1 are identical.De-Greasing

The assembly shall be de-greased and delivered to site in a sealed polythene bag or cover and labelled to the effect that if is degreased and shall on no account be

contaminated by dirt oil or grease during erection of afterwards.Precautions against Leakages.

All parts of the control panel shall be constructed of materials, which will not deteriorate during service and lead to leakages. Diaphragm gaskets of pressure regulators shall not be of fibre but brass.

2.1.5. Service or Emergency Point.

Each gas (or air) installation shall include a service or emergency point in the manifold room on the wall near to the control panel and on the outgoing distribution pipe into which a supply can be connected manually from a standby cylinder when the control panel is to be serviced or has failed.

The service point shall be in form of a terminal unit complete with check valve and isolating valve, into which a flexible pipe with probe can be inserted. See 6.11.8 for details.

The unit shall be capable of passing 275 litres/min. minimum at a nominal gauge pressure of 4.1 bar (60 p.s.i.) with a pressure loss not exceeding 0.55 bar (8 p.s.i.).

The unit shall be rigidly piped up to the distribution main and the height of the unit above floor level shall be such that the flexible pipe probe can inserted easily by a person of average height standing on floor level.

The service point shall be identified indelibly with the name of the gas and by colour code to B.S. 1710 (1971), schedule No. 13 of this specification.

2.2. DISTRIBUTION PIPEWORK SYSTEM

2.2.1. Extent of Pipework

The Specialist contractor shall supply, install, connect up and test all the pipework and valves required from the supply source to the distribution terminals for each gas, air and vacuum.

The pipe sizes and valve positions shall be as given on the Contract Drawings and test procedure as described later.

2.2.2. Pipe Installation

2.2.2.1. Fixing

All pipework shall be fixed without any springing or forcing. A clearance of 150mm (6”) shall be maintained between the pipework and other services. Where pipework crosses other services a clearance of 25mm (1”) minimum shall be maintained.

2.2.2.2. Gradients

Gradients are not required on gas, air or vacuum pipelines.

2.2.2.3. Drainage

A full way drain lock is to be provided at the bottom of each main vertical run on the air and vacuum pipework.

Branches on horizontal air pipe work shall be taken from the topside of mains to avoid pockets of moisture.

2.2.2.4. Diversion Sets

The use of fittings for the diversion sets shall not be permitted and the sets shall be formed from a long length in one piece and cold drawn or hot drawn in a neat manner without bucking or thinning.

2.2.2.5. Routing to avoid Fire Risk Areas

The routes of the pipework shall avoid fire risk areas including laundries boiler houses, generator rooms, incinerator rooms, storage rooms for combustible materials (unless the pipes are to be cased), lift shafts and kitchens.

2.2.2.6. Pipework Supports

Pipework shall be supported at not greater than the intervals shown in the table below:

SPACING OF SUPPORTS FOR COPPER PIPES

Nominal Pipe outside diameter mm BS 2871
Part 1 Table X Maximum Intervals

For Vertical Runs	Maximum Intervals For Horizontal Runs
Metres	Metres
10	1.2	-
12	1.2	1
15	1.8	1.2
18	2	1.5
22	2.4	1.8
28	2.4	1.8
35	3	2.4
42	3	2.4
54	3	2.7
76.1	3.6	3

Where valves are fitted the pipe shall be supported at both sides of the valve to facilitate valve operation without valve movement.

Fixing brackets or supports shall be of a suitable non-ferrous material or suitability treated to minimize corrosion and prevent electronic action.

The specialist contractor shall drill and plug walls and ceilings as required fastening the supports. Where roof decking is encountered the specialist, contractor shall provide cavity fixing devices to fasten the supports.

2.2.2.7. Pipework in Floors, Walls, Ceilings

Pipework in rooms and corridors shall be concealed either behind ceiling panels, or in walls, ducts or trucking. Removable covers or panels shall be provided to allow access to pipework.

Pipework shall not be buried solidly in floors, walls or ceiling except with the approval of the Engineer. Approval will normally be given only for tail pipes in one piece from Terminal unit to service duct or ceiling void and for unjointed pipes from control value to void. The route of the buried pipe should be clearly and continuously marked by

chalk, coloured adhesive tape or otherwise, during construction, to discourage the driving of nails into or near the pipe. Where pipes are to be installed in partition walls the tail pipes of terminal unit shall be in one piece (without joint) form the terminal unit to the service doctor ceiling void.

Service ducts or voids should have adequate ventilation to prevent gas concentration in the event of a leak.

Where pipes pass through floors, walls or partitions, copper sleeves shall project between 1.5 and 3mm (1/16" and 1/18") beyond finished surfaces and plates shall be fitted. All joints shall be accessible, and no joint shall be made so that it's inside the pipe sleeve.

Where pipework is to be concealed it shall not be covered over until it has satisfactory passed all pressure tests.

Pipework in service ducts, or voids or in rooms or in corridors where the pipework is not required to be concealed shall be surface run.

2.2.2.8. Special Precautions against Corrosion.

Where pipework is supported by or is liable to come into contact with timber that has been treated with compounds likely to cause corrosion of copper, the pipe shall be protected locally by impermeable materials such as p.v.c. tape or spacers.

2.2.2.9. Cleanliness during installation

Great care shall be taken during installation to ensure that no extraneous materials are allowed to enter the pipework. Where any section of the pipework is left incomplete during erection the open end of the pipe shall be sealed immediately with plastic cap.

2.2.2.10. Bonding and Earthing

Wherever possible, pipeline shall be physically separated from the metal sheath and amour of electric cables and from metal conduits, trunking and bare earth continuity conductor s associated with any cables which operate at low voltage or above.

Where physical separation is impossible or when pipeline is in metal trucking and bed head units the pipeline shall be bonded to the I.E.E Regulations B. 53 and D.10.

The above work shall be carried out by specialist contractor or other.

2.2.3. Pipework Material and Size

2.2.3.1. Material

Pipework material for gases, air and vacuum shall be phosphorous de-oxidized non-arsenical copper to B.S 1172

2.2.3.2. Sizes

Pipework sizes shall be to metric outside diameters in accordance with B.S. 2871, Part 1, Table X.

2.2.4. Fittings and Joints

2.2.4.1. Capillary Fittings

All fittings shall be “high Duty” Capillary Type suitable for a “steam” working pressure of 17bar (250p.s.i.) gauge.

The fittings shall have integral rings of silver brazing alloy complying with composition to B.S 1845 (1966) Table 2, Type AG.11 Brazing by the end-feed method shall not be permitted.

The fitting shall be non-ferrous and capable of withstanding corrosion and dezincification.

2.2.4.2. Flux

Because of the high temperatures required for their effective use borax or borax-based fluxes shall NOT be used.

The flux shall be provided by the Fitting Manufacture to suit the work. Fluxes shall be free from grease and agents which promote corrosion or deposits of chlorides. Care shall be taken to avoid any excess of flux which might enter the pipe bore and when the joint is cool excess flux shall be washed and wire brushed off. A visual inspection of each brazed joint shall be made to confirm that the hardened flux has not formed a temporary seal which holds test pressure.

2.2.4.3. Fittings

Fittings on moisture eliminators and trap sets for vacuum and compressed air shall be brass competition type fittings, or flanged fittings as appropriate.

2.2.4.4. Valve Joints. Capillary or Screwed

Joining of valves to the pipelines shall preferably be made with a capillary joint similar to 6.5.1. but the end feed method may have to be used in this case. *(57). If, however, the valve connection is screwed a capillary to screwed adaptor shall be used but in this case the joint shall be made by tinning the male thread with soft solder. Litharge and Glycerin or an approved oxygen lung or scaling compound are also acceptable. See also 6.7.1.

The screwed joint shall be factory made using silver alloy as specified for capillary fittings and the adaptor screwed up while the “tining” is molten. This shall be done with valves dismantled to avoid damage to internal parts and the same care shall be taken when making the capillary to the damage diaphragms, seating etc.

The parts of the valves shall be maintained in a degreased condition. Screw threads shall be tampered either to B.S. 3643 or BS. 21. Parallel threads shall not be used.

2.2.5. Degreasing of Pipes and Fittings

2.2.5.1. Extent. Protection Labelling

All pipework and fittings for medical Gas, air and vacuum shall be degreased at the manufacturer’s works, the pipes to be individually fitted with purpose made tightly fitting plastic caps or plugs to protect the bores before dispatch to site. Pipes shall be delivered in bundles in protective wrappings and fittings in sealed polythene bags, no capping required.

The bundles and bags shall be securely and clearly labelled: - “Degreased Materials”. For use on Medical Gas Installations. Do not allow to come into contact with oil or grease”.

The specialist Contractor shall take great care in storing these materials and any materials contaminated while on site shall be returned to the manufacturer for degreasing, all at the expense of the Specialist Contractor.

2.2.5.2. Degreasing Processes

The pipes shall be degreased internally by steam, then dried, shot blasted and blown through with medical quality bottled air. After a visual inspection each pipe shall be capped individually at both ends.

If steam cleaning is not economical, pipes above 54mm outside diameter may be alternatively cleaned using an approved solvent such as such as methyl chloride, which will leave no poisonous or explosive residues and the fittings shall be dried out, inspected and capped or sealed as specified in 6.6.1.

While the degreasing process is primarily concerned with the bore of pipes care shall be taken to avoid oil or grease on the outside, as being a possible source for bore contamination t occur from.

Degreasing of values is dealt with under 6.7.4.

2.2.6. Valves on Distribution Pipework

The Specialist Contractor Shall supply and fit valves at the positions shown on the Contract Drawings and any deviations from these positions shall be agreed in writing by the Engineer.

The height of valves is to be stated under “Valve Boxes”, (6.8.3.) but in plant or manifold rooms valves may be arranged differently providing they are easily accessible for emergency or maintenance use.

2.2.6.1. *(59) Valve Materials and Types

All valves shall be of non-ferrous material and of the non-lubricated type, to the following details. If screwed, threads shall be tampered either to BS.3643 or BS.21 (see 6.5.4.) Parallel threads shall not be allowed.

a) Medical Gas Valves (specify)

Type
Bores
End Connections
Manufacture

b) Compressed Air valves (specify)

Type
Bores
End Connections
Manufacture

c) Vacuum Valves (specify)

Type
Bores

End connections
Manufacture

2.2.6.2. Direction of Valve Closure

Wheel screw valves shall close in a clockwise direction. Lever Ball Valves shall have the direction of closing indelibly cast or engraved on the wheel by means of an arrow and the word “CLOSE”.

Lever ball valves shall have “ON” / “OFF” cast or engraved on to show when the valve is open or closed.

2.2.6.3. Maker’s Identification

Each valve shall carry the manufacturer’s serial numbers or identification and valve size.

2.2.6.4. Pressure Testing and Degreasing

All valves shall be pneumatically tested by the manufacturers to twice the working pressure and afterwards de-greased for medical gas services using a suitable method as given as at 6.6.2 before being individually sealed in polythene bags, capping not required.

The valves shall be securely and clearly labelled: -

“Degreased Valve. For use on Medical Gas installations. Do not allow to come into contact with oil or grease”.

2.2.6.5. Certificates

A certificate shall be supplied by the manufacturer for each valve or batch stating that pressure tests and degreasing has been carried out and that any solvents have been completely removed.

2.2.6.6. Valves for System Testing Purposes

The Specialist Contractor Shall Supply and fit at the position(s) shown on the Contract Drawings (s), a three-valve arrangement to facilitate providing and testing of the installation(s).

The Principle of the method is shown on schedule No.6 and the procedure laid down under Testing and Commissioning Requirements. The valves shall be of non-ferrous material, de-greased and comply with relevant requirements, as previously specified and to be to following details: -

Type
Bores
End Connections
Manufacture

The valves shall be suitably labelled as described under 6.10

2.2.6.7. Extended. Phased. Modified, Installations

New work during installation shall be physically separated from the existing system and final joining up left to the last after completing all tests in section 10.

2.2.7. Valve Boxes

2.2.7.1. Location

The Specialist Contractor shall supply and install lockable valve boxes for all the medical gas, air and vacuum valves located outside manifold and plant rooms and not contained in ducts or cupboards etc.

2.2.7.2. Purpose

The boxes shall render the valves tamper proof and shall have a transparent breakable panel to facilitate emergency operation of the valve.

2.2.7.3. Mounting Height

The valves shall serve for the both emergency and maintenance purposes and because of the former requirement the box and valve shall be mounted at the centre height of 1.22metres (4 feet) above floor level in a position not obstructed in a anyway by other equipment. Boxes for the different gases grouped together may be fixed one above another in which case the mean height is to be 1.22m.

2.2.7.4. Mounting Depth

The boxes shall be set into the wall with any projection being kept to a minimum and surface mounted boxes shall be avoided if at all possible. The Specialist Contractor shall ascertain from the Architect or Site the nature of the wall into which the boxes will fit.

2.2.7.5. Standardised Type Boxes

The design of box offered shall be of a standardized pattern throughout the installation and have the following features:

(a) Ease of access for fitting valve and maintenance
(b) Designed so that the pipework can be fitted easily, either by having a split box or other suitable means
(c) Ventilation to obviate a possible build-up of gas in case of a leak,
(d) Non-interchangeable keys so that a maintained permit – to – work system can be operated
(e) Keys in duplicate
(f) Keys and locks with numbers engraved on
(g) Breakable transparent panel
(h) Non-interchangeability box covers if this could wrongly identify – covers to be hinged on.
(i) Boxes shall accommodate one valve only, ganging not permitted.

2.2.7.6. Box Material

The boxes shall not be of wooden construction but of robust plastic or metallic material and capable of withstanding hazards from blows, abrasions and fire.

The finished appearance of the boxes shall be such that they match the décor of the rooms and are not unsightly.

2.2.8. Valves in Ducts or Cupboards

The valves shown on the Construct Drawings in ducts or cupboards are intended for maintenance purpose only and are not required to be in valve boxes, providing the valves are lockable in the open and closed position. Suitable locking arrangements and duplicate non-interchangeable keys shall be provided so that such valves can be included in any permit to work scheme. (See 6.8.5.d.).

Care shall be taken not to install valves in cupboards or ducts which are poorly ventilated or in cupboards used for other materials which could be affected by leakages. Any pipe runs so situated shall be drawn to the attention of the Engineer before proceeding on site.

2.2.9. Identification of Valves

An engraved label of white "Traffolyte" or similar material shall be permanently fixed adjacent to each valve box to indicate the service and give the following information:

a) In Red Letter — Engraving Required

1. Service — e.g. "OXYGEN"
2. Area Served — e.g. 'WARD 1"
3. Emergency Instruction e.g. "IN EMERGENCY BREAK PANEL AND CLOSE VALVE"

b) In Black letters:

1. Valve number — e.g. "VALVE 6"

This number is for maintenance purpose and is to be agreed later on site.

Valves in ducts or cupboards shall be similarly identified except for emergency instructions.

The titles of areas served shall be finally agreed on site and the labels shall be installed before the systems are tested and commission in order to prove their correctness.

2.2.10. Terminal Units

2.2.10.1. Extent of Works

The Specialist Contractor shall supply, install and connect to the distribution pipework all the terminal, install and connect to the distribution pipe work all the terminal units required at the positions shown approximately on the Contract Drawings and as listed on the Schedule of Terminal Units.

2.2.10.2. Definition

A terminal unit shall be defined as a single outlet point for a specific gas shall be a separate unit for that one gas only.

2.2.10.3. Fascia Plate

Terminal Units for different gases at one location may be house under a common fascia plate but it shall not be possible to amount the fascia plate incorrectly and reverse or alter the identification of the services. The Units should be mounted on a common back plate to ensure accurate centering of the units and allow precise fitting of the fascia plate so that the probes enter freely.

2.2.10.4. Mounting Order

The Terminal Unit when viewed facing the units shall be mounted in the following order horizontally from left to right: -

Oxygen. Nit: Oxide. Nit Oxide/Oxy: Mixture Carbon Dioxide. Compressed Air. Vacuum.

2.2.10.5. Type (select either as required)

The terminal units shall be of the flush mounted type set into the wall. Or the Terminal units shall be of the raised surface mounted type with probe connection made vertically underneath.

2.2.10.6. Mounting Height

The mounting height of the terminal units above floor level shall be as follows: -

a)	For Flush Mounted Units	1.3m (4'- 4") to centre of Unit
b)	For Raised Surface Mounted Units	1.6m (5'- 2") to centre of unit
c)	For "Rail" Systems areas	1.5m (5'-0") to centre of unit.*(65a)

2.2.10.7. Exact Positioning of Terminal Unit

The exact position of the terminal units relative to the beds, operating tables, etc. shall be finally agreed between the Medical Officers and Architect/Engineer, and the Architect/Engineer shall provide the Specialist contractor with suitable drawings.

Due regard shall be given to ensure that nursing stall can couple up equipment easily, the short for flexible pipes to apparatus can be achieved without obstruction movement to staff or equipment round the patient and the access to the units for maintenance is easy without disruption to patients or other services.

2.2.10.8. Essential Design Features of Units

Terminal Units shall be designed to incorporate the following features: -

(a) The ability to accept, retain ad release the inserted probe by means of a quick release mechanism designed for single handed operation.
(b) A secondary locking mechanism to prevent accidental ejection of the probe which is to be finally removed by hand.
(c) Two Valves: -
    i. A valve on the inlet to the unit which can be closed to isolate the unit only, without the need to isolate a complete section when maintenance is carried out.
    ii. A self-sealing check valve which is opened by the probe and or withdrawal closes before secondary lock engages.
(d) Non-swivel type terminal socket to probe connection so that secondary equipment such as a flow meter is not titled during use.
(e) The terminal socket and check valve shall only accept the correct probe for the specified "gas" and not allow intern-changeability with or partial operation by probes for any other service.
(f) It shall not be possible to interchange the parts of a unit for one gas with those for a different gas and so enable a probe to be connected to the wrong position.

(g) Fascia plates which is such that interchangeability of fascia plates between the different gas terminal units is impossible.
(h) The front face around the terminal socket to be exposed and to carry "gas" name and colour identification, unless incorporated as at 6.11.8(7).
(i) Identification by shape incorporated on the problem is not an essential feature but if adopted by a manufacturer the following shapes shall be used:

Service	Shape
Oxygen	Hexagonal
Nitrous Oxide	Round
Nitrous Oxide /Oxygen Mixture	Round with two opposing flats
Carbon Dioxide	Triangular with radiuses corners
Medical Air	Round with one flat
Medical Vacuum	Square

2.2.10.9. Identification Colours and Wording on Units

The following names and colours shall apply:

Service	Colour	Wording
Oxygen	White	Oxygen
Nitrous Oxide	French Blue	Nitrous Oxide
Nitrous Oxide/Oxygen Mixture	French Blue and white quarters	N2O+O2 (50/50)
Carbon dioxide	French Grey	Carbon dioxide
Medical Air	White and Black Quarters	Medical Air
Medical Vacuum	Prim Rose	Vacuum

The name and colour shall be permanent, and it shall not be possible to transfer either to a different terminal.

Painting on of colour or wording is not permissible.

2.2.10.10. Pressure Loss across Terminal Units

The terminal units shall be capable of passing the following flow rates without exceeding the stated pressure losses across the terminal units.

Nominal Gauge Pressure at back of Service Terminal Unit	Maximum permissible		Maximum Rate of floor required at this pressure		Maximum permissible loss across terminal unit	
	Bar	p.s.i.	Litre/min.at STP		bar	p.s.i.
Medical Gases	3.93	57	40		0.034	0.5
NitorousOxide/Oxygen Mixture	3.93	57	275		0.55	8
Medical Air	6.9	100	250		0.34	5
Medical Vacuum	Minus 400mm Hg (360 mmHg absolute)		40		100mm Hg	

The figures relate to the performance required of the terminal units.

The actual design flow rates for purposes of sizing the installation and determining pipeline diameters should be taken from Section V of HTM 22.

2.3. SPECIAL FITTINGS FOR OPERATING THEATRES

2.3.1. Location and Type

The Specialist Contractors shall supply, install and connect to the distribution pipework in each operating Theatre. These fittings are in additional to the wall mounted terminal units specified earlier.

2.3.2. Gases to be dispensed

The fittings(s) shall supply the following “gases”:-
Oxygen, AGSS, nitrous oxide and medical air.

2.3.3. Design of fittings

2.3.3.1. Boom Assembly, Open Type A

The boom shall be designed to carry flexible pipes connected into standard type flush fitting terminal units mounted at a height of 1.8M (5’-11”) above floor level.

2.3.3.2. Boom Assembly, Enclosed Type B

The boom shall be designed to carry concealed pipes of nylon connected to the distribution Pipework in a suitable wall unit.

2.3.3.3. Ceiling Pendant, Multipoint, Type C.

The pendant shall comprise a heavily chromed or stainless steel removable ceiling rose thought which flexible hoses with terminal end connections are suspended.

The connections to the distribution pipework shall be within the ceiling rose space and the design shall be such that all strain is taken off the hose connections

The hose to distribution pipe connections shall not be interchangeable between the different services.

2.3.3.4. Ceiling Pendant, Single Point, Type D

The Pedant shall comprise a heavily chromed or stainless steel removable ceiling rose through which a flexible hose with terminal end connection is suspended.

The connection to the distribution pipe shall be within the ceiling rose space and the design shall be such be that all strain is taken off the hose connection.

2.3.3.5. Terminal Connections

The terminal connection on all fittings shall only accept standard type probes and shall incorporate all the necessary features of the wall mounted terminal units as regards non-interchangeability, self-sealing check valves, isolating valves, identification.

2.3.3.6. Valves

Where the design of the terminal connection on the fitting or hose does not include an isolating valve, this shall be provided elsewhere weather within or near to the fittings on the incoming distribution pipe work, in any easily assessable position for maintenance purposes.

2.3.3.7. Special Precautions

The design of all special fittings and hoses shall ensure that during use and movement of the fitting the pipework or hose cannot be twisted, kinked, uncoupled at either end, overstrained or otherwise damaged.

2.3.3.8. Anti-static Precautions

All fittings and hoses shall be of anti-static construction.

2.3.3.9. Cleanliness

All fittings shall be designed to present minimum lodgement of dirt, dust. etc. and be easy to keep clean . The materials of construction shall have complete freedom from rusting, scaling or deterioration and may be enamelled finish, stainless steel, or heavily chromed finish.

2.3.3.10. Order of Arrangement of Terminal Connections

On multi-point fittings the order arrangement of the terminal connections shall be as follows: - Oxygen. Nit: Oxide. Nit: Oxide/ Oxy: Mixture. Carbon Dioxide. Comp.Air. Vacuum

For pendants and columns, the above order clockwise nearest to the hinge.

2.3.3.11. Headroom Clearance

All fittings shall provide a minimum clearance of 1.8m (5'-11") above floor level and on telescopic fittings when in the retracted position.

2.3.3.12. Dimensions of Fittings

The terminal outlet connections of fittings shall not be more than 1.9m (6'-3") above floor level on booms, pedant hoses and columns.

The depth of fittings and pendant hose length shall suit the height of the room.

These dimensions shall be verified on site by the specialist Contractor.

2.3.3.13. Structural Requirements for fittings

The specialist contractor shall state in his tender the requirements for structural strength of walls or ceilings to which the special fittings are to be fastened.

2.3.3.14. Positioning of Special Fittings

The exact positioning of special fittings shall be agreed between the Medical Officers and Architect, and the Architect shall provide layout drawings for the Specialist Contractor.

2.3.3.15. Electrical Services in Fittings

The bedhead unit shall carry electrical services which shall be in solid drawn rust-proof conduit separate from the medical service pipes.

The electrical fittings shall be arranged in a neat manner to fit in with the medical terminal outlets and shall afford easy access for coupling up equipment.

2.4. IDENTIFICATION OF PIPELINES

2.4.1. Permanent Identification

The Specialist Contract shall carry out identification of the installations(s) by colour coding in accordance with Data Sheet EE 10.11/12 and B.S. 1710 (1971).

The identification shall comprise: -

a) Colour handing applied at valves, junctions; either side of walls, floors and at intervals of about 2m (6 feet) on short runs up to 4m (13 feet) on long straight runs).
b) The name of the service printed on the colour hand in a contrasting colour.
c) An arrow at each colour band showing direction of flow.

Letters to be a minimum of 6mm (¼") high.
Self-adhesive plastic labels or tapes of approved manufacture may be used as an alternative to painting. Where valves are in a valve boxes and identified by "Traffolyte" labels, colour handing is not required.

2.4.2. Temporary identification

During installation of piping, individual pipes, valves junctions and ends shall be identified as the work progresses. This identification shall be at intervals similar to final identification

requirements and may be made with removable labels. These temporary identification labels must be subsequently replaced by the permanent ones at an appropriate stage.

2.5. WARNING AND ALARM SYSTEMS

2.5.1. Extent of Works

The specialist Contractor shall supply, install and commission the following warning and Alarm systems comprising a combination of (select) flashing/steady lights and audible alarms, for the appropriate services.

2.5.2. Master and Slave indicating Units

A Master indicating Units shall be installed in nurse stations to monitor all the services in one combined unit.

The Master Unit shall relay to slave Units installed in the following rooms in all other nurse station as will be shown in the drawings.

2.5.3. Electrical Power

The systems shall work on low voltage D.C. current stepped down from a 250 volt single phase supply via a double earth screened transformer. The power pack may be incorporated in the Master Unit.

2.5.4. *(76) Essential Features of Flashing Light Units

The Master Unit and Slave Units shall be of similar construction and embody the following features:-

1. On the Master Unit, solid state flasher unit to operate the lamps thought the system.
2. On Master and slave Units, translucent coloured panels for each service engraved with the “fault”conditions.
3. Two under-run low voltage white lamps in parallel behind each panel.
4. A green panel to indicate that the unit is operational.
5. A Standardized size and type of lamp throughout the system.
6. Lamps suitable for rapid on/off flashing operation with long life.
7. Lamp test button on each unit to test all lamps on the unit simultaneously.
8. Audible alarms as indicated in Schedule No. 4
9. On the Master Unit, A Key operated muting switch:-
   a) Make flashing lights steady on Master Unit and Slave Units
   b) Mute Audible alarms on Master Unit only.
10. One each Slave Unit, a key operated muting switch to mute audible alarms.
11. The muting switches to deal with only one alarm signal at a time and to re-set automatically.
12. On the Master Unit a System Alarm Circuit run from a dry battery to indicate: -
    a) Failure of flasher unit.
    b) Failure to low voltage supply.

These faults to be indicated by a coloured orange engraved panel with steady twin lights and audible alarm with key operated muting switch and automatic =-re-set.

A test button shall be provided to simulate “a” ad “b” to test the above circuit.

2.5.5. *(76) Essential Features of Steady Light Units

The Master Unit and Slave Units shall be of similar construction and embody the following features: -

1. Translucent coloured panels for each service engraved with the “fault” condition.
2. A translucent green panel to each service to indicate that low voltage supply is on and services are operating normally.
3. Two under-run low voltage while lamps in parallel being each panel.
4. A standardized size and type off lamp thought the system.
5. Lamp suitable for long life.
6. A lamp test bottom on each unit to test all lamps on the unit simultaneously.
7. Audible alarms as indicated in Schedule No.5
8. On the Master Unit, key Operated muting switch to mute audible alarms on the Master Unit only.
9. On each Slave Unit, a Key operated muting switch to mute audible alarms on the Unit.
10. The muting switches to deal with only one alarm signal at a time and to re-set automatically.
11. On the Master Unit, a System Alarm Circuit run from a dry battery to indicate failed of low voltage supply.

This fault to be indicated by a coloured orange engraved panel with steady twin lights and an audible alarm with key operated muting switch and automatic re-set.

A test button shall be provided to simulate low voltage supply failure to test the above circuit.

2.5.6. Working of Master and Slave Units – “Flashing” System

The units shall indicate the condition of all the monitored services simultaneously and for each service more than one panel may be indicating at a time as outlined in Schedule No. 4.

The audible alarm on each unit shall be common to all the services and be arranged to re-set automatically after being mute d, or if muting is not carried out, after the fault is rectified.

2.5.7. Working of master and Slave Units – “Steady” System

The units shall indicate the conditions of all the monitored services simultaneously and for each service only one panel will be indicating at a time as outlined in Schedule No.5.
The audible alarm on each unit shall be common to all the services and be arranged to re-set automatically after being muted, or if muting is not carried out, after the fault is rectified.

2.5.8. Arrangement of Panels on Units

The order in which the services shall be arranged on the Master and Slave Units shall be that adopted for terminal unit: -

When facing the panels the service shall be in the following order reading left to right: -
OXY. NIT.OXIDE. NIT OXIDE. CABRBON DIOXIDE COMPRESSED AIR VACUUM OXY.MIXTURE

2.5.9. Engraving of Fascia Panels of Units

The fascia panels of the Units shall be engraved with the name of the service, either at the top or bottom of each column of translucent panels.

The function of the various press buttons and switches shall also be engraved on the fascia panels.

All engraving shall be picked out in contrasting indelible colour.

2.5.10. Monitoring Equipment

The Specialist Contractor shall include for supply and fixing all necessary sensing Devices, Operating switches and Relays on the plant for the initiation of the Warning and Alarms signals. The Sensing devices, etc. on the Liquid Oxygen Plant and Standby manifold shall be supplied and installed by the Specialist Oxygen Supplier.

Absolute reliability and long life of contracts in relay units shall be as essential feature of the equipment.

The relays shall be energized under normal operating conditions and the alarm contracts shall “break” under “fault” conditions.

The alarm terminal block shall be remote from the electrically isolated from all other terminals and energized from a separate source.

The monitored unit alarm contracts shall be rated at 250 volts 3Amp, 50 Hz and the alarm system contacts at 50 volts, 0.5 Amp, D.C.

On a “Flashing” system the alarm circuit conductors to the slave units shall be suitable so that when the green, white and orange panels on every slave unit are illuminated simultaneously the pressure loss does not exceed 5% of the rated operating voltage.

On a “Steady” System the alarm circuit conductors to the slave units shall be suitable so that when any signal is illuminated simultaneously on all slaves the pressure loss does not exceed 5% of the rated operating voltage.

(Delete the system not required)

2.5.11. Setting of Sensing Devices

The sensing devices shall be set so that the conditions are indicated as soon as the following limits are reached: -

Conditions on Schedule

*(81) Manual manifolds

1. When duty bank falls to approximately: -

    (a) 10% of full capacity on oxygen systems
    (b) 8% of full capacity on N2 0/02 systems
    (c) 6% of full capacity on N20 systems

Automatic Manifold

2. When duty bank becomes “exhausted” and change-over to reserve bank made.

3. When with one bank empty, duty bank falls to approximately: -
    (a) 10% of full capacity on oxygen systems
    (b) 8% of full capacity on N2 0/0 2 systems
    (c) 6% of full capacity on N20 systems

    Liquid Oxygen Installations

4. When change-over to standby manifold made.

5. When one standby bank becomes exhausted and changeover to reserve bank made.

Medical Compressed Air Plant

6. When “standby compressor cuts in to back up “duty” compressor.
7. When change-over to standby air manifold made (denoting fault on compressors or air temperature too high).
8. When dew point of air from dryers is rising above 0°C (32°F) at 7.3 bar (105 p.s.i.) gauge.

Medical Vacuum Plant

9. When “standby” vacuum pump cuts in to back up “duty” vacuum pump.

All PMG &V Plant Installations

10. When either one or both pumps fail to operate
11. When pressure in distribution pipe work falls to:-
    a) 10% below normal on medical gas lines
    b) 15% below normal on air and vacuum lines

2.5.12. Electrical Wiring

The interconnecting wiring shall be carried out by others, but the specialist Contractor shall supply all necessary wiring diagrams, induplicate, within……weeks of being awarded the contract.

PART B:

PARTICULAR SPECIFICATION FOR MEDICAL GASES

3. PART B: PARTICULAR SPECIFICATION FOR MEDICAL GASES

3.1. MEDICAL GASES

To be tapped off from existing lines

3.2. PLANT ALARMS

Supply and installation of a plant alarm to supervise all the medical gas plant. This plant alarm panel shall display gas pressure, normal and alarm conditions of all gases; panel shall contain audible and visual alarm indicators. Each gas service shall consist of a bank of five dual-circuit LED indicators, one green (for "normal" indication), three yellow and one red (for four output conditions).

3.2.1. Terminal Units

Medical gas terminal units shall be as Medaes Gem 10 or approved equivalent and shall conform to BS 5682: 1984 and International Standard 9170.

Terminal units shall be gas specific and accept only the correct medical gas probe.

Gas specific components shall be pin-indexed to ensure that a correct gas specific assembly is achieved such that in the normal course of dismantling for repair or maintenance, parts from other gases cannot inadvertently be used.

Terminal units shall be designed to allow easy and accurate installation and shall be supplied with installation instructions and a comprehensive Operating and Maintenance Manual.

Terminal units shall be capable of single handed insertion and removal of the correct BS 5682: 1984 medical gas probe and shall have a minimum 3 year warranty. All terminal unit installations can be achieved the use of Double Arm Pendants, Ceiling fixed Pendants, Bedhead Units, Wall Terminal units etc. depending on the application.

3.12.2 Isolating Valves

Medical gas line ball valves shall be as Medaes Limited or approved equal and shall be constructed of a nickel plated brass body, PTFE seats/seals and a brass chrome plated ball. The valve shall operate by a manual operating lever selected through 90˚. All medical gas line ball valves shall provide a full bore flow and shall be cleaned for oxygen service and fully tested prior to dispatch. Smaller Type V valve assemblies (15 to 42mm inclusive) shall incorporate stainless steel “Dowty” bonded seals and mechanically sealed connectors. Larger Type VF valve assemblies (54 to 108mm inclusive) shall be flanged, installed with stainless steel bolts, nuts and spring washers, with 3mm Viton sealing gaskets. In all cases, the use of PTFE tape or any other thread sealing medium shall not be used during installation.

Each medical gas line ball valve assembly shall terminate in copper stub pipes to enable brazing direct into the distribution system, using the fluxless brazing technique. A lockable device shall be provided and enable the valve to be locked in either the fully open or fully closed position.
Medical gas ball valve assemblies shall comply with, and fully satisfy, the pressure drop requirements of the United Kingdom Health Technical Memorandum No. 2022 and Model Specification C11.

3.1 DISTRIBUTION PIPEWORK

3.1.1 Introduction

Distribution pipework shall be manufactured, installed and commissioned in accordance with the United Kingdom Health Technical Memorandum No. 02-01 (where specified), and the National Health Service – Model Engineering Specification C11.

3.1.2 Pipework Materials

Pipework materials are manufactured by a licensee of the BS 5750 quality assurance certification scheme and all pipes and fittings are marked with the BSI kitemark.

3.1.3 Component Cleanliness and Protection

Component cleanliness and protection procedures are carried out on all pipes, fittings, components and equipment for use with all Medical gas services. Final residual contamination level does not exceed 100mg/m² when tested by the method specified in ASTM B280 Clause 12. All equipment and items supplied to site are fully protected against the ingress of dirt and contamination by:

(a) Sealing small components in polythene bags or boxes.

(b) Individual end capping of pipes.

(c) Bundling and sleeving pipework in polythene bags.

(d) Wrapping or boxing

3.1.4 Cleaning and Degreasing

Copper pipes are cleaned and degreased by oxygen service in accordance with BOC Specification 399394. Fittings are cleaned, flux removed, dryed and degreased for oxygen service in accordance with BOC Specification 399856. All packaging is labeled “Degreased for Medical gas service”.

3.1.5 Pipework Supports

3.1.6 Spacing

Distribution system pipework is normally supported at intervals specified in table below:

Metric sizes outside diameter Mm	Maximum internals for vertical runs Metres	Maximum intervals for horizontal runs Metres
6	1.0	1.0
12	1.2	1.0
15	1.8	1.2
22	2.4	1.8
28	2.4	1.8
35	3.0	2.4
42	3.0	2.4
54	3.0	2.7
76	3.6	3.0

3.1.7 Secondary Fixing Brackets

Except for vertical drops to terminal units, secondary fixing brackets comprise a suitable metallic, non-ferrous material or a ferrous material suitably treated to prevent corrosion and electrolyte action. For vertical drops to terminal units, secondary fixing brackets comprise a suitable metallic, non-ferrous material or a non-metallic material.

3.1.8 Brazed Pipework Jointing

Copper to copper joints made on-site, utilize a copper phosphorous brazing alloy type CP1 or CP4 to BS 1845 and an inert gas shield and no flux. Copper or brass or gunmetal joints made off-site, utilize a silver brazing material type AG13 to AG18 to BS 1845, with a flux, and the joint is subsequently cleaned and degreased for oxygen service.

3.1.9 Pipe Preparation

Pipe ends are cut clean and square with the pipe axis using wheel cutters.

Cut ends and the inside of fittings are thoroughly cleaned. Expanded tube joints are formed with the correct pipe expanding tools and are only used for straight tube to tube joints on pipe sizes 28mm and below.

3.1.10 Inert Gas Shielding

Inert gas shielding is provided internally for all on-site fluxless jointing and hot forming of bends. Inert gas is Nitrogen to BS 4105.

PART C

BILLS OF QUANTITIES

4 PRICE SCHEDULES

4.1 GENERAL NOTES TO TENDERERS

1. The Bills of Quantities form part of the contract documents and are to be read in conjunction with the contract drawings and general specifications of materials and works.

2. The prices quoted shall be deemed to include for all obligations under the sub-contract including but not limited to supply of materials, labour, delivery to site, storage on site, installation, testing, commissioning (**excluding VAT**).

3. All prices omitted from any item, section or part of the Bills of Quantities shall be deemed to have been included to another item, section or part thereof.

4. The brief description of the items given in the Bills of Quantities are for the purpose of establishing a standard to which the sub-contractor shall adhere. Otherwise alternative brands of **equal** and **approved** quality will be accepted.

5. Should the sub-contractor install any material not specified here in before receiving **written approva**l from the Project Manager, the sub-contractor shall remove the material in question and, **at his own cost**, install the proper material.

6. The grand total of prices in the Summary page must be carried forward to the **volume 1**.

7. The Bills of Quantities are divided generally into three sections:-

   a. Contractual Requirements – Bill 1

   These captured under main works specification document.

   b. Installation Items – Other Bills

   The brief description of the items in these Bills of Quantities should in no way modify or supersede the detailed descriptions in the contract Drawings, conditions of contract in Volume 1 and specifications. The unit of measurements and observations are as per those described in the contract documents.

   c. Summary

   The summary contains tabulation of the separate parts of the Bills of Quantities carried forward with provisional sum, summary volume included. The sub-contractor shall insert his totals and enter his grand total tender sum in the summary.

   This grand total tender sum shall be carried forward to main summary of volume 1 of the main works

PROPOSED LABOR WARD RENOVATIONS AT THE NAIROBI HOSPITAL

MEDICAL GASES INSTALLATIONS

BILLS OF QUANTITIES

SECTION D.W. (I) TITLE: PRELIMINARIES & CONTRACTUAL REQUIREMENTS

Item	Description	Unit	Qty	Rate	Cost KShs.
	PRELIMINARIES & CONTRACTUAL REQUIREMENTS				
A.	Preparation of working drawings, printing and distribution.	Sum			-
					-
B.	Preparation of 'As Installed Drawings", printing and distribution as specified. Drawings to include:				-
	(a) Blue Prints - 4 sets of each.	Sum			-
	(b) AutoCAD on Flash Drive (5 GB) – 2 No.	Sum			-
	(c) Operational Instructions, manuals and test certificates - 4 Sets	Sum			-
					-
C	Allow for any other preliminary stated in the conditions of contract	Sum			-
D	Any other item necessary to complete the installations in this section (please state)	Sum			-
	Carried to Main Summary Page				-

SECTION D.W. 1 - - EXTERNAL MEDICAL GASES PIPEWORK

Item	Description	Unit	Qty	Rate	Cost KShs.
1.1	**EXTERNAL MEDICAL GASES PIPEWORK** **Supply , Install, Test and Commission the following materials, equipment, apparatus, fittings etc. including erection, testing and commissioning as described below and shown on the drawings-** The distribution pipe work shall be manufactured, installed, tested and commissioned in accordance with UK Health Technical Memorandum 02-01 and the Nation Health Service – Model Engineering Specification C11. Pipework materials shall be manufactured by a licensee of the BS 5760 quality assurance certification scheme and all pipes and fittings are marked with the BSI Kitemark. Pipes to be phosphorous de-oxidised non-arsenical copper to BS 6017 and BS 2871 and marked to BS 2871. Tenderers to allow for brazing, reducers supports, flux, clippings, cleaning, bending, forming and degreasing as necessary for the proper functioning of the installations as specified:				
A	15mm dia. copper pipe.	LM	0		-
B	22mm dia. ditto.	LM	120		-
	Fittings to BS 6017 Grade C106 of sizes and manufacture to BS 864 Part 2.				
C	15mm dia. copper bend.	No.	0		-
D	22mm dia. ditto.	No.	33		-
E	15mm dia. tee.	No.	0		-
F	22mm dia. ditto.	No.	9		-
G	22mm dia. Medical gas line ball valve assemblies	No.	6		-
	Carried to main collection page				-

SECTION D.W. 2 - - MEDICAL GASES PIPEWORK

Item	Description	Unit	Qty	Rate	Cost KShs.
2.1	**INTERNAL MEDICAL GASES PIPEWORK** **Supply , Install, Test and Commission the following materials, equipment, apparatus, fittings etc. including erection, testing and commissioning as described below and shown on the drawings-** The distribution pipe work shall be manufactured, installed, tested and commissioned in accordance with UK Health Technical Memorandum 02-01 and the Nation Health Service – Model Engineering Specification C11. Pipework materials shall be manufactured by a licensee of the BS 5760 quality assurance certification scheme and all pipes and fittings are marked with the BSI Kitemark. Pipes to be phosphorous de-oxidised non-arsenical copper to BS 6017 and BS 2871 and marked to BS 2871. Tenderers to allow for brazing, reducers supports, flux, clippings, cleaning, bending, forming and degreasing as necessary for the proper functioning of the installations as specified:				
A	15mm dia. copper pipe.	LM	180		-
B	22mm dia. ditto.	LM	90		-
	Fittings to BS 6017 Grade C106 of sizes and manufacture to BS 864 Part 2.				
C	15mm dia. copper bend.	No.	60		-
D	22mm dia. ditto.	No.	30		-
E	15mm dia. tee.	No.	16		-
F	22mm dia. ditto.	No.	8		-
G	22mm dia. Medical gas line ball valve assemblies	No.	6		-
	Carried to main collection page				-

SECTION D.W. 3- - MEDICAL GASES ACCESSORIES

Item	Description	Unit	Qty	Rate	Cost KShs.
3.1	**Bedheads, Medical Gases accessories, ZSU's, Alarm Panel etc** **Supply , Install, Test and Commission the following materials, equipment, apparatus, fittings etc. including erection, testing and commissioning as described below and shown on the drawings-**				
A	Medical Bedhead Unit with 3 No. Medical gases terminals, (1No. Oxygen, 1 No. Medical Air, 1 No. vacuum), 1 No. nurse call system, 2No. Raw power twin sockets, 4No. Clean power twin non-standard socket, 3 Gang switch, equipotential earth socket, telephone point, 4No. data points room, reading and examination lights, and a top rail for other fixings as Beacon Medaes or equal and approved.	No.	8		-
B	Medical Gas Terminal unit (wall mounted) complete with all accessories as Medaes GEM 10 or equal and approved. Medical gas outlets:				
	(i) Vacuum Outlets	No.	8		-
	(ii) Medical Gases Outlets	No.	8		-
	(iii) Oxygen outlets	No.	8		-
C	Zone service unit for 1 No. gases in valve boxes 22mm dia. with pressure switch mounting as Beacon Medaes ZSU or approved equivalent.	No.	3		-
D	Allow for careful removal of all existing bedhead units and handover to the client. Rate to include cart away of materials that will not required.	item	1		-
		Carried to next page			-

SECTION D.W. 3 - - MEDICAL GASES ACCESSORIES

Item	Description	Unit	Qty	Rate	Cost KShs.
	bal b/f				-
	Local/Area Alarm system				
E	The LCD Alarm shall be capable of displaying all alarms includes pressure high, low, or normal, flow and report to main control centre or computer screen via the facility's ethernet or internet complete. Alarm Panel to be as Medipoint 26 by Beacon Medaes and to be capable of monitoring 3 No. Gases, and complete with all associated accessories, including all high and low pressure sensors, cabling, etc	No.	1		-
	Testing & Commissioning				
F	Allow for flushing of the existing pipework, pressure testing, repairs, testing and commissioning of the entire system (including already installed copper pipework) in the . Rates to capture all neccesary accessories and tools required for testing and commissioning of the installation.	No.	1		-
				Carried to Main-Collection	-

MAIN COLLECTION PAGE

Item	Description				Price (KShs.)
	PROPOSED LABOR WARD AT THE NAIROBI HOSPITAL **MEDICAL GASES INSTALLATIONS** **MAIN COLLECTION PAGE**				
(i)	Preliminaries and General Conditions				-
1	External pipework				-
2	Internal pipework				-
3	Medical Gases Accessories				-
	Sub-Total (Inclusive of VAT)				-
	Total				-
	TOTAL FOR MEDICAL GASES CARRIED TO MAIN SUMMARY PAGE				-

APPENDICES

1.2 Appendix II; Statement of Compliance

Technical Schedules shall be submitted by tenderers to facilitate and enable the Engineer to evaluate tenders. Failure on the part of the tenderer to submit said schedules shall constitute an affirmation by the tenderer that the tenderer shall provide the equipment and brands as specified in the bill of quantity.

Tenderers shall submit separate leaflets and catalogues giving technical and physical details for all fittings and accessories described in the Technical Schedule at the time of tendering.

Completion of Technical Schedule shall not relieve the Contractor from complying with the requirements of the Specification except as may be approved by the Engineer in writing. Award of contract to the tenderer shall not constitute approval of any proposed equipment to be supplied, as detailed in the tenderers submitted technical schedules.

…….. **(Signed)**

…….. **(Date)**

1.4 Appendix IV; System Warranties

The tenderer shall outline the warranties for all systems installed on this site as specified elsewhere.

These shall include but not limited, to the following:

- Bedheads
- Head Walls
- ZSU's
- Alarm Panels
- Terminal Units

Etc.

Appendix V
Schedule of Unit Rates

1.5 Appendix V; Schedule of Unit Rates

The tenderers shall provide a schedule of unit rates (under Tables (a) and (b) below) that shall be used to build up rates for variation items not specified in the bill of quantity. This section, and the terms filled herein shall form part of the contract, and shall be considered locked for the duration of the project.

Rates filled herein shall be evaluated as part of the tender evaluation process.

The sub-contractor shall disclose the cost of the material offered by the supplier, including or manufacturer or any other sources to the Engineer used to build up the rates in respect to schedule of table (a) and table (b) below. The engineer can reject the disclosed sources where the conflict of interest seems to prevail.

Table (a) and Table (b) shall be deemed to be exhaustive in capturing all cost components and the percentages filled herein shall be considered to be locked for the duration of the contract.

- **Locally Available Items**

Unit rates for items that can be procured locally shall be generated according to table (a) below. Table (a) consists of the below items:

- Material cost – This is the supplier's unit cost for the item, i.e. the cost at the shop/supplier.
- Labor – This is to include all transportation, security, hoisting, installation, tools and consumables, testing, commissioning, costs, etc. The tenderer is to provide his/her labor cost as a percentage of material cost.
- Overheads and Profit – This is to capture all Contractor's overheads, margins, profit, etc. The tenderer is to provide his/her overheads and profit as a percentage of material cost.
- Further to this, tenderers are expected to list all other cost carriers not deemed to have been captured in the table below, as a percentage of material cost.

- *Table (a): Locally Available Items.*

Material Cost Kshs. (a)	Labour (as a percentage of material cost) (b)	Overheads and Profit (as a percentage of material cost) (c)	List any other component as necessary (as a percentage of material cost) (d)	Total Installed Cost of item shall Kshs. a + (axb%) + (axc%) + (axd%) (VAT exclusive)
	……..%	……..%	……..%	

- **Imported Items**

Unit rates for items that will require importation shall be generated according to table (b) below. Table (b) consists of the below items:

- Material cost – This is the supplier's unit cost for the item as landed and cleared in Kenya. It includes FOB price, Carriage Insurance & Freight, Inspection Charges, Duty, Port Levies, Clearance Charges and VAT

- Labor – This is to include cost for transportation from port to site, security, hoisting, installation, tools and consumables, testing, commissioning and associated costs, etc. The tenderer is to provide his/her labor cost as a percentage of material cost.
- Overheads and Profit – This is to capture all Sub-contractor's overheads, margins, profit, etc. The tenderer is to provide his/her overheads and profit as a percentage of material cost.
- Further to this, tenderers are expected to list all other cost carriers not deemed to have been captured in the table below, as a percentage of material cost.

- *Table (b): Imported Items.*

Material Cost Kshs. (a)	Labour (as a percentage of material cost) (b)	Overheads and Profit (as a percentage of material cost) (c)	List any other component as necessary (as a percentage of material cost) (d)	Total Installed Cost of item shall Kshs. a + (axb%) + (axc%) + (axd%) (VAT exclusive)
	……..%	……..%	……..%	

1.6 Appendix VI; Day Work Terms for Labour

(To Be Completed By Tenderer)

Description of Artisan	Cost Per Hour
Supervisor	……
Technician 1	……
Technician 2	……
Technician 3	……
Labour	……
Apprentices	……

1.7 Appendix IV; Technical Schedule

TECHNICAL SCHEDULE

The tenderer must complete in full the technical schedule. Apart from the information required in the technical schedule, the tenderer **MUST SUBMIT** comprehensive manufacturer's technical schedules details for all items listed in this schedule (fill forms attached).

ITEM No.	Description	Remarks
A	Copper pipe	
B	Bedhead	
C	ZSU's	
D	Terminal units	

THE NAIROBI HOSPITAL

PROPOSED IMPROVEMENT OF THE LABOUR WARD

BOOK OF DRAWINGS

1. Architectural
2. Civil/Structural
3. Mechanical Services
4. Electrical Services

January 2024

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PROPOSED IMPROVEMENT OF THE LABOUR WARD

ARCHITECTURAL BOOK OF DRAWINGS

January 2024

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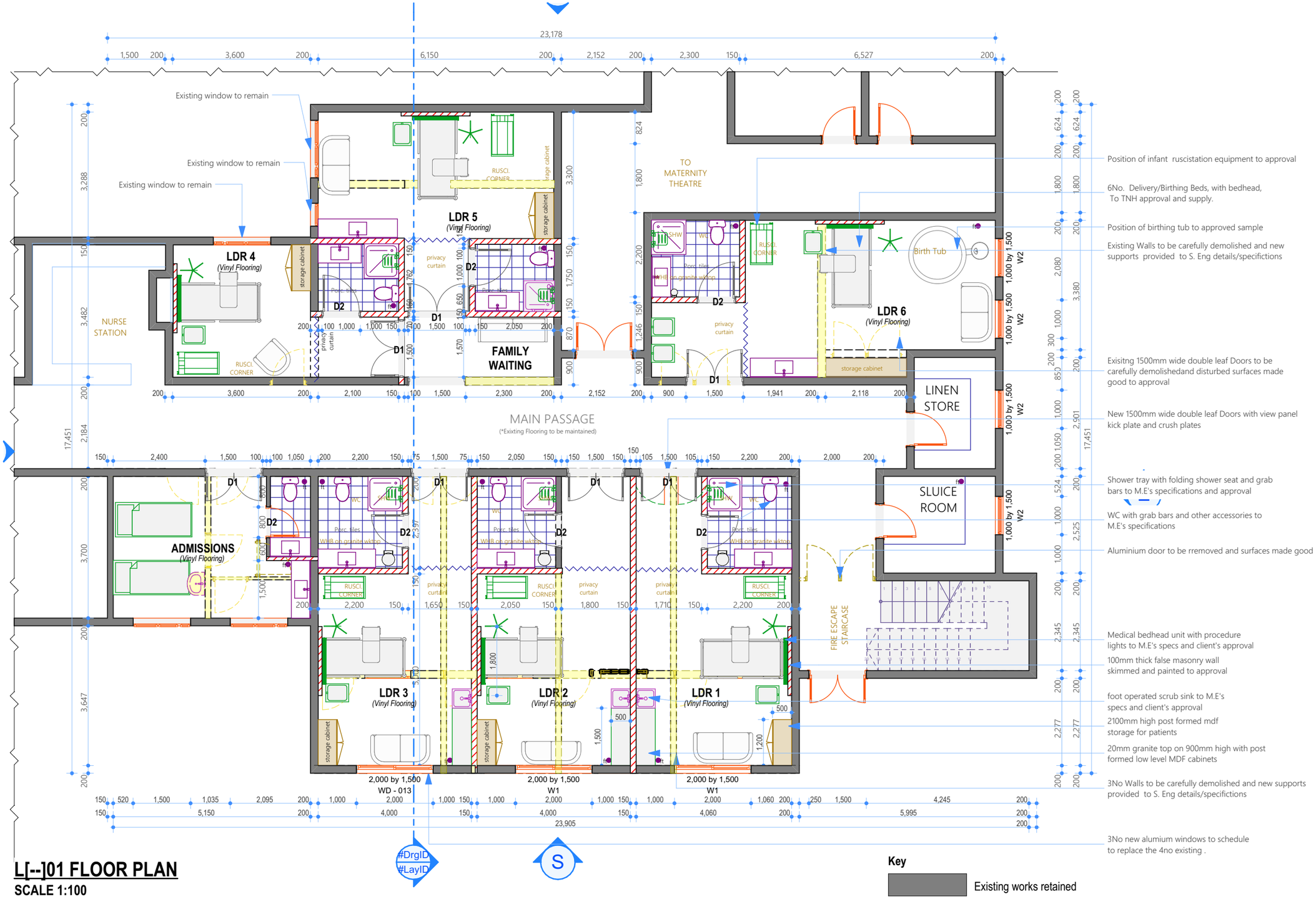

L[--]01 FLOOR PLAN

SCALE 1:100

Key

- Existing works retained
- Demolition works
- New works

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NOTES

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4. Any discrepanies in this drawing must be reported to the architect before construction commences.

REVISIONS

NO.	REVISION/ISSUE	DONE BY:	INSTRUCTION BY:	DATE

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PROJECT
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Plot L. R. No. 209/4209/2, ARGWINGS KODHEK ROAD, NAIROBI COUNTY.

DRAWING TITLE
WORKING DRAWINGS

JOB NO.	
2515 - 16	

DRAWING NO.	REV
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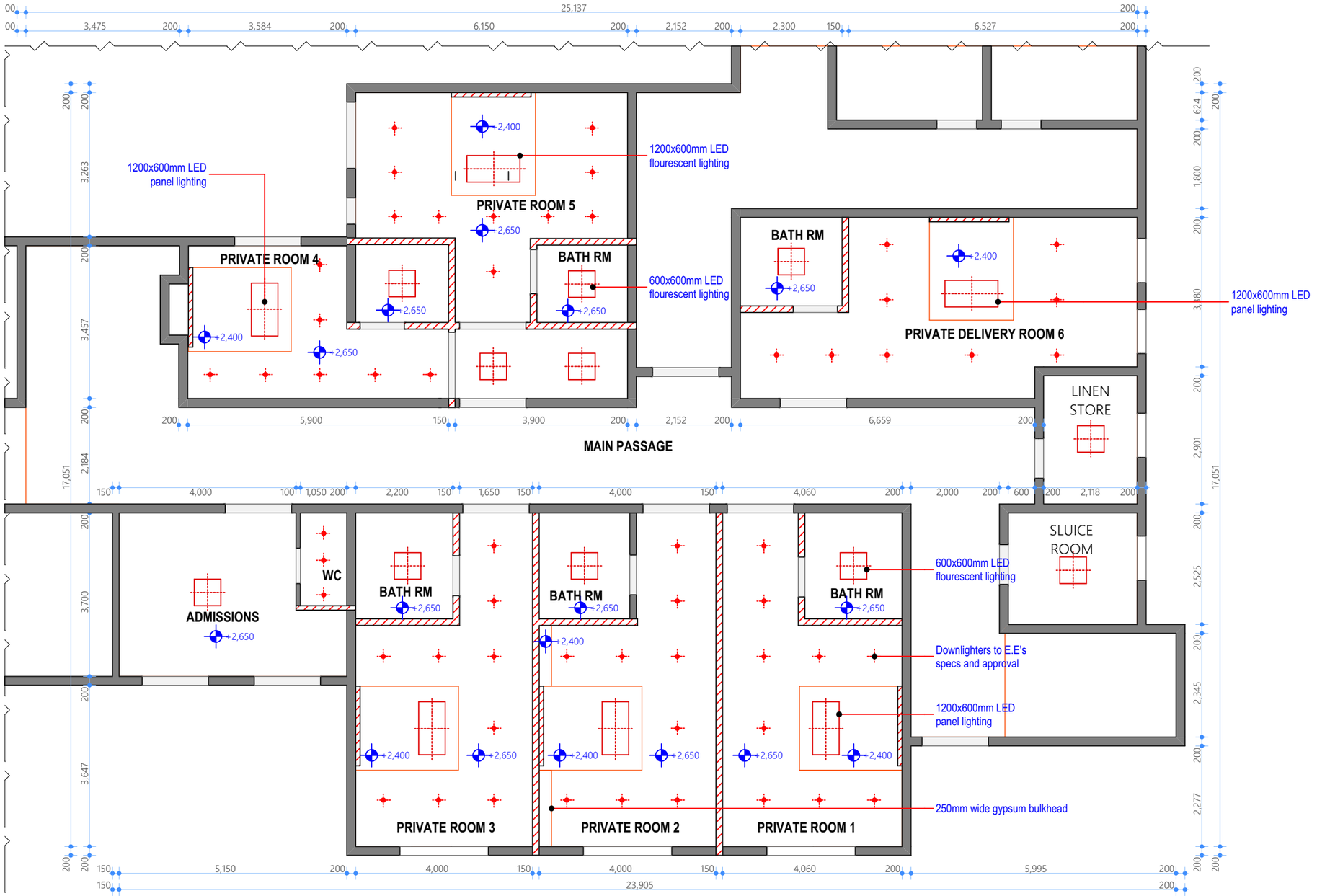

L[--]02 REFLECTED CEILING PLAN

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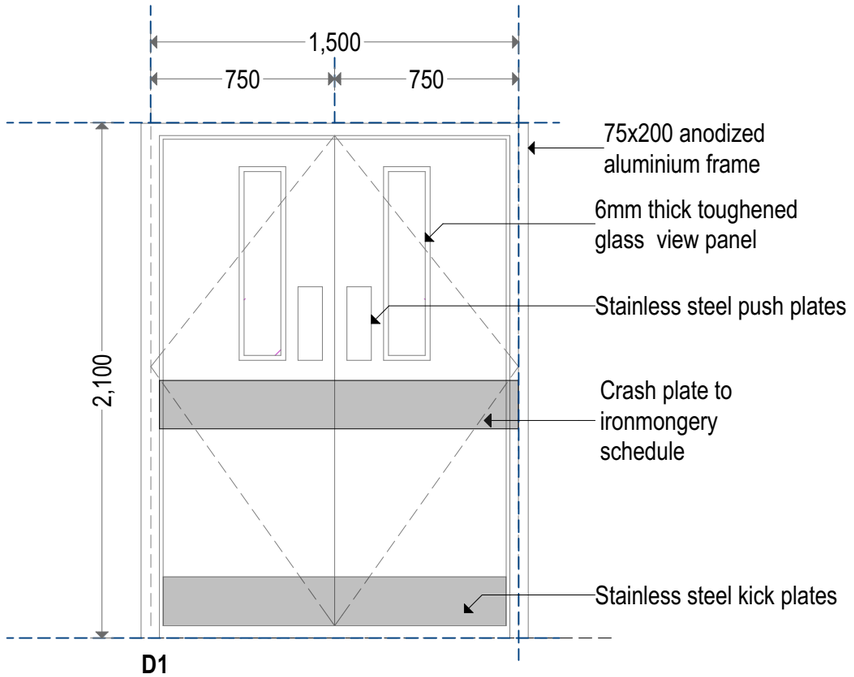
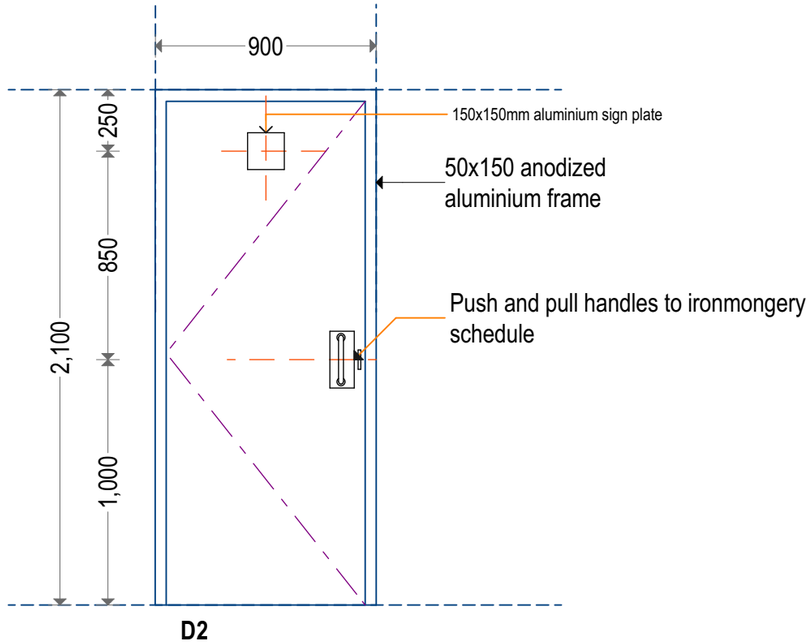


D1

Description;

45mm thick post formed door with concealed lipping

IRONMONGERY:
-6 nos.S.S ball bearing hinges 'HN 2BB-403030'
-1 pair 200mm stainless steel pull handles mounted on S.S plate engraved
-2 lever lock 2 wayaction
-Cylinder stainless steel floor mounted door stop 'DH005 SS'
-Door closer,power 2-6 STD ARM 9shenfei) '7836 SIL'
-



D2

Description;

45mm thick post formed door with concelaed lipping

IRONMONGERY:
-3no. 100mm steel butt hinges as Union 'HN 2BB-403030'
-Steel door lock as 'Union 05-22931'
-Stainless steel door stop as 'Union DH005'
-Stainless steel heavy duty door closer as 'Union 8247 SS'
-Stainless steel euro cylinder lock case, 72 centres with gull on plate handle as 'UNION QDS001047-72'

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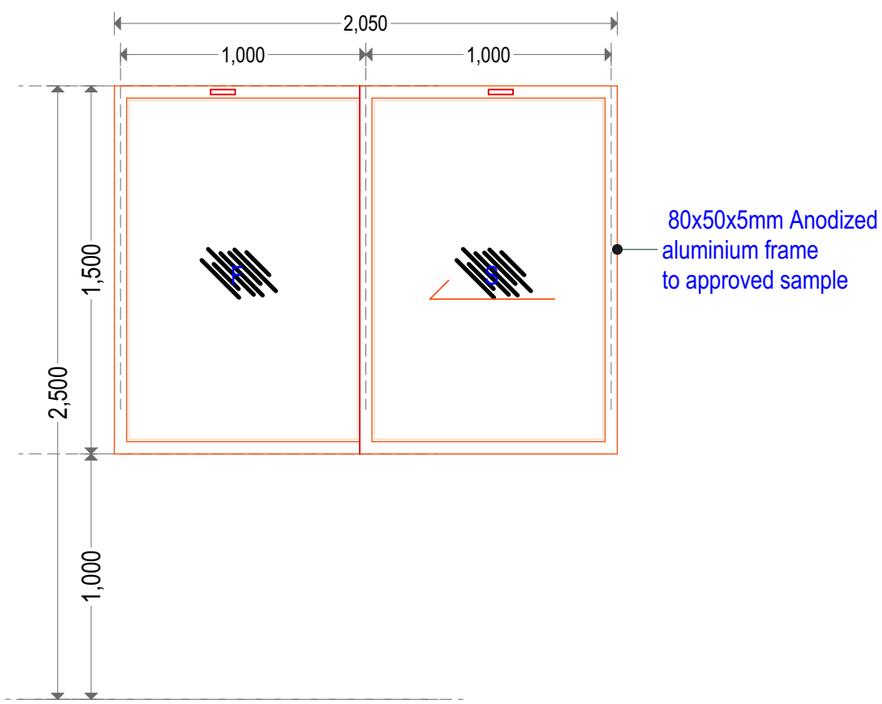


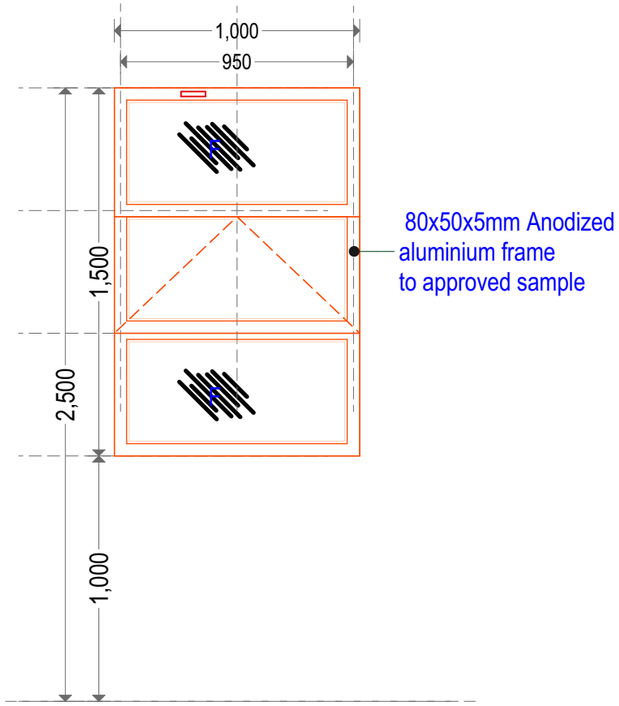
W1

Description;

Purpose made anodized aluminium glazed sliding window, with 8mm one way glass, with 150x20mm thick galaxy black granite in window board to sample to approval.

Iron Mongery;

fasterners,stays,hinges and sliding rails to manufacturers specs.



W2

Description;

Purpose made anodized aluminium glazed window, with 8mm one way glass, with 150x20mm thick galaxy black granite in window board to sample to approval.

Iron Mongery;

fasterners,stays,hinges and sliding rails to manufacturers specs.

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4. Any discrepanies in this drawing must be reported to the architect before construction commences.

REVISIONS

NO.	REVISION/ISSUE	DONE BY;	INSTRU-CTION BY;	DATE

CLIENT

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LINEAR PROJECTS LIMITED

PROJECT

PROPOSED MATERNITY ROOMS IMPROVEMENT NAIROBI HOSPITAL -

SITE

Plot L. R. No. 209/4209/2, ARGWINGS KODHEK ROAD, NAIROBI COUNTY.

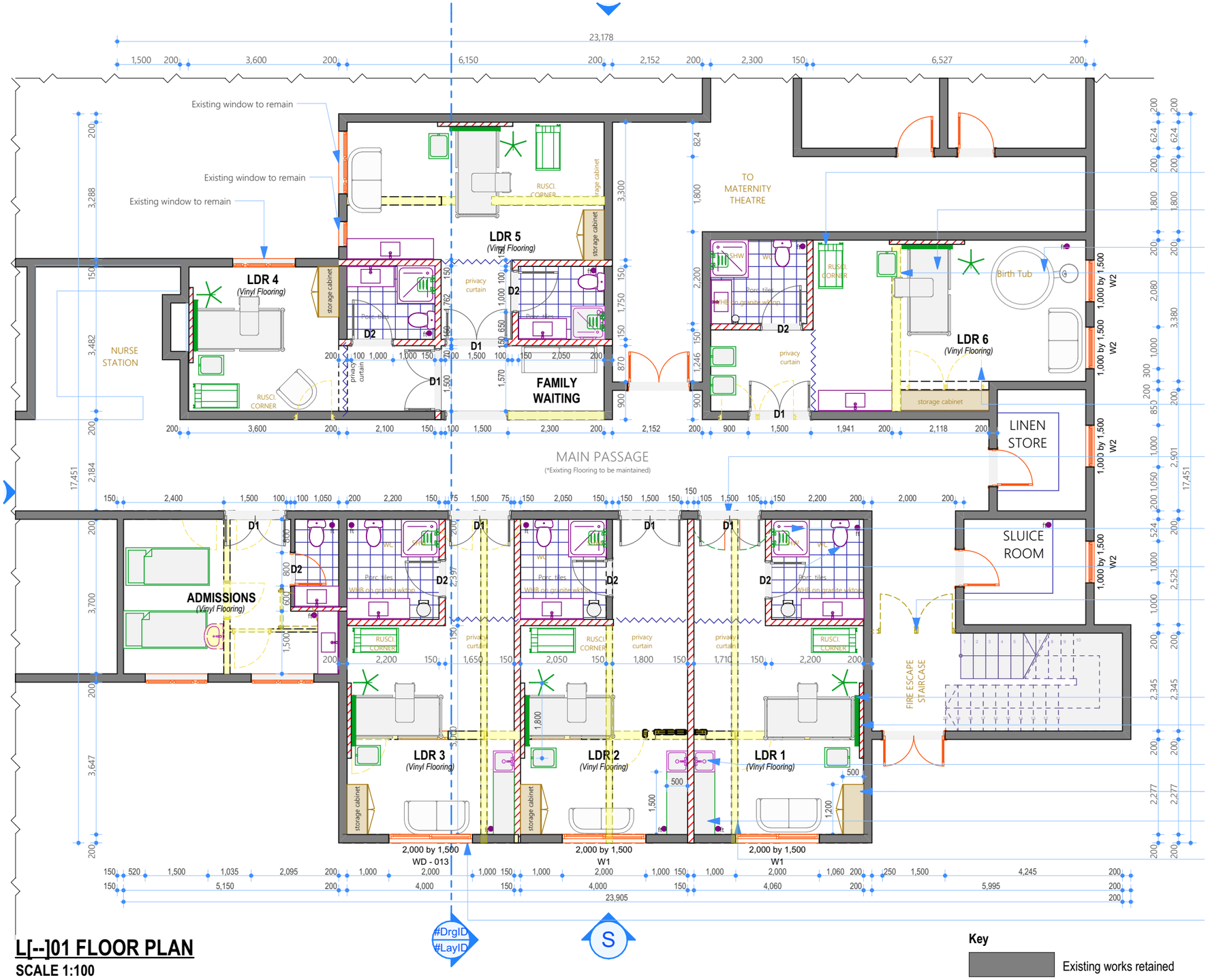
DRAWING TITLE

WORKING DRAWINGS

JOB NO. **2515 - 16**

DRAWING NO. **2515 - 15/1** REV **00**

DATE	06/1 /2024	DRAWN	Arch. M.L
SCALE	1:75	CHECKED	ARCH.E . KIGAI



L[--]01 FLOOR PLAN

SCALE 1:100

#DrgID
#LayID

S

Key

- Existing works retained
- Demolition works
- New works

Position of infant ruscistation equipment to approval

6No. Delivery/Birthing Beds, with bedhead, To TNH approval and supply.

Position of birthing tub to approved sample

Existing Walls to be carefully demolished and new supports provided to S. Eng details/specifictions

Exisitng 1500mm wide double leaf Doors to be carefully demolishedand disturbed surfaces made good to approval

New 1500mm wide double leaf Doors with view panel kick plate and crush plates

Shower tray with folding shower seat and grab bars to M.E's specifications and approval

WC with grab bars and other accessories to M.E's specifications

Aluminium door to be rremoved and surfaces made good

Medical bedhead unit with procedure lights to M.E's specs and client's approval

100mm thick false masonry wall skimmed and painted to approval

foot operated scrub sink to M.E's specs and client's approval

2100mm high post formed mdf storage for patients

20mm granite top on 900mm high with post formed low level MDF cabinets

3No Walls to be carefully demolished and new supports provided to S. Eng details/specifictions

3No new alumium windows to schedule to replace the 4no existing .

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NOTES

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REVISIONS

NO.	REVISION/ISSUE	DONE BY:	INSTRU-CTION BY:	DATE

CLIENT

THE NAIROBI HOSPITAL
P.O. Box 30026 - 00100 NAIROBI

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projects : strategy : risk : management

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LINEAR PROJECTS LIMITED

PROJECT
PROPOSED MATERNITY ROOMS IMPROVEMENT NAIROBI HOSPITAL -

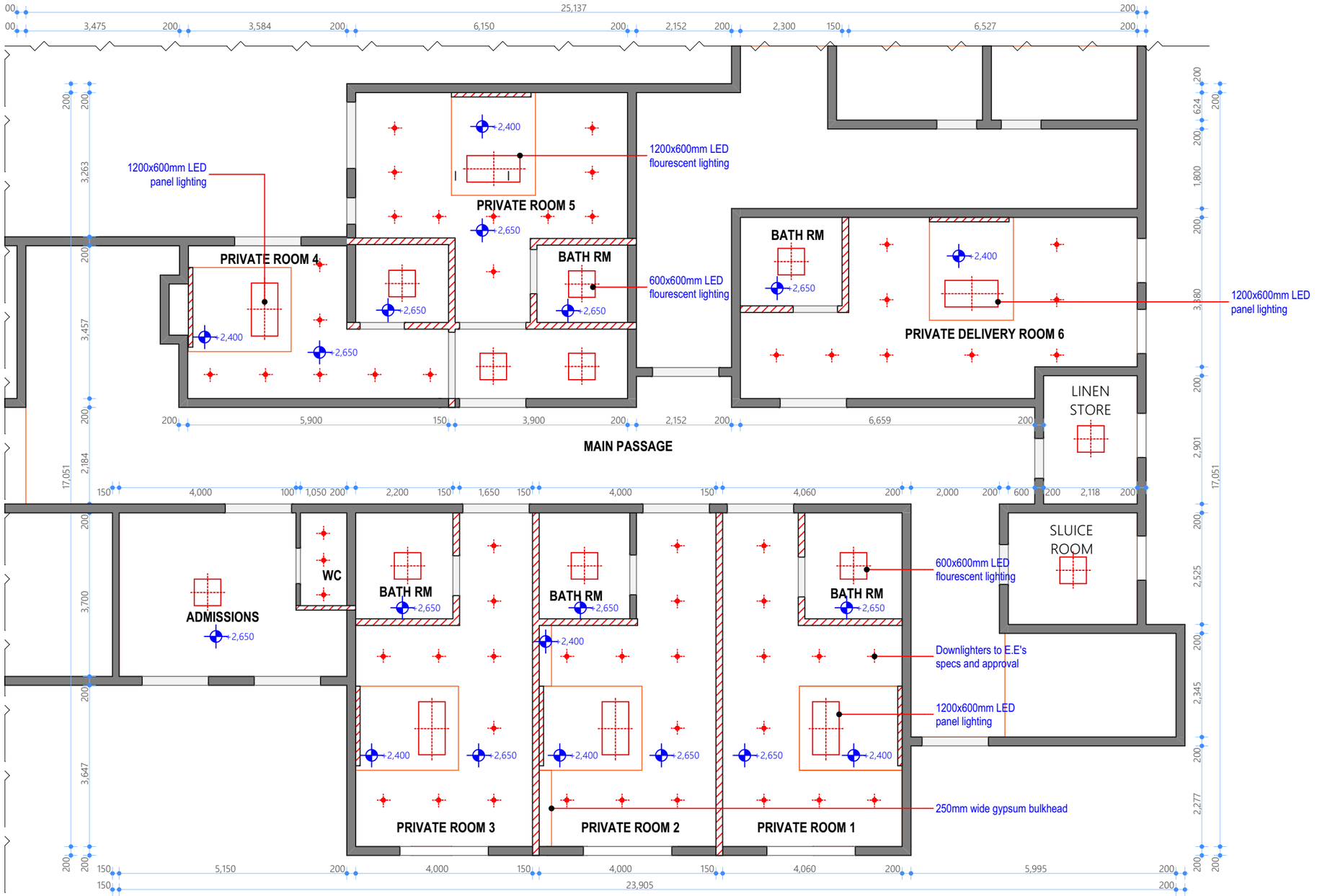
SITE
Plot L. R. No. 209/4209/2, ARGWINGS KODHEK ROAD, NAIROBI COUNTY.

DRAWING TITLE
WORKING DRAWINGS

JOB NO. **2515 - 16**

DRAWING NO. **2515 - 15/1** REV **00**

DATE	06/1 /2024	DRAWN	Arch. M.L
SCALE	1:75	CHECKED	ARCH . E . KIGAI



L[--]02 REFLECTED CEILING PLAN

SCALE 1:100

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SITE

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DRAWING TITLE

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DATE	06/1 /2024	DRAWN	Arch. M. L
SCALE	1:75	CHECKED	ARCH . E . KIGAI

BOOK OF DRAWINGS

FOR

CIVIL & STRUCTURAL DRAWINGS

PROPOSED FIY OUTS AND REORGANIZATION FOR THE NAIROBI HOSPITAL

LABOR WARDS

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DRAWINGS TITLE

JOB NO.

DRAWING NO. REV

DATE	SCALE	DRAWN	CHECKED

PROJECT
PROPOSED REDEVELOPMENT AT NAIROBI HOSPITAL CENTRAL CORE RECEPTION ALTERATION & REHABILITATION WORKS

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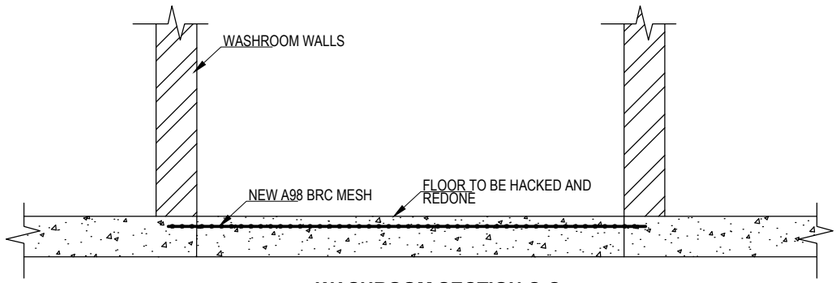
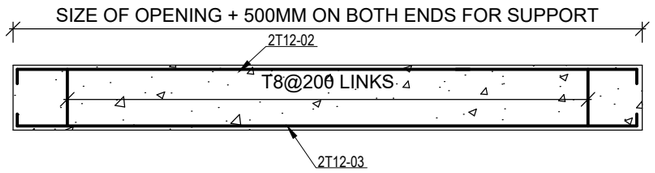
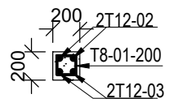


WASHROOM SECTION C-C



LINTEL BEAM (200X200)



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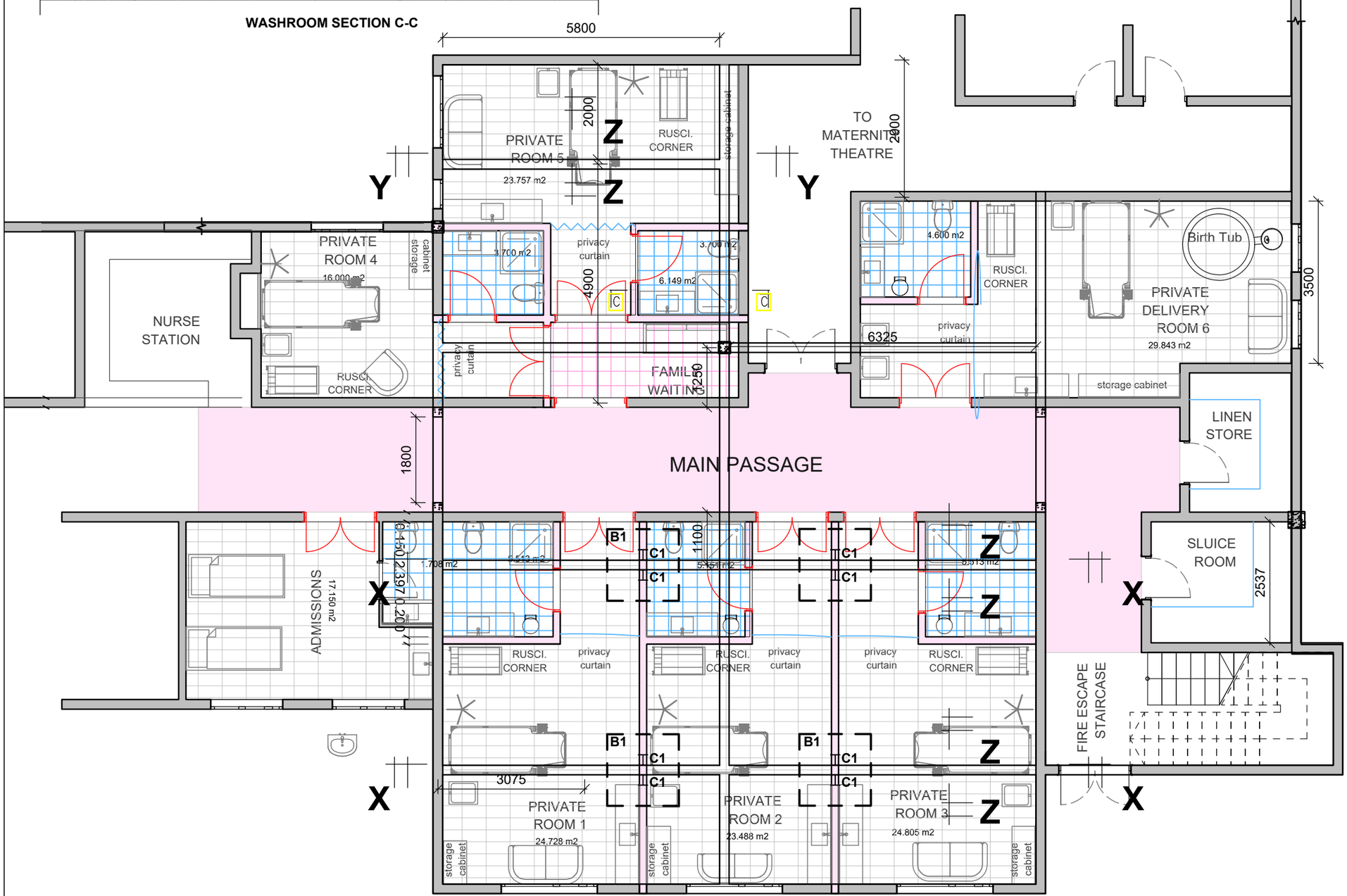

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PROJECT
PROPOSED FIT-OUTS AND RE-ORGANIZATION FOR THE NAIROBI HOSPITAL

SITE
Plot L. R. No. 209/6442/1,
NAIROBI COUNTY.

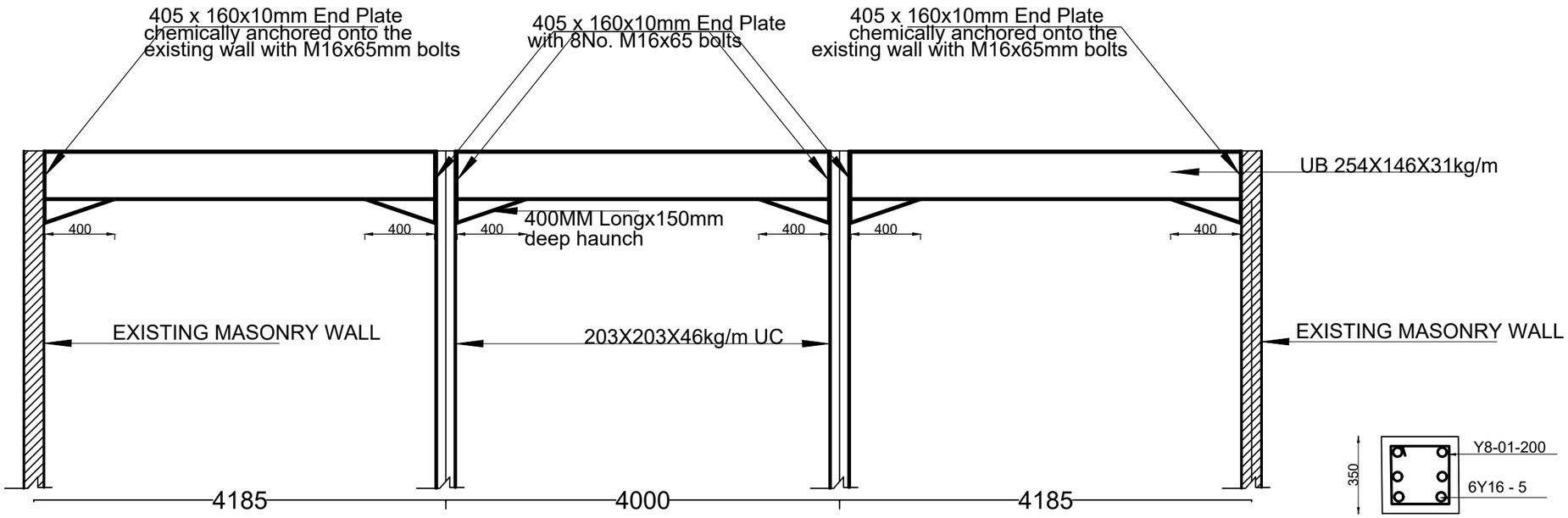
DRAWING TITLE
TNH MATERNITY IMPROVEMENT WORKS
Layout

JOB NO.

DRAWING NO. Nat24_TNH_labour_01

REV

DATE	SCALE	DRAWN	CHECKED
07-Jan-24		P.N.N	Eng. P.N.M



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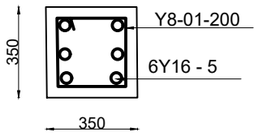

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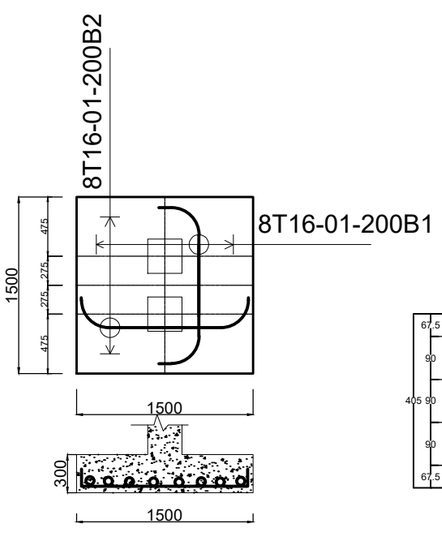

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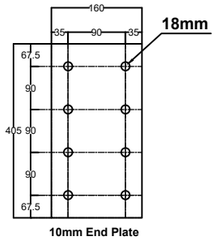

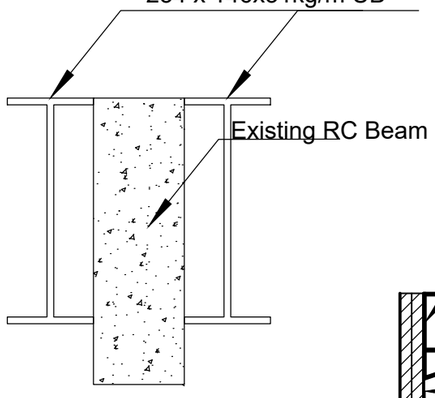

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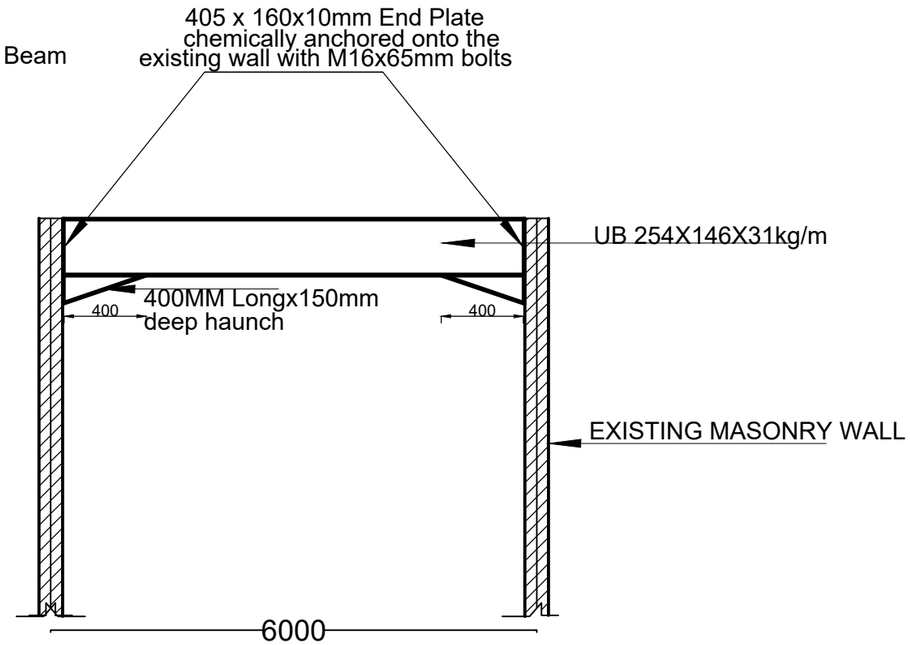

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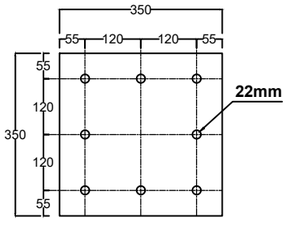

350X350X15MM BP-2 Nos
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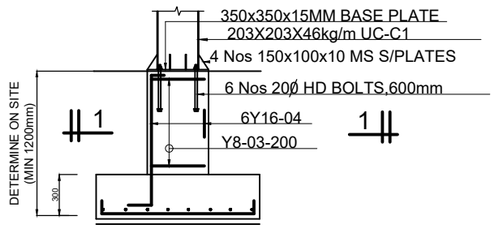

350x350 COL C1-2 Nos
SCALE 1:25

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P.O. Box 30026 - 00100 NAIROBI

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PROJECT
PROPOSED FIT-OUTS AND RE-ORGANIZATION FOR THE NAIROBI HOSPITAL

SITE
Plot L. R. No. 209/6442/1,
NAIROBI COUNTY.

DRAWING TITLE
TNH MATERNITY IMPROVEMENT WORKS
Beam Details

JOB NO.

DRAWING NO. Nat24_TNH_labour_02
REV

DATE	SCALE	DRAWN	CHECKED
07-Jan-24		P.N.N	Eng. P.N.M

THE NAIROBI HOSPITAL

PROPOSED RE-ORGANIZATION AT THE NAIROBI HOSPITAL

PROPOSED MATERNITY LABOR WARDS IMPROVEMENT

MECHANICAL SERVICES BOOK OF DRAWINGS

PREPARED BY

GEOMAX CONSULTING ENGINEERS

GEOMAX CONSULTING | DESIGN|MANAGEMENT

DRAWING REFERENCE AND CODING KEY

L (- -)01 ← DRAWING NUMBER
↑ ↑ SERVICES CODE
LAYOUT CODE

L(50) - MECHANICAL SCHEDULE OF DRGS.
L(52) - DRAINAGE SERVICES
L(53) - PLUMBING & FIRE PROTECTION
L(57) - AIR CONDITIONING & MECHANICAL VENTILATION

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5. Any discrepancies in this drawing must be reported to the Engineer before construction commences
6. All drainage pipes passing under buildings and drive ways to be pvc pipes and encased in concrete.
7. All inspection chambers on driveways to have heavy duty covers.
8. All sanitary fittings to be in accordance with MoH rules, regulations and specifications.
9. All final services connections to existing to be agreed with the client and approved by the Engineer
10. Existing services disconnections shall be effected with explicit approval from the client and the Engineer

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projects : strategy : risk : management.

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PROJECT

PROPOSED MATERNITY LABOR WARDS IMPROVEMENTS

FOR THE NAIROBI HOSPITAL

SITE
Argwings Kodhek Road, Nairobi

DRAWING TITLE:
COVER PAGE

JOB NO.
J2106.27

DRAWING NO. REV

DATE	SCALE	DRAWN	CHECKED
JAN-2024	N.T.S	SKK	SKK

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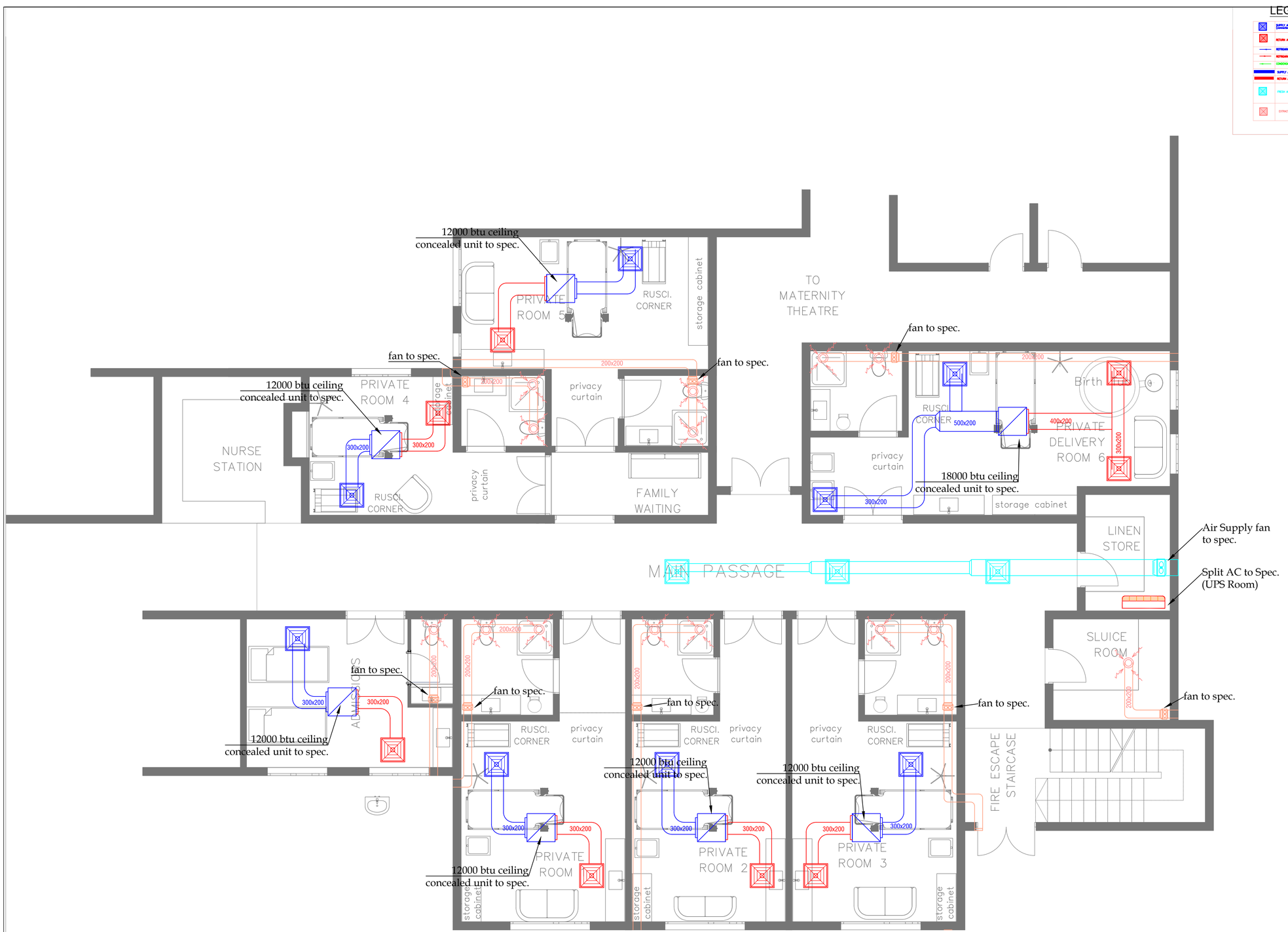

LEGEND

- SUPPLY AIR DIFFUSER SIZE 600x600mm (Perforated To AC Units)
- RETURN AIR DIFFUSER SIZE 600x600mm
- REFRIGERANT SUCTION LINE PIPE
- REFRIGERANT DISCHARGE LINE PIPE
- CONDENSATE DRAIN PIPE
- SUPPLY AIR SLOT DIFFUSER SIZE 1200x200mm
- RETURN AIR SLOT DIFFUSER SIZE 1200x200mm
- FRESH AIR SUPPLY DIFFUSER SIZE 600x600mm
- EXTRACT AIR DIFFUSER SIZE 600x600mm

DRAWING REFERENCE AND CODING KEY

L (- -)01
- 01 ← DRAWING NUMBER
- (- -) ← SERVICES CODE
- L ← LAYOUT CODE

L(50) - MECHANICAL SCHEDULE OF DRGS.
L(52) - DRAINAGE SERVICES
L(53) - PLUMBING & FIRE PROTECTION
L(57) - AIR CONDITIONING & - MECHANICAL VENTILATION

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PSRM CONSULTANTS projects : strategy : risk : management.

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PROJECT

PROPOSED MATERNITY LABOR WARDS IMPROVEMENTS

FOR THE NAIROBI HOSPITAL

SITE

Argwings Kodhek Road, Nairobi

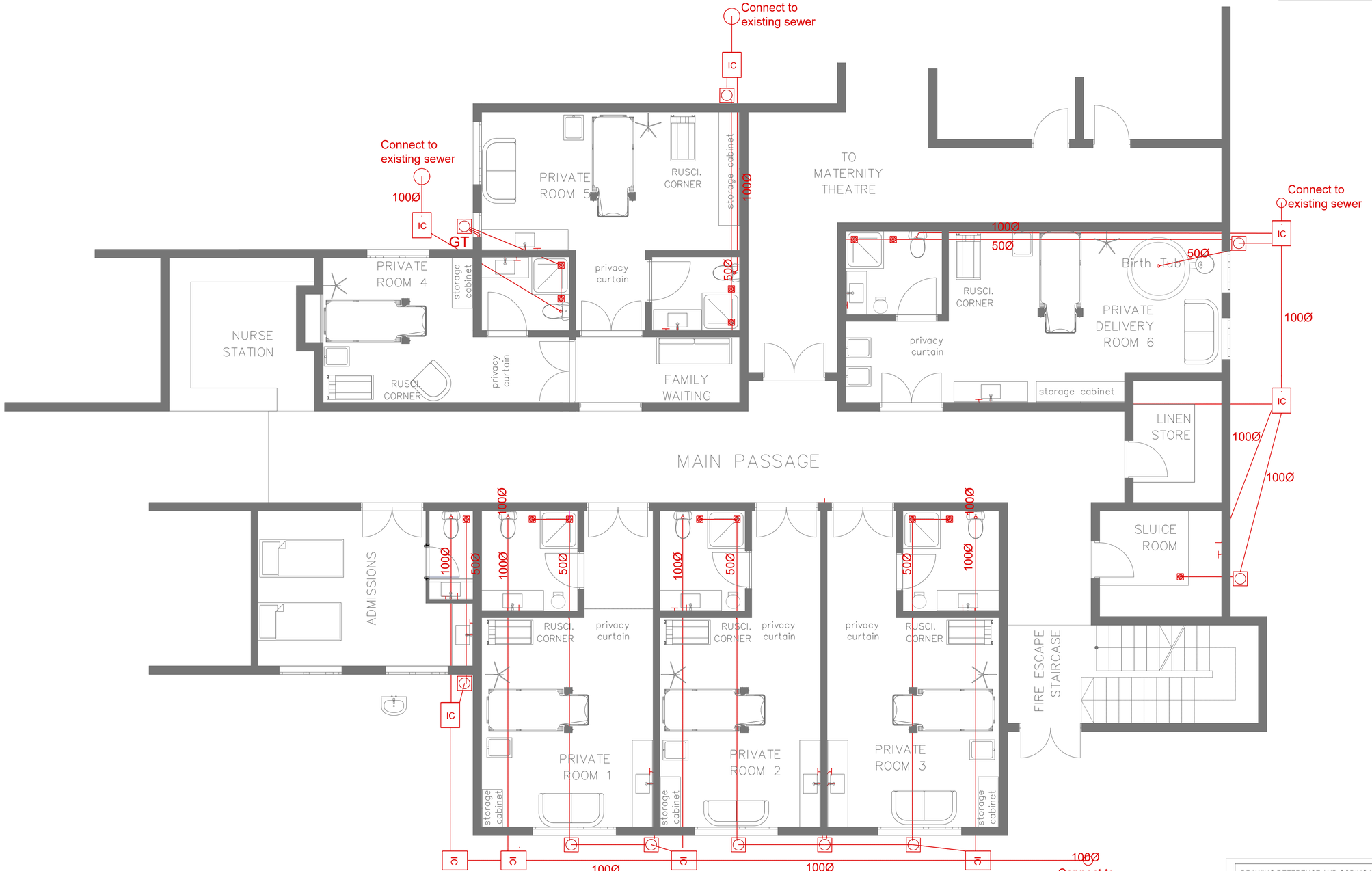
DRAWING TITLE: MATERNITY LABOR WARD IMPROVEMENTS

AIR CONDITIONING & MECHANICAL VENTILATION LAYOUT

JOB NO. J2106.27

DRAWING NO. J2106.27 - L(57) - 01 REV 0

DATE	SCALE	DRAWN	CHECKED
JAN – 2024	1:50(A1)	SKK	SKK



LEGEND

- CWS- COLD WATER SUPPLY PIPE
- HWS- HOT WATER SUPPLY PIPE
- HWR - HOT WATER RETURN LINE
- RM ..... RISING MAIN
- FA ..... FROM ABOVE
- TB ..... TO BELOW
- HR 90m HOSEREEL
- FE 9ltr. WATER CO2 FIRE EXTINGUISHER
- FE 9kg ABC DRY POWDER FIRE EXTINGUISHER

DRAWING REFERENCE AND CODING KEY

L (- -)01
- 01 ← DRAWING NUMBER
- SERVICES CODE
- LAYOUT CODE

L(50) - MECHANICAL SCHEDULE OF DRGS.
L(52) - DRAINAGE SERVICES
L(53) - PLUMBING & FIRE PROTECTION
L(57) - AIR CONDITIONING & - MECHANICAL VENTILATION

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10. Existing services disconnections shall be effected with explicit approval from the client and the Engineer

REVISIONS

NO.	REVISION/ISSUE	DONE BY;	INSTRU-CTION BY;	DATE

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PROJECT

PROPOSED MATERNITY LABOR WARDS IMPROVEMENTS FOR THE NAIROBI HOSPITAL

SITE

Argwings Kodhek Road, Nairobi

DRAWING TITLE: MATERNITY LABOR WARD IMPROVEMENTS

DRAINAGE LAYOUT

JOB NO. J2106.27

DRAWING NO. J2106.27 - L(52) - 02 REV 0

DATE	SCALE	DRAWN	CHECKED
JAN–2024	1:50(A1)	SKK	SKK

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FE ..... 9kg ABC DRY POWDER FIRE EXTINGUISHER

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SERVICES CODE
LAYOUT CODE

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PROJECT

PROPOSED MATERNITY LABOR WARDS IMPROVEMENTS

FOR THE NAIROBI HOSPITAL

SITE
Argwings Kodhek Road, Nairobi

DRAWING TITLE: MATERNITY LABOR WARD IMPROVEMENTS
PLUMBING LAYOUT

JOB NO.
J2106.27

DRAWING NO. J2106.27 - L(53) - 03
REV 0

DATE	SCALE	DRAWN	CHECKED
JAN-2024	1:50(A1)	SKK	SKK

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- L — LAYOUT CODE

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projects : strategy : risk : management.

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PROJECT

PROPOSED MATERNITY LABOR WARDS IMPROVEMENTS

FOR THE NAIROBI HOSPITAL

SITE
Argwings Kodhek Road, Nairobi

DRAWING TITLE: MATERNITY LABOR WARD IMPROVEMENTS
PLUMBING LAYOUT

JOB NO.
J2106.27

DRAWING NO. J2106.27 - L(53) - 04 REV 0

DATE	SCALE	DRAWN	CHECKED
JAN-2024	1:50(A1)	SKK	SKK

THE NAIROBI HOSPITAL

PROPOSED RE-ORGANIZATION AT THE NAIROBI HOSPITAL

PROPOSED MATERNITY ROOMS IMPROVEMENT

ELECTRICAL SERVICES
BOOK OF DRAWINGS

PREPARED BY

GEOMAX CONSULTING ENGINEERS

GEOMAX
CONSULTING | DESIGN|MANAGEMENT

TENDER ISSUE

DRAWING REFERENCE AND CODING KEY

L(--)01 ← DRAWING NUMBER
SERVICES CODE
LAYOUT CODE

L(60) - ELECTRICAL SCHEDULES
L(61) - ELECTRICAL SUPPLY
L(62) - POWER LAYOUT
L(63) - LIGHTING LAYOUT
L(64) - COMMUNICATIONS LAYOUT
L(67) - LIGHTNING PROTECTION LAYOUT
L(68) - FIRE ALARM/SECURITY LAYOUT

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PROJECT

PROPOSED FIT-OUTS AND REORGANIZATION FOR THE NAIROBI HOSPITAL LABOUR WARDS

SITE
Argwings Kodhek Road, Nairobi

DRAWING TITLE: LABOUR WARDS COVER PAGE

JOB NO.
J2106.27

DRAWING NO. J2106.27 - L(00) - 00
REV 0

DATE	SCALE	DRAWN	CHECKED
JAN-24	NTS(A2)	VKM	GMN

SCHEDULE OF ELECTRICAL SERVICES CONTRACT DRAWINGS

2024								YEAR
01								MONTH
								DAY

DRAWING NO.	DESCRIPTION	ISSUE/REVISION						SIZE	SCALE
J2106.27 L(60)00	SCHEDULE OF ELECTRICAL DRAWINGS	0						A2	NTS
J2106.27 L(61)01	RAW POWER SINGLE LINE WIRING DIAGRAM	0						A2	NTS
J2106.27 L(61)02	CLEAN POWER SINGLE LINE WIRING DIAGRAM	0						A2	NTS
J2106.27 L(62,64)03	POWER AND COMMUNICATION LAYOUT	0						A2	1:75
J2106.27 L(63)04	LIGHTING LAYOUT	0						A2	1:75
J2106.27 L(65)05	SECURITY SYSTEMS LAYOUT	0						A2	1:75
J2106.27 L(68)06	FIRE DETECTION AND ALARM SYSTEM LAYOUT	0						A2	1:75
J2106.27 L(64)07	NURSE CALL LAYOUT	0						A2	1:75

TENDER ISSUE

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PROJECT

PROPOSED FIT-OUTS AND REORGANIZATION FOR THE NAIROBI HOSPITAL LABOUR WARDS

SITE
Argwings Kodhek Road, Nairobi

DRAWING TITLE: LABOUR WARDS
SCHEDULE OF ELECTRICAL DRAWINGS

JOB NO.
J2106.27

DRAWING NO. REV
J2106.27 - L(64,68) - 03 0

DATE	SCALE	DRAWN	CHECKED
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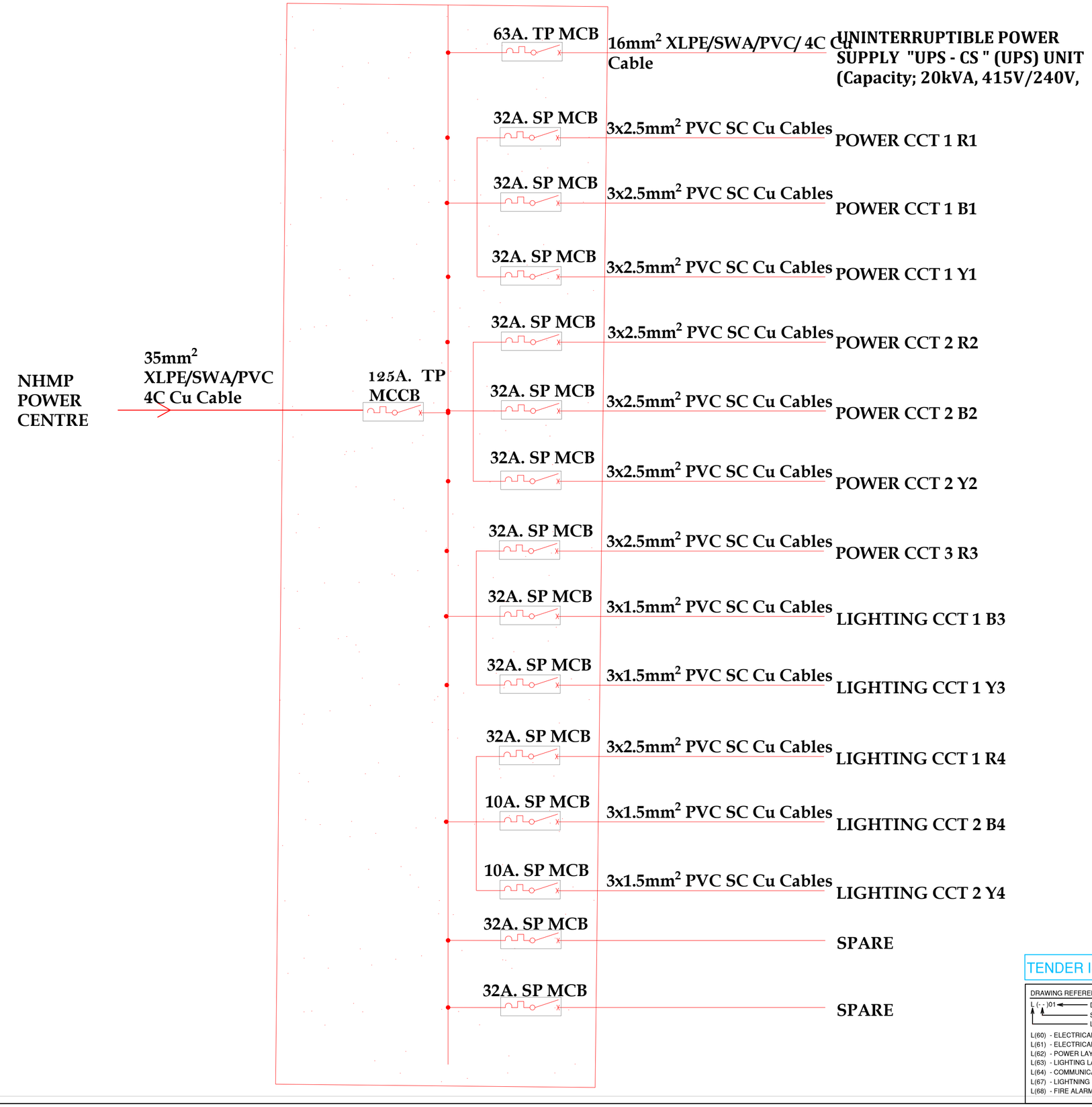

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NOTES

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3. ALL MAIN BUSBARS MUST BE THE SAME SIZE INCLUDING THE NEUTRAL BUSBAR.
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REVISIONS

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CLIENT

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PROJECT

PROPOSED FIT-OUTS AND REORGANIZATION FOR THE NAIROBI HOSPITAL LABOUR WARDS

SITE

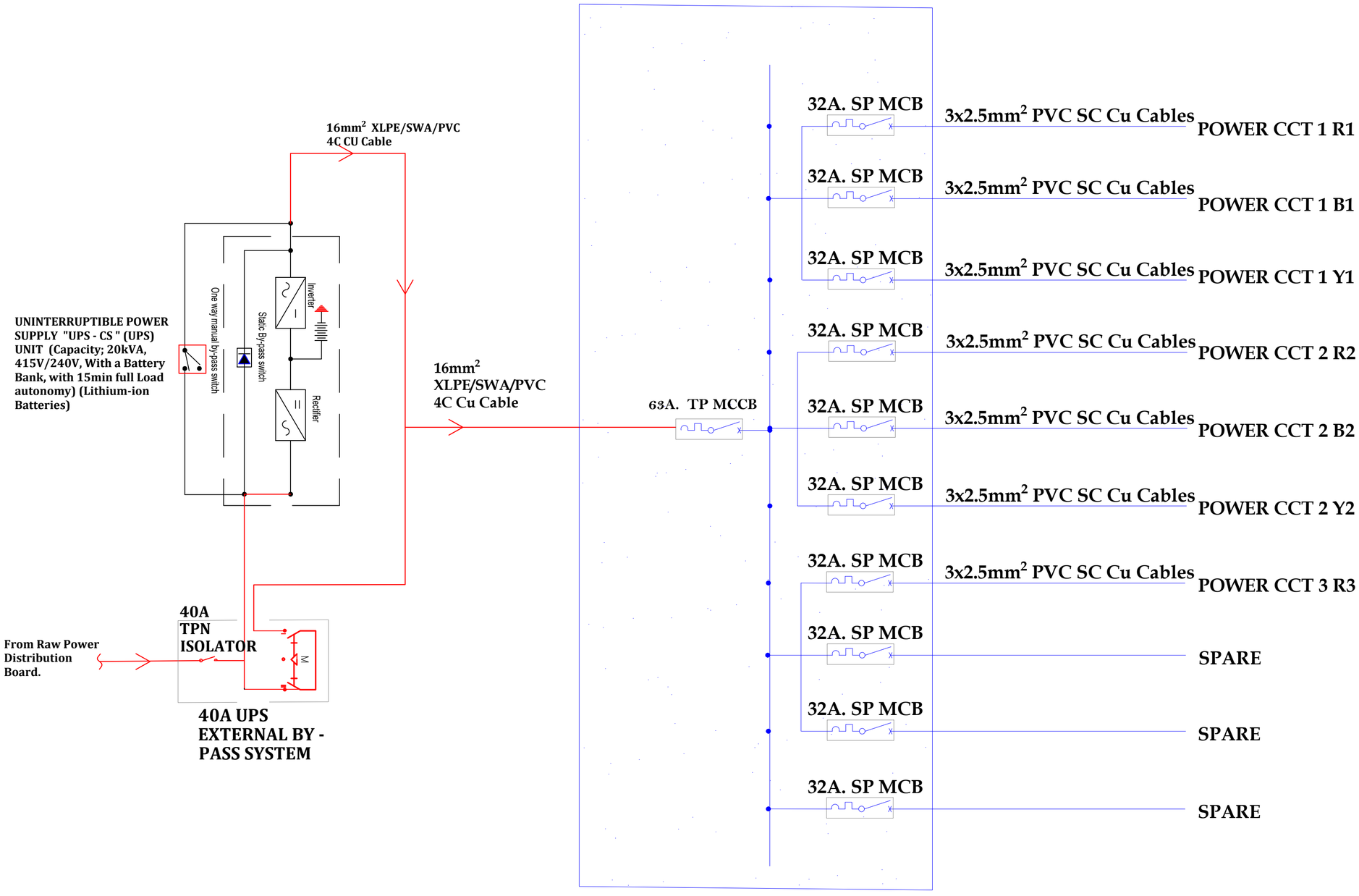
Argwings Kodhek Road, Nairobi

DRAWING TITLE: LABOUR WARDS
RAW POWER DISTRIBUTION BOARD

JOB NO. J2106.27

DRAWING NO. J2106.27 - L(61) - 01 REV 0

DATE	SCALE	DRAWN	CHECKED
JAN-24	NTS,A2)	VKM	GMN



LABOR WARD CLEAN POWER DB

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PROJECT

PROPOSED FIT-OUTS AND REORGANIZATION FOR THE NAIROBI HOSPITAL LABOUR WARDS

SITE

Argwings Kodhek Road, Nairobi

DRAWING TITLE: LABOUR WARDS CLEAN POWER DISTRIBUTION BOARD

TENDER ISSUE

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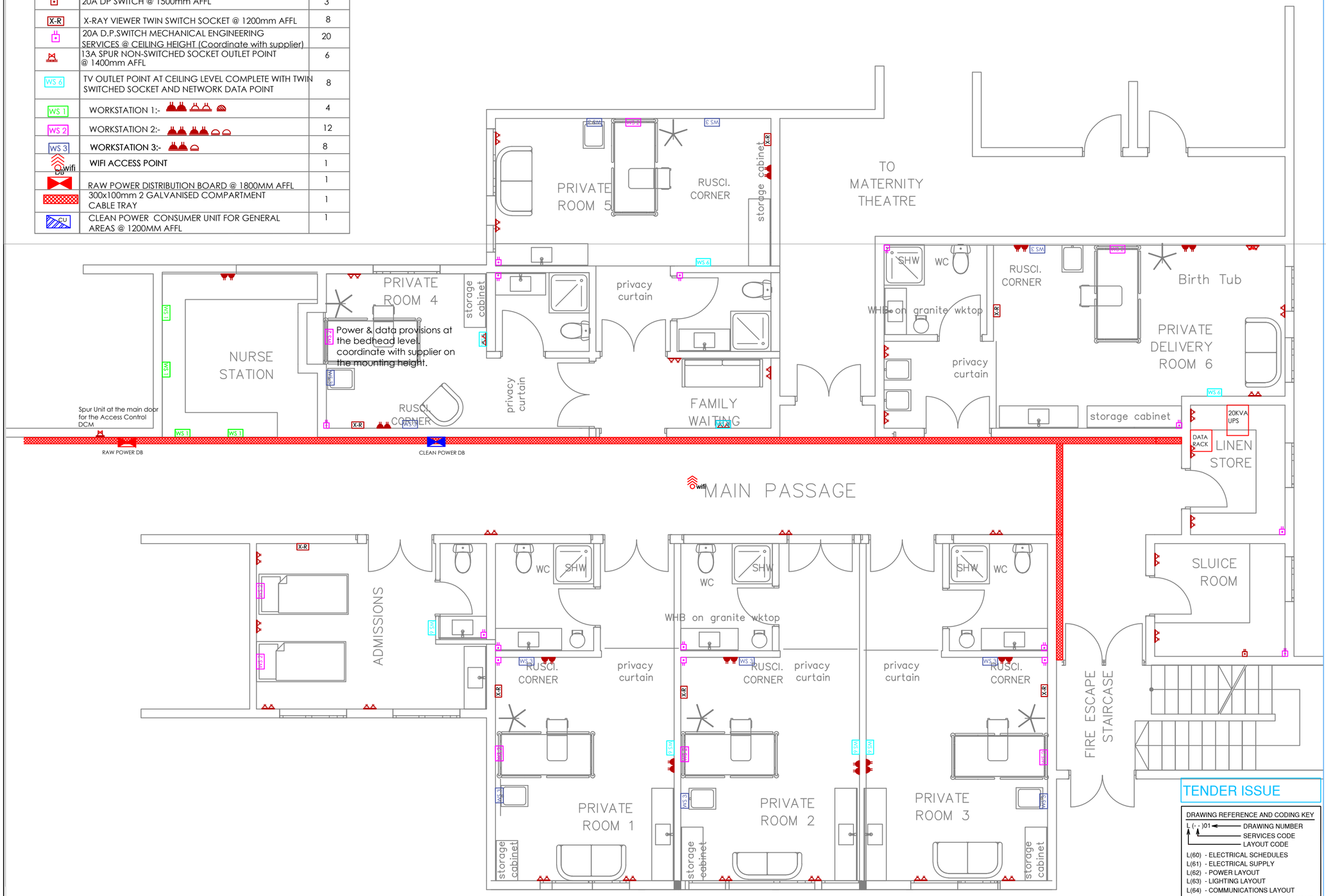
L(64) - COMMUNICATIONS LAYOUT
L(67) - LIGHTNING PROTECTION LAYOUT
L(68) - FIRE ALARM/SECURITY LAYOUT

JOB NO. J2106.27

DRAWING NO. J2106.27 - L(61) - 02 REV 0

DATE	SCALE	DRAWN	CHECKED
JAN-24	NTS,A2)	VKM	GMN

LEGEND		
SYMBOL	DESCRIPTION	QTY
	DUAL DATA/TELEPHONE POINT	0
	13A TWIN SWITCHED SOCKET - WATER PROOF	2
	13A TWIN SWITCHED SOCKET	20
	13A TWIN(UPS - CONTINUITY) SWITCHED SOCKET	14
	ISOLATOR SWITCH TO SPEC@ 1500mm AFFL	2
	20A DP SWITCH @ 1500mm AFFL	3
X-R	X-RAY VIEWER TWIN SWITCH SOCKET @ 1200mm AFFL	8
	20A D.P.SWITCH MECHANICAL ENGINEERING SERVICES @ CEILING HEIGHT (Coordinate with supplier)	20
	13A SPUR NON-SWITCHED SOCKET OUTLET POINT @ 1400mm AFFL	6
WS 6	TV OUTLET POINT AT CEILING LEVEL COMPLETE WITH TWIN SWITCHED SOCKET AND NETWORK DATA POINT	8
WS 1	WORKSTATION 1:-	4
WS 2	WORKSTATION 2:-	12
WS 3	WORKSTATION 3:-	8
wifi	WIFI ACCESS POINT	1
DB	RAW POWER DISTRIBUTION BOARD @ 1800MM AFFL	1
	300x100mm 2 GALVANISED COMPARTMENT CABLE TRAY	1
CU	CLEAN POWER CONSUMER UNIT FOR GENERAL AREAS @ 1200MM AFFL	1



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4. All lighting circuit cables shall be not less than 2x1.5mm^2 pvc sc + 1.5mm^2 e.c.c cables unless otherwise specified.
5. All lighting circuits conduits shall be not less 20mm dia. minimum unless otherwise specified.
6. All distribution boards and or consumer units shall be mounted at a height of 1800mm a.f.f.l. unless otherwise stated.
7. All ring circuits shall have 4x2.5mm^2 pvc sc + 2x2.5mm^2 e.c.c cables unless otherwise specified.
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PROJECT

PROPOSED FIT-OUTS AND REORGANIZATION FOR THE NAIROBI HOSPITAL LABOUR WARDS

SITE
Argwings Kodhek Road, Nairobi

DRAWING TITLE: LABOUR WARDS POWER & COMMUNICATION LAYOUT

TENDER ISSUE

DRAWING REFERENCE AND CODING KEY

L(--)01 ← DRAWING NUMBER
SERVICES CODE
LAYOUT CODE

L(60) - ELECTRICAL SCHEDULES
L(61) - ELECTRICAL SUPPLY
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L(64) - COMMUNICATIONS LAYOUT
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L(68) - FIRE ALARM/SECURITY LAYOUT

JOB NO. J2106.27

DRAWING NO. J2106.27 - L(64,68) - 03 REV 0

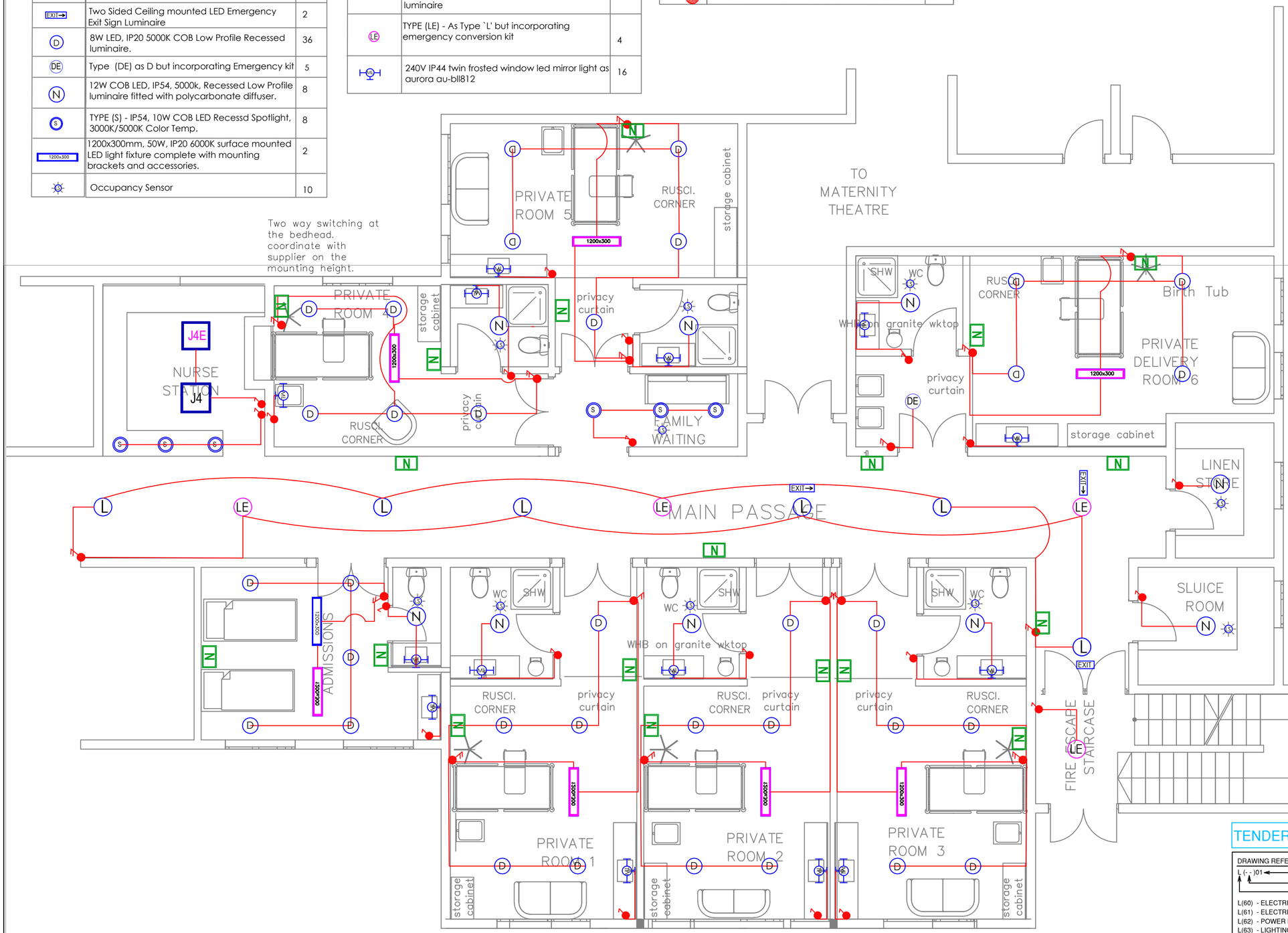
DATE	SCALE	DRAWN	CHECKED
JAN-24	1:75(A2)	VKM	GMN

L E G E N D		
SYMBOL	DESCRIPTION	QTY
J4	TYPE (J4) - 600X600mm, IP20, 36W, 5000K SMD LED Dimmable Panel Luminaire.	1
J4E	Type (J4E) as J4 but incorporating Emergency kit	1
EXIT	One Sided Wall mounted LED Emergency Exit Sign Luminaire	1
EXIT→	Two Sided Ceiling mounted LED Emergency Exit Sign Luminaire	2
D	8W LED, IP20 5000K COB Low Profile Recessed luminaire.	36
DE	Type (DE) as D but incorporating Emergency kit	5
N	12W COB LED, IP54, 5000k, Recessed Low Profile luminaire fitted with polycarbonate diffuser.	8
S	TYPE (S) - IP54, 10W COB LED Recessd Spotlight, 3000K/5000K Color Temp.	8
1200x300	1200x300mm, 50W, IP20 6000K surface mounted LED light fixture complete with mounting brackets and accessories.	2
	Occupancy Sensor	10

L E G E N D		
1200x300	1200x300mm, 50W, IP20 6000K surface mounted LED light fixture complete with mounting brackets and accessories and incorporating emergency conversion Kit	9
N	3W, IP66, 3000K SMD LED Rectangular recessed Night Light at 300mm AFFL	20
L	TYPE (L) - 16W IP65 rated, Surface mounted polycarbonate bulkhead luminaire	6
LE	TYPE (LE) - As Type `L' but incorporating emergency conversion kit	4
W	240V IP44 twin frosted window led mirror light as aurora au-bll812	16

L E G E N D		
Symbol	Description	
	10A 1Gang 1Way Lighting Switch @ 1400mm AFFL	10
	10A 1Gang 2Way Lighting Switch @ 1400mm AFFL	5
	10A 2Gang 2Way Lighting Switch @ 1400mm AFFL	16
	10A 3Gang 2Way Lighting Switch @ 1400mm AFFL	0

Two way switching at the bedhead. coordinate with supplier on the mounting height.



TENDER ISSUE

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PROJECT
PROPOSED FIT-OUTS AND REORGANIZATION FOR THE NAIROBI HOSPITAL LABOUR WARDS

SITE
Argwings Kodhek Road, Nairobi

DRAWING TITLE: LABOUR WARDS LIGHTING LAYOUT

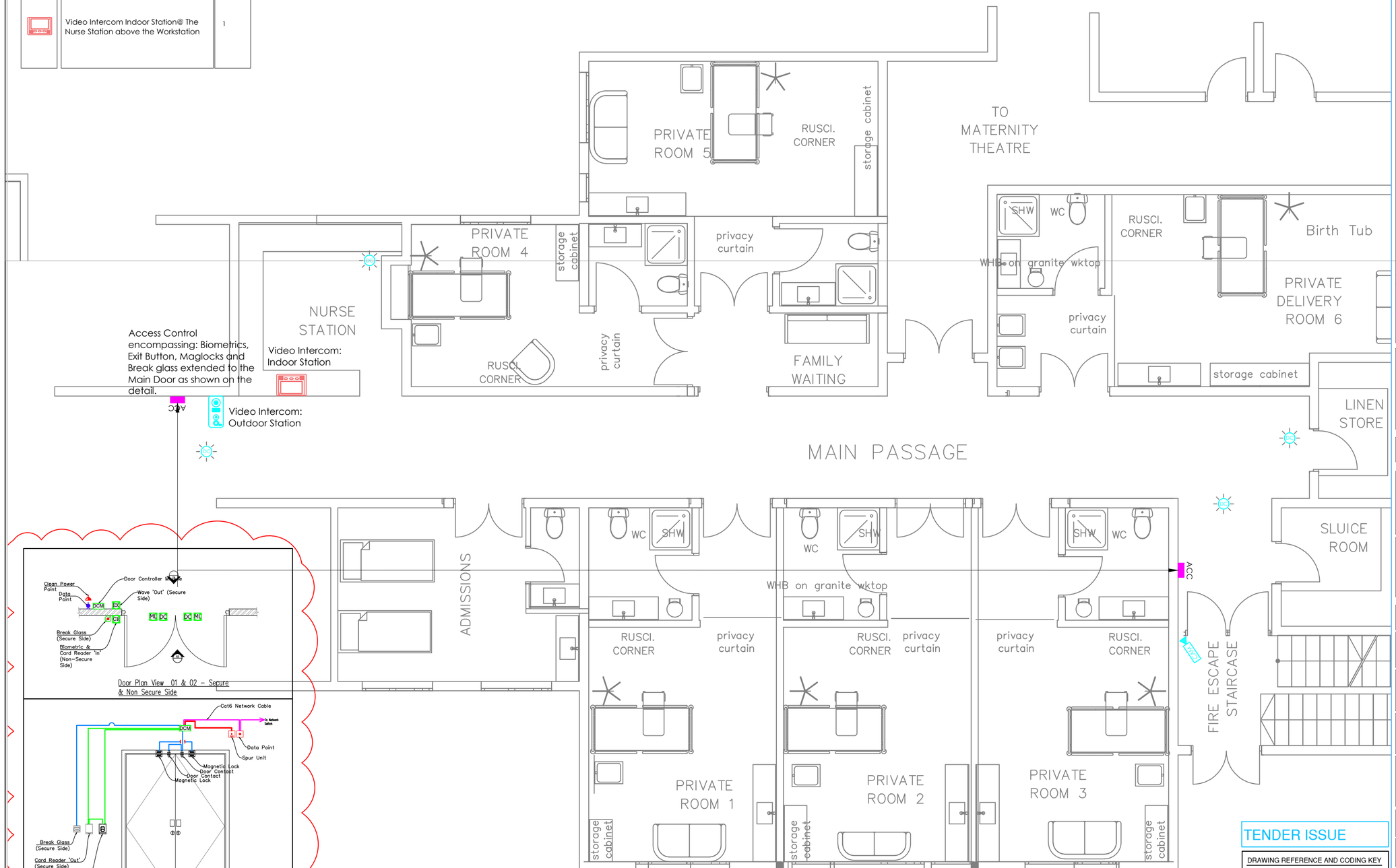
JOB NO. J2106.27

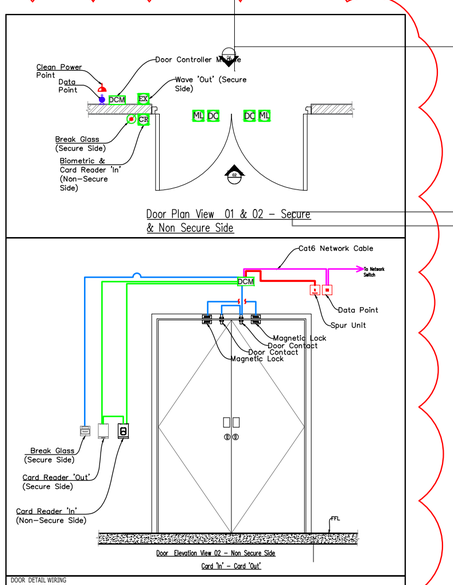
DRAWING NO. J2106.27 - L(63) - 04 REV 0

DATE	SCALE	DRAWN	CHECKED
JAN-24	1:75(A2)	VKM	GMN

LEGEND

CAM	IP BASED BULLET CAMERA	1
	IP BASED DOME CAMERA	4
ACC	IP BASED ACCESS CONTROL UNIT @ 1350mm AFFFL	2
	Video Intercom Outdoor Station@ 1400MM AFFL	1
	Video Intercom Indoor Station@ The Nurse Station above the Workstation	1





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PROJECT

PROPOSED FIT-OUTS AND REORGANIZATION FOR THE NAIROBI HOSPITAL LABOUR WARDS

SITE

Argwings Kodhek Road, Nairobi

DRAWING TITLE: LABOUR WARDS SECURITY SYSTEM LAYOUT

TENDER ISSUE

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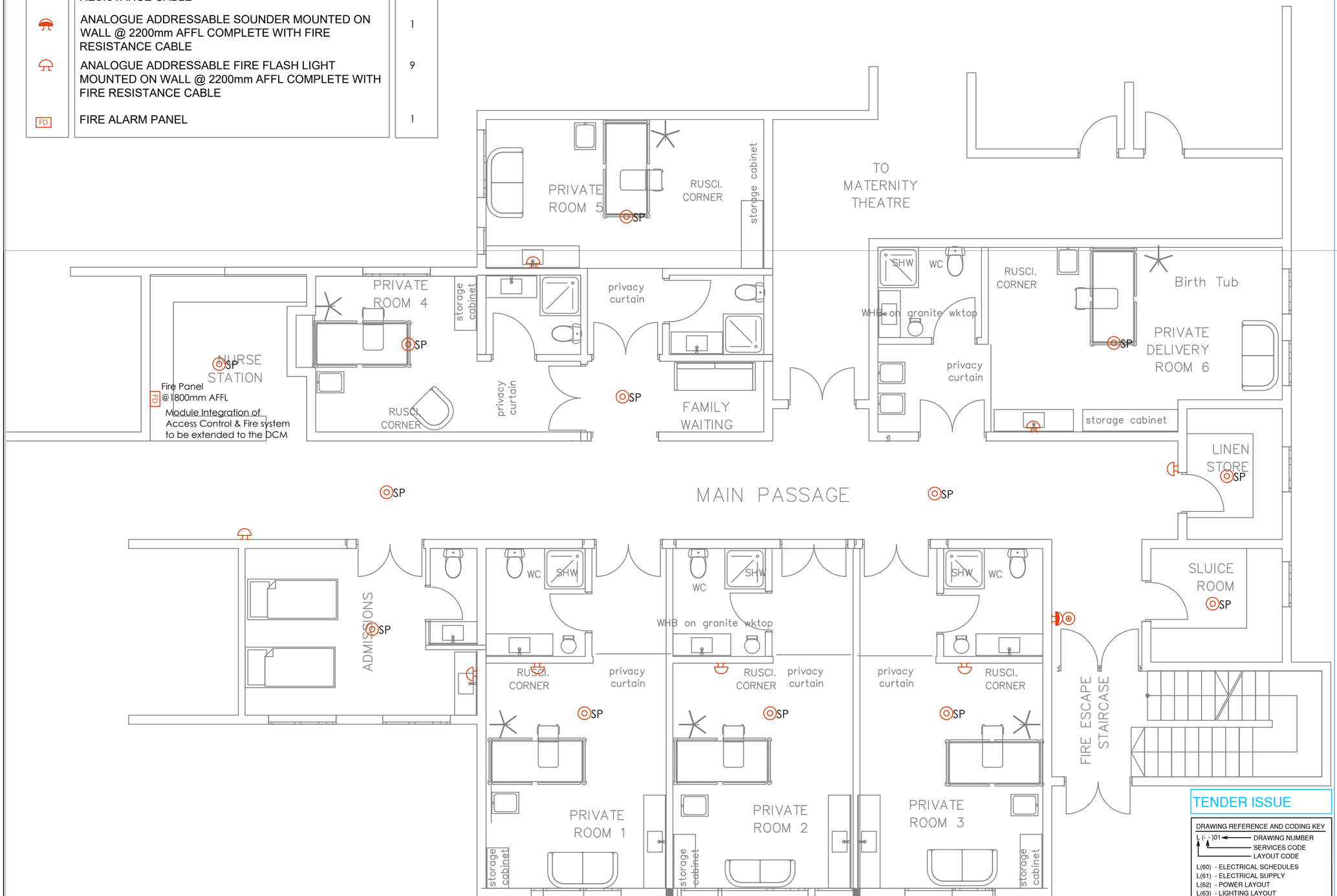
JOB NO. J2106.27

DRAWING NO. J2106.27 - L(65) - 05 REV 0

DATE	SCALE	DRAWN	CHECKED
JAN-24	1: 75(A2)	VKM	GMN

LEGEND		
SP	ANALOGUE ADDRESSABLE SMOKE DETECTOR MOUNTED ON CEILING/WALL COMPLETE WITH FIRE RESISTANCE CABLE	14
	ANALOGUE ADDRESSABLE PUSH BUTTON MOUNTED ON WALL @ 1450mm AFFL COMPLETE WITH FIRE RESISTANCE CABLE	2
	ANALOGUE ADDRESSABLE SOUNDER MOUNTED ON WALL @ 2200mm AFFL COMPLETE WITH FIRE RESISTANCE CABLE	1
	ANALOGUE ADDRESSABLE FIRE FLASH LIGHT MOUNTED ON WALL @ 2200mm AFFL COMPLETE WITH FIRE RESISTANCE CABLE	9
FD	FIRE ALARM PANEL	1



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PROJECT

PROPOSED FIT-OUTS AND REORGANIZATION FOR THE NAIROBI HOSPITAL LABOUR WARDS

SITE

Argwings Kodhek Road, Nairobi

DRAWING TITLE: LABOUR WARDS
FIRE DETECTION & ALARM SYSTEM LAYOUT

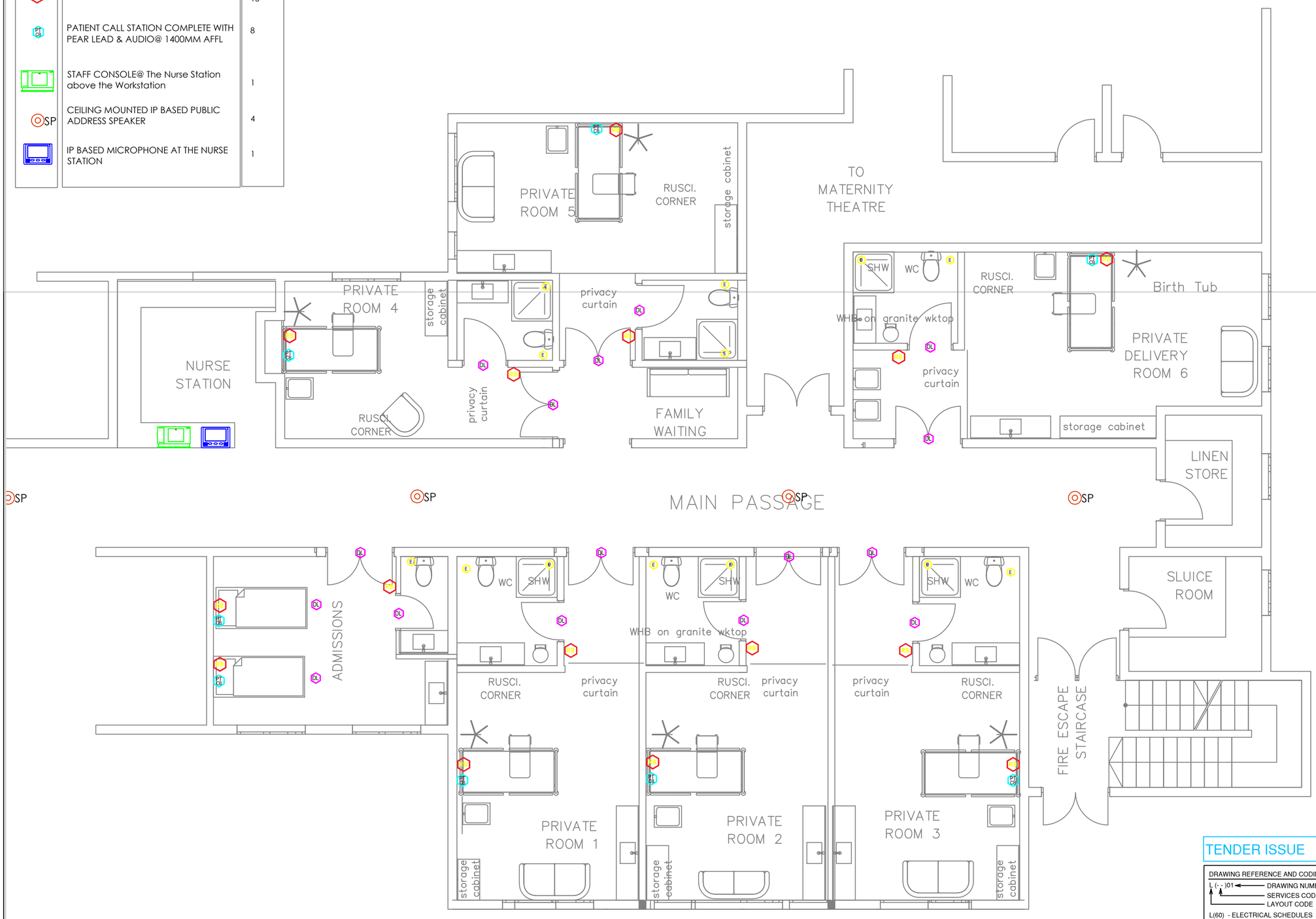
JOB NO. J2106.27

DRAWING NO. J2106.27 - L(68) - 06 REV 0

DATE	SCALE	DRAWN	CHECKED
JAN-24	1: 75(A2)	VKM	GMN

LEGEND

E	CEILING MOUNTED EMERGENCY PULL CORD	13
DL	DOME LIGHT WALL MOUNTED ABOVE THE DOOR	14
RB	RESET BUTTON @ 1400mm AFFFL	15
PT CB	PATIENT CALL STATION COMPLETE WITH PEAR LEAD & AUDIO@ 1400MM AFFL	8
	STAFF CONSOLE@ The Nurse Station above the Workstation	1
SP	CEILING MOUNTED IP BASED PUBLIC ADDRESS SPEAKER	4
	IP BASED MICROPHONE AT THE NURSE STATION	1



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Argwings Kodhek Road, Nairobi

DRAWING TITLE: LABOUR WARDS
NURSE CALL & PUBLIC ADDRESS SYSTEM

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