HEALTH DEPARTMENT
GOVERNMENT OF SINDH

SINDH GOVERNMENT QATAR HOSPITAL KARACHI(OLD & NEW)

Tender Document
VOLUME-I
CONDITIONS OF CONTRACT

REHABILITATION AND RENOVATION OF SINDH GOVERNMENT HOSPITAL AT KARACHI (OLD AND NEW).

ISSUE TO M/S_____

Address: (Office of The Director Health Services Karachi Division) Civic Centre, 6TH Floor, Hassan Square, Karachi. 75300

Phone: +92300-2247244

SUMMARY OF CONTENTS

(DR. RASHID SIRAJ)
MEDICAL SUPERINTENDENT
SINDH GOVT. QATAR HOSPITAL
ORANGI TOWN KARACHI

DR SAQIB ALI SHAIKH
Director Health Services
Karachi Division

Superintending Engineer,
Provincial Quality Control Circle
Health Works Circle, Hyderabad.

INVITATION FOR BIDS

NOTICE INVITING TENDER

Director Health Services Karachi Division invites E-Bids through E-Pak Acquisition and Disposal System (EPADS) from PEC Registered Constructors/ Contractors in the Category of C-4 and above, and with Active Taxpayers List of the FBR/SRB (whichever is applicable) for the **Rehabilitation & Renovation Of Sindh Government Qatar Hospital (old & New) Karachi** for the Financial year 2025-26.

Name of Work	Tender Fee (Rs.)	Bid Security	Estimated Cost (PKR)	Completion Time
REHABILITATION AND RENOVATION OF SINDH GOVERNMENT QATAR HOSPITAL KARACHI (OLD & NEW)	Rs. 3000/=	2% of the bid cost	65.589 M	4 Months

1. The Eligibility Criteria in details is mentioned in the bidding documents, refer **clause IB.2** for meeting the requirements of this tender.
2. A complete set of bidding documents may be purchased from date of publication upto **February , 2026 before 2:00 PM** upon payment of tender fee (non- *refundable)* against tender package in the form of pay order in favor of Director Health Services Karachi with written application along with a copy of letter of invitation.
3. The method of procurement would be ***Single Stage One Envelope***
4. Tender Fees Receipt should be uploaded with the Technical Proposal on EPADS. Electronic Bids should be submitted through EPADS only, Manual bid shall not be received. Interested Bidders are required to register themselves on EPAD System at the link: https://sindh.eprocure.gov.pk/#/supplier/registration for submission of electronic-bids.
5. The bids would be rejected and considered non-responsive under following conditions;
   (i) Conditional and telegraphic bids/tenders;
   (ii) Bids not accompanied by bid security of required amount and form (Soft should be uploaded on EPADS while Hardcopy to be submitted in person with Bids Hardcopy);
   (iii) Bids received / uploaded on EPADS after specified date and time.
   (iv) Non-Submission of Original set of Documents in Hard Copy to the Designated office.
6. Bid validity Period is (90) days
7. (i) **Submission:** The bids prepared in accordance with the instructions in the bidding documents, must be submitted on EPADS by **February , 2026** ***up to 2:00 PM on EPADS*** and the original instrument of tender fee Rs. 3,000/- and the bid security @ 2% of the bid price must reach the following procurement agency before the deadline for submission of e-bids, which will be opened on the same day i.e
   (ii) **Opening:** tenders will be opened on **February , 2026 @** ***3:00 PM*** at the below mentioned address in the presence of Procurement Committee and representative of bidders.
   (iii) **Place** of issuance, inquiries and opening will be below mention postal Address.
   (iv) In case of Govt, announces any Public Holiday or any unfavorable circumstances, the tender /bids original set of documents will be opened on next working day, with same Venue and Time.
8. Director Health Services reserves the right to reject all or any bids subject to the relevant provisions of Sindh Public Procurement Rules, 2010, amended 2023.

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Karachi Division

INSTRUCTIONS TO BIDDERS & BIDDING DATA

Notes on the Instructions to Bidders

This section of the bidding documents should provide the information necessary for bidders to prepare responsive bids, in accordance with the requirements of the Procuring Agency. It should also give information on bid submission, opening and evaluation, and on the award of contract.

Matters governing the performance of the Contract or payments under the Contract, or matters affecting the risks, rights, and obligations of the parties under the Contract are not normally included in this Section, but rather in the appropriate sections of the *Conditions of Contract* and/or *Contract Data.*

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INSTRUCTIONS TO BIDDERS

A. GENERAL

IB.1 Scope of Bid & Source of Funds

1.1 Scope of Bid

The Procuring Agency as defined in the Bidding Data (hereinafter called the Office of Director Health Services Karachi, wishes to receive Bids for the Works summarized in the Bidding Data (hereinafter referred to as the Works **"Rehabilitation and Renovation of Sindh Government Qatar Hospital, Karachi (OLD & NEW)."**

Bidders must quote for the complete scope of work. Any Bid covering partial scope of work will be rejected as non-responsive.

1.2 Source of Funds

The Employer has arranged funds from Government of Sindh/ Health Department for eligible payments under the Contract for which these Bidding Documents are issued.

IB.2 Eligible Bidders

2.1 Bidding is open to all firms and persons meeting the following requirements:

1. The tender fee must be paid in prescribed manner
2. Bid Security 2% of the Quoted bid Price in the shape of Pay order in favour of Director Health Services Karachi Division.
3. Tender documents duly signed and stamped by signing authority.
4. Documents showing Registration of the Firm document under the Law as Sole Proprietor, Partnership or Pvt. Limited firm.
5. Copy of NTN certificate & FBR activated account certificate.
6. Copy of last year paid income tax return.
7. Copy of registration with SRB.
8. Bank certificate showing financial capability. (At least 25% cash reserves/working capital funds or credit lines facility from schedules bank available against the estimated contract amount, proof of documents to be submitted)
9. Copy of valid certificate of Pakistan Engineering Council is mandatory with minimum C-5 Category and having PEC codes CE-10, CE10 (vii), EE1, ME01, ME02, ME06(ii), ME06(vii), BC04.
10. The Bidder must possess relevant experience for execution of such similar nature of projects in any Government, Semi-Government or private institutions of Pakistan in the last 3 years provide documentary evidence.

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11. The Bidder must provide the documentary evidences of containing the information and data tendering to prove experience, expertise, source and import documents, required skills, human and financial resources and completion certificate of executing such assignments.
12. Submit Affidavit at Original Stamp paper that firm is not black listed in any Government, Semi-Government, Autonomous body & Private Institutions and not involve in any litigation
13. Bid will be recommended to the most advantageous bidder.

IB.3 Cost of Bidding

3.1 The bidder shall bear all costs associated with the preparation and submission of its bid and the Office of "Director Health Services Karachi" will in no case be responsible or liable for those costs, regardless of the conduct or outcome of the bidding process (SPP Rules 24 & 25).

B. BIDDING DOCUMENTS

IB.4 Contents of Bidding Documents

4.1 In addition to Invitation for Bids, the Bidding Documents are those stated below, and should be read in conjunction with any Addendum issued in accordance with Sub-Clause IB.6.1.

1. Instructions to Bidders & Bidding Data
2. Form of Bid, Qualification Information & Schedules to Bid Schedules to Bid comprise the following:

   (i) Schedule A: Schedule of Prices/ Bill of Quantities (BOQ).
   (ii) Schedule B: Specific Works Data
   (iii) Schedule C: Works to be Performed by Subcontractors
   (iv) Schedule D: Proposed Programme of Works
   (v) Schedule E: Method of Performing Works
   (vi) Schedule F: Integrity Pact (works costing Rs 10 million and above)

3. Conditions of Contract & Contract Data

4. Standard Forms
   (i) Form of Bid Section
   (ii) Form of Performance Security;
   (iii) Form of Contract Agreement;
   (iv) Form of Bank Guarantee for Advance Payment.

5. Specification Drawings, if any

IB.5 Clarification of Bidding Documents

5.1 A prospective bidder requiring any clarification(s) in respect of the Bidding Documents may notify the Office of "Director Health Services Karachi" address indicated in the Bidding Data.

5.2 An interested bidder, who has obtained bidding documents, may request for clarification of

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contents of bidding documents in writing and procuring agency shall respond to such quarries in writing within three calendar days, provided they are received at least five calendar days prior to the date of opening of bid (SPP Rule 23-1).

IB.6 Amendment of Bidding Documents (SPP Rules 22(2) & 22).

6.1 At any time prior to the deadline for submission of Bids, the Procuring Agency may, for any reason, whether at his own initiative or in response to a clarification requested by a interested bidder, modify the Bidding Documents by issuing addendum.

6.2 Any addendum thus issued shall be part of the Bidding Documents pursuant to Sub-Clause 6.1 hereof, and shall be communicated in writing to all purchasers of the Bidding Documents. Prospective bidders shall acknowledge receipt of each addendum in writing to the Procuring Agency.

6.3 To afford interested bidders reasonable time in which to take an addendum into account in preparing their Bids, the Procuring Agency may at its discretion extend the deadline for submission of Bids.

C. PREPARATION OF BIDS

IB.7 Language of Bid

7.1 All documents relating to the Bid shall be in the language specified in the Contract Data.

IB.8 Documents Comprising the Bid

8.1 The Bid submitted by the bidder shall comprise the following:

a) Offer /Covering Letter
b) Form of Bid duly filled, signed and, in accordance with IB.14.3.
c) Schedules (A to F) to Bid duly filled and initialled, in accordance with the instructions contained therein & in accordance with IB.14.3.
d) Bid Security furnished in accordance with IB.13.
e) Power of Attorney in accordance with IB 14.5.
f) Documentary evidence in accordance with IB.2(c) & IB.11
g) Documentary evidence in accordance with IB.12.

IB.9 Sufficiency of Bid

9.1 Each bidder shall satisfy himself before Bidding as to the correctness and sufficiency of his Bid and of the premium on the rates of CSR / rates and prices quoted/entered in the Schedule of Prices, which rates and prices shall except in so far as it is otherwise expressly provided in the Contract, cover all his obligations under the Contract and all matters and things necessary for the proper completion of the works.

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9.2 The bidder is advised to obtain for himself at his own cost and responsibility all information that may be necessary for preparing the bid and entering into a Contract for execution of the Works.

IB.10 Bid Prices, Currency of Bid and Payment

10.1 The bidder shall fill up the Schedule of Prices (Schedule A to Bid) indicating the percentage above or below the Composite Schedule of Rates/unit rates and prices of the Works to be performed under the Contract. Prices in the Schedule of Prices/Bill of Quantities shall be quoted entirely in Pak Rupees keeping in view the instructions contained in the Preamble to Schedule of Prices.

10.2 Unless otherwise stipulated in the Conditions of Contract, prices quoted by the bidder shall remain fixed during the bidder's performance of the Contract and not subject to variation on any account.

10.3 The unit rates and prices in the Schedule of Prices or percentage above or below on the composite schedule of rates shall be quoted by the bidder in the currency as stipulated in Bidding Data.

10.4 Items for which no rate or price is entered by the Bidder will not be paid for by the Procuring Agency when executed and shall be deemed covered by the other rates and prices in the Bill of Quantities.

IB.11 Documents Establishing Bidder's Eligibility and Qualifications

11.1 Pursuant to Clause IB.8, the bidder shall furnish, as part of its bid, documents establishing the bidder's eligibility to bid and its qualifications to perform the Contract if its bid is accepted.

11.2 Bidder must possess and provide evidence of its capability and the experience as stipulated in Bidding Data and the Qualification Criteria mentioned in the Bidding Documents.

IB.12 Documents Establishing Works' Conformity to Bidding Documents

12.1 The documentary evidence of the Works 'conformity to the Bidding Documents may be in the form of literature, drawings and data and the bidder shall furnish documentation as set out in Bidding Data.

12.2 The bidder shall note that standards for workmanship, material and equipment, and references to brand names or catalogue numbers, if any, designated by the Procuring Agency in the Technical Provisions are intended to be descriptive only and not restrictive.

IB.13 Bid Security

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9.2 The bidder is advised to obtain for himself at his own cost and responsibility all information that may be necessary for preparing the bid and entering into a Contract for execution of the Works.

IB.10 Bid Prices, Currency of Bid and Payment

10.1 The bidder shall fill up the Schedule of Prices (Schedule A to Bid) indicating the percentage above or below the Composite Schedule of Rates/unit rates and prices of the Works to be performed under the Contract. Prices in the Schedule of Prices/Bill of Quantities shall be quoted entirely in Pak Rupees keeping in view the instructions contained in the Preamble to Schedule of Prices.

10.2 Unless otherwise stipulated in the Conditions of Contract, prices quoted by the bidder shall remain fixed during the bidder's performance of the Contract and not subject to variation on any account.

10.3 The unit rates and prices in the Schedule of Prices or percentage above or below on the composite schedule of rates shall be quoted by the bidder in the currency as stipulated in Bidding Data.

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IB.13 Bid Security

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13.1 Each bidder shall furnish, as part of his bid, at the option of the bidder, a Bid Security as percentage of bid price/estimated cost or in the amount stipulated in Bidding Data in Pak. Rupees in the form of *Deposit at Call/ Payee's Order/Demand Draft or a Bank Guarantee* issued by a Scheduled Bank in Pakistan in favour of the "Director Health Services Karachi" valid for a period up to Ninety (90) days beyond the bid submission date as per SPP Rule 37 the Bid Security shall be 2% (Two Percent).

13.2 Any bid not accompanied by an acceptable Bid Security shall be rejected by the "Office of Director Health Services Karachi" as non-responsive. Soft copy of Bid Security shall be uploaded on EPADS while, Hardcopy should be submitted to the "Office of Medical "Director Health Services Karachi" along with Hardcopy of Bid.

13.3 The bid securities of unsuccessful bidders will be returned upon award of contract to the successful bidder or on the expiry of validity of Bid Security whichever is earlier.

13.4 The Bid Security of the successful bidder will be returned when the bidder has furnished the required Performance Security, and signed the Contract Agreement (SPP Rule 37).

13.5 The Bid Security may be forfeited:

a) if a bidder withdraws his bid during the period of bid validity; or
b) if a bidder does not accept the correction of his Bid Price, pursuant to Sub-Clause 16.4 (b) hereof; or
c) in the case of a successful bidder, if he fails within the specified time limit to:
   (i) furnish the required Performance Security or
   (ii) sign the Contract Agreement.

IB.14 Validity of Bids, Format, Signing and Submission of Bid

14.1 Bids shall remain valid for the period stipulated in the Bidding Data after the date of bid opening.

14.2 In exceptional circumstances, Procuring Agency may request the bidders to extend the period of validity for an additional period but not exceeding 1/3 of the original period. The request and the bidders' responses shall be made in writing or by cable. A Bidder may refuse the request without forfeiting the Bid Security. A Bidder agreeing to the request will not be required or permitted to otherwise modify the Bid, but will be required to extend the validity of Bid Security for the period of the extension, and in compliance with IB.13 in all respects (SPP Rule 38).

14.3 All Schedules to Bid are to be properly completed and signed.

14.4 No alteration is to be made in the Form of Bid except in filling up the blanks as directed. If any alteration be made or if these instructions be not fully complied with, the bid may be rejected.

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14.5 Each bidder shall prepare number of copies specified in the Bidding Data of the documents comprising the bid as described in IB.8 and clearly mark them **"COPY"** as appropriate.

14.6 The original and all copies of the bid shall be typed or written in indelible ink and shall be signed by a person or persons duly authorized to sign (in the case of copies, Photostats are also acceptable). This shall be indicated by submitting a written Power of Attorney authorising the signatory of the bidder to act for and on behalf of the bidder. All pages of the bid shall be initialed and official seal be affixed by the person or persons signing the bid.

14.7 The Bid shall be uploaded on EPADS before the deadline mentioned in the bidding data sheet and submit a hard copy delivered in person or sent by registered mail at the address to Procuring Agency as given in Bidding Data.

D. SUBMISSION OF BID

IB.15 Deadline for Submission, Modification & Withdrawal of Bids

15.1 Bids must be uploaded on EPADS and also received by the Office of "Director Health Services Karachi", at the address provided in Bidding Data not later than the time and date stipulated therein.

15.2 The inner and outer envelopes shall

a) Be addressed to the Office of "Director Health Services Karachi" at the address provided in the Bidding Data;
b) Bear the name and identification number of the Contract as defined in the Bidding and Contract Data; and
c) Provide a warning not to open before the specified time and date for Bid opening as defined in the Bidding Data.
d) In addition to the identification required in 15.2, the inner envelopes shall indicate the name and address of the Bidder to enable the Bid to be returned unopened in case it is declared late
e) If the outer envelope is not sealed and marked as above, the Procuring Agency will assume no responsibility for the misplacement or premature opening of the Bid.

15.3 Bids Should be Submitted Electronically through EPADS, Bids submitted through telegraph, telex, fax or e-mail shall not be considered. However, One Sealed Set of Bids should be Submitted in person to the office of the Director Health Services, Karachi Division. Along with Bid Security

15.4 Any bid received by the Procuring Agency after the deadline for submission prescribed in Bidding Data will not be considered.

15.5 Any bidder may modify or withdraw his bid after bid submission provided that the modification or written notice of withdrawal is received by the Procuring Agency prior to the deadline for submission of bids.

15.6 Withdrawal of a bid during the interval between the deadline for submission of bids and the expiration of the period of bid validity specified in the Form of Bid may result in forfeiture of

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the Bid Security pursuant to IB.13.5 (a).

E. BID OPENING AND EVALUATION

IB.16 Bid Opening, Clarification and Evaluation (SPP Rules 41, 42 & 43)

16.1 The Office of "Director Health Services Karachi" will open the bids, in the presence of bidder's representatives Electronically through EPADS System, at the time, date and in the place specified in the Bidding Data.

16.2 The bidder's name, Bid Prices, any discount, the presence or absence of Bid Security, and such other details as the Procuring Agency at its discretion may consider appropriate, will be announced by the Procuring Agency at the bid opening. The Procuring Agency will record the minutes of the bid opening. Representatives of the bidders who choose to attend shall sign the attendance sheet.

Any Bid Price or discount which is not read out and recorded at bid opening will not be taken into account in the evaluation of bid.

16.3 To assist in the examination, evaluation and comparison of Bids the Engineer/Procuring Agency may, at its discretion, ask the bidder for a clarification of its Bid. The request for clarification and the response shall be in writing and no change in the price or substance of the Bid shall be sought, offered or permitted (SPP Rule 43).

16.4 (a) Prior to the detailed evaluation, pursuant to IB.16.7 to 16.9, the Engineer/Procuring Agency will determine the substantial responsiveness of each bid to the Bidding Documents. For purpose of these instructions, a substantially responsive bid is one which conforms to all the terms and conditions of the Bidding Documents without material deviations. It will include determining the requirements listed in Bidding Data.

(b) Arithmetical errors will be rectified on the following basis:

If there is a discrepancy between the unit price and 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 there is a discrepancy between the words and figures the amount in words shall prevail. If there is a discrepancy between the Total Bid price entered in Form of Bid and the total shown in Schedule of Prices-Summary, the amount stated in the Form of Bid will be corrected by the Procuring Agency in accordance with the Corrected Schedule of Prices.

If the bidder does not accept the corrected amount of Bid, his Bid will be rejected and his Bid Security forfeited.

16.5 A Bid determined as substantially non-responsive will be rejected and will not subsequently be made responsive by the bidder by correction of the non-conformity.

16.6 Any minor informality or non-conformity or irregularity in a Bid which does not constitute a material deviation **(major deviation)** may be waived by "Director Health Services Karachi",

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Provided such waiver does not prejudice or affect the relative ranking of any other bidders.
(A). Major (material) Deviations include:

Bid has been not properly signed;

(i) is not accompanied by the bid security of required amount and manner;
(ii) stipulating price adjustment when fixed price bids were called for;
(iii) failing to respond to specifications;
(iv) failing to comply with Mile-stones/Critical dates provided in Bidding Documents;
(v) sub-contracting contrary to the Conditions of Contract specified in Bidding Documents;
(vi) refusing to bear important responsibilities and liabilities allocated in the Bidding Documents, such as performance guarantees and insurance coverage;
(vii) taking exception to critical provisions such as applicable law, taxes and duties and dispute resolution procedures;
(viii) a material deviation or reservation is one :

(a) which affect in any substantial way the scope, quality or performance of the works;
(b) adoption/rectification whereof would affect unfairly the competitive position of other bidders presenting substantially responsive bids.

(B) Minor Deviations

Bids that offer deviations acceptable to the Procuring Agency and which can be assigned a monetary value may be considered substantially responsive at least as to the issue of fairness. This value would however be added as an adjustment for evaluation purposes only during the detailed evaluation process.

16.7 The Office of "Director Of Health Services Karachi" will evaluate and compare only the bids previously determined to be substantially responsive pursuant to IB.16.4 to 16.6 as per requirements given hereunder. Bids will be evaluated for complete scope of works. The prices will be compared on the basis of the Evaluated Bid Price pursuant to IB.16.8 herein below.

Technical Evaluation: It will be examined in detail whether the works offered by the bidder complies with the Technical Provisions of the Bidding Documents. For this purpose, the bidder's data submitted with the bid in Schedule B to Bid will be compared with technical features/criteria of the works detailed in the Technical Provisions. Other technical information submitted with the bid regarding the Scope of Work will also be reviewed.

16.8 Evaluated Bid Price

In evaluating the bids, the Engineer/Procuring Agency will determine for each bid in addition to the Bid Price, the following factors (adjustments) in the manner and to the extent indicated below to determine the Evaluated Bid Price:

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(i) Making any correction for arithmetic errors pursuant to IB.16.4 hereof.

(ii) Discount, if any, offered by the bidders as also read out and recorded at the time of bid opening.

(iii) Excluding **provisional sums** and the provisions for **contingencies** in the Bill of Quantities **if any**, but including **Day work,** where priced competitively.

IB.17 Process to be Confidential

17.1 Subject to IB.16.3 heretofore, no bidder shall contact Engineer/Procuring Agency on any matter relating to its Bid from the time of the Bid opening to the time the bid evaluation result is announced by the Procuring Agency. The evaluation result shall be announced at least seven (07) days prior to award of Contract (SPP Rule 45). The announcement to all bidders will include table(s) comprising read out prices, discounted prices, price adjustments made, final evaluated prices and recommendations against all the bids evaluated.

17.2 Any effort by a bidder to influence Office of "Director Health Services Karachi" in the Bid evaluation, Bid comparison or Contract Award decisions may result in the rejection of his Bid. Whereas any bidder feeling aggrieved, may lodge a written complaint to Complaint Redressal Committee as per terms and conditions mentioned in SPP Rules 31 & 32. However, mere fact of lodging a complaint shall not warrant suspension of procurement process.

17.3 Bidders may be excluded if involved in **"Corrupt and Fraudulent Practices"** means either one or any combination of the practices given below SPP Rule 2(q);

(i) —**Coercive Practice** means any impairing or harming, or threatening to impair or harm, directly or indirectly, any party or the property of the party to influence the actions of a party to achieve a wrongful gain or to cause a wrongful loss to another party;

(ii) —**Collusive Practice** means any arrangement between two or more parties to the procurement process or contract execution, designed to achieve with or without the knowledge of the procuring agency to establish prices at artificial, non-competitive levels for any wrongful gain;

(iii) —**Corrupt Practice** means the offering, giving, receiving or soliciting, directly or indirectly, of anything of value to influence the acts of another party for wrongful gain;

(iv) —**Fraudulent Practice** means any act or omission, including a misrepresentation, that knowingly or recklessly misleads, or attempts to mislead, a party to obtain a financial or other benefit or to avoid an obligation;

(v) —**Obstructive Practice** means harming or threatening to harm, directly or indirectly, persons or their property to influence their participation in a procurement process, or affect the execution of a contract or deliberately destroying, falsifying, altering or concealing of evidence material to the investigation or making false statements before investigators in order to materially impede an investigation into allegations of a corrupt, fraudulent, coercive or collusive practice; or threatening, harassing or intimidating any party to prevent it from disclosing its knowledge of matters relevant to the investigation or from pursuing the investigation, or acts intended to materially impede the exercise of inspection and audit rights provided for under the Rules.

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F. AWARD OF CONTRACT

IB.18. Post Qualification

18.1 The Office of, Director Health Services Karachi, at any stage of the bid evaluation, having credible reasons for or *prima facie* evidence of any defect in contractor's capacities, may require the contractors to provide information concerning their professional, technical, financial, legal or managerial competence whether already pre-qualified or not:

Provided, that such qualification shall only be laid down after recording reasons therefore in writing. They shall form part of the records of that bid evaluation report.

18.2 The determination will take into account the bidder's financial and technical capabilities. It will be based upon an examination of the documentary evidence of the bidders 'qualifications submitted under B.11, as well as such other information required in the Bidding Documents.

IB.19 Award Criteria

19.1 Subject to IB.19.2, the Office of Director Health Services Karachi, Karachi will award the Contract to the bidder whose bid has been determined to be Most Advantageous Bid and substantially responsive to the Bidding Documents and who has offered the lowest evaluated Bid Price, provided that such bidder has been determined to be qualified to satisfactory perform the Contract in accordance with the provisions of the IB.18.

19.2 Notwithstanding IB.19.1, the Procuring Agency reserves the right to accept or reject any bid, and to annul the bidding process and reject all bids, at any time prior to award of Contract, without thereby incurring any liability to the affected bidders or any obligation to inform the affected bidders of the grounds for the Procuring Agency's action except that the grounds for its rejection of all bids shall upon request be communicated, to any bidder who submitted a bid, without justification of the grounds. Notice of the rejection of all the bids shall be given promptly to all the bidders (SPP Rule 25).

IB.20 Notification of Award & Signing of Contract Agreement

20.1 Prior to expiration of the period of bid validity prescribed by the Procuring Agency, the Procuring Agency will notify the successful bidder in writing (Letter of Acceptance) that his bid has been accepted (SPP Rule 49).

20.2 Within seven (07) days from the date of furnishing of acceptable Performance Security under the Conditions of Contract, the Procuring Agency will send the successful bidder the Form of Contract Agreement provided in the Bidding Documents, incorporating all agreements

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Karachi Division

Superintending Engr.
Provincial Building
Health Works Sindh

between the parties.

20.3 The formal Agreement between the Office of Director Health Services Karachi and the successful bidder duly stamped at rate of 0.35% of bid price (updated from time to time) stated in Letter of Acceptance shall be executed within seven (07) days of the receipt of Form of Contract Agreement by the successful bidder from the Procuring Agency.

IB.21 Performance Security

21.1 The successful bidder shall furnish to the Procuring Agency a Performance Security in the form and the amount stipulated in the Conditions of Contract within a period of fourteen (14) days after the receipt of Letter of Acceptance (SPP 39).

21.2 Failure of the successful bidder to comply with the requirements of Sub-Clauses IB.20.2 & 20.3 or 21.1 or Clause IB.22 shall constitute sufficient grounds for the annulment of the award and forfeiture of the Bid Security.

21.3 Publication of Award of Contract: within seven days of the award of contract, the procuring shall publish on the website of the authority and on its own website, if such a website exists, the results of the bidding process, identifying the bid through procurement identifying Number if any and the following information:

1) Evaluation Report;
2) Form of Contract and letter of Award;
3) Bill of Quantities or Schedule of Requirements. (SPP Rule 50)

IB.22 Integrity Pact The Bidder shall sign and stamp the Form of Integrity Pact provided at Schedule-F to Bid in the Bidding Document for all Sindh Government procurement contracts exceeding Rupees ten (10) million. Failure to provide such Integrity Pact shall make the bid non-responsive (SPP Rule 89).

Superintending Engineer, Provincial Buildings Circle Health Works Sindh, Hyderabad.

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BIDDING DATA

Instructions to Bidders Clause Reference

1.1 **Name of Procuring Agency**

Office of Director Heath Services Karachi

Brief Description of Works

5.1 (a) Procuring Agency's address:

Address (Postal): **Director Health Services Karachi Division,**
Civic Center, 6th Floor, Hassan Square, Karachi. (75300)
Phone: +92300-2247244

10.3 Bid shall be quoted entirely in Pak. Rupees. The payment shall be made in Pak. Rupees.

11.2 The bidder has the financial, technical and constructional capability necessary to perform the Contract (*as per NIT)*

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Health Works Hyderabad.

12.1 (a) A detailed description of the Works, essential technical and performance characteristics.

(b) Complete set of technical information, description data, literature and drawings as required in accordance with Schedule B to Bid, Specific Works Data. This will include but not be limited to a sufficient number of drawings, photographs, catalogues, illustrations and such other information as is necessary to illustrate clearly the significant characteristics such as general construction dimensions and other relevant information about the works to be performed.

13.1 **Amount of Bid Security**

(2%) of the bid amount in the shape of Pay order or Demand Draft in Favour of Director Health Services Karachi.

14.1 **Period of Bid Validity**

(90 Days)

14.4 **Number of Copies of the Bid to be submitted:**

One original Hard copy to be submitted in person and also same to be Uploaded on EPADS before Deadline.

14.6 **(a) Address for the Purpose of Bid Submission**

Address (Postal): **Director Health Services Karachi Division,**
Civic Center, 6th Floor, Hassan Square, Karachi. (75300)|
Phone: +92300-2247244

15.1 **Deadline for Submission of Bids**

As notified in "Tender Notice"

16.1 **Venue, Time, and Date of Bid Opening**

As notified in "Tender Notice"

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16.4 **Responsiveness of Bids**

(i) Bid is valid till required period,
(ii) *Bid prices are firm during currency of contract/Price adjustment;
(iii) Completion period offered is within specified limits,
(iv) Bidder is eligible to Bid and possesses the requisite experience, capability and qualification.
(v) Bid does not deviate from basic technical requirements and
(vi) Bids are generally in order, etc.

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Superintending Engineer,
Projects Circle
Health Works Wing, Hyderabad

FORM OF BID AND SCHEDULES TO BID

(LETTER OF OFFER)

Bid Reference No. _____

(Name of Works)

To:

Gentlemen,

1. Having examined the Bidding Documents including Instructions to Bidders, Bidding Data, Conditions of Contract, Contract Data, Specifications, Drawings, if any, Schedule of Prices and Addenda Nos. _____ for the execution of the above-named works, we, the undersigned, being a company doing business under the name of and address _____ and being duly incorporated under the laws of Pakistan hereby offer to execute and complete such works and remedy any defects therein in conformity with the said Documents including Addenda thereto for the Total Bid Price of Rs_____(Rupees_____) or such other sum as may be ascertained in accordance with the said Documents.

2. We understand that all the Schedules attached hereto form part of this Bid.

3. As security for due performance of the undertakings and obligations of this Bid, we submit herewith a Bid Security in the amount of _____ _____ drawn in your favour or made payable to you and valid for a period of Ninety (90) days beyond the period of validity of Bid.

4. We undertake, if our Bid is accepted, to commence the Works and to deliver and complete the Works comprised in the Contract within the time(s) stated in Contract Data.

5. We agree to abide by this Bid for the period of _____ days from the date fixed for receiving the same and it shall remain binding upon us and may be accepted at any time before the expiration of that period.

6. Unless and until a formal Agreement is prepared and executed, this Bid, together with your written acceptance thereof, shall constitute a binding contract between us.

7. We undertake, if our Bid is accepted, to execute the Performance Security referred to in Conditions of Contract for the due performance of the Contract.

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8. We understand that you are not bound to accept the lowest or any bid you may receive.

9. We do hereby declare that the Bid is made without any collusion, comparison of figures or arrangement with any other person or persons making a bid for the Works.

Dated this _____day of _____, 20 Signature _____ in the capacity of _____duly authorized to sign bid for and on behalf of

(Name of Bidder in Block Capitals) (Seal)

Address:

_____

_____

_____

Witness:

(Signature)_____

Name: _____

Address: _____

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Superintending Engineer,
Provincial Buildings Circle
Health Works Sindh, Hyderabad.

[SCHEDULES TO BID INCLUDE THE FOLLOWING:

Schedule A to Bid: Schedule of Prices – Schedule B to Bid: Specific Works Data – Schedule C to Bid: Works to be Performed by Subcontractors – Schedule D to Bid: Proposed Program of Works – Schedule E to Bid: Method of Performing Works – Schedule F to Bid: Integrity Pact]

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SCHEDULE – A TO BID
SCHEDULE OF PRICES

Sr. No.

1 Preamble to Schedule of Prices.....

2 Schedule of Prices.....

*(a) Summary of Bid Prices

* (b) Detailed Schedule of Prices /Bill of Quantities (BOQ)

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SCHEDULE -A TO BID

PREAMBLE TO SCHEDULE OF PRICES

1. General

1.1 The Schedule of Prices shall be read in conjunction with the Conditions of Contract, Contract Data together with the Specifications and Drawings, if any.

1.2 The Contract shall be for the whole of the works as described in these Bidding Documents. Bids must be for the complete scope of works.

2. Description

2.1 The general directions and descriptions of works and materials are not necessarily repeated nor summarized in the Schedule of Prices. References to the relevant sections of the Bidding Documents shall be made before entering prices against each item in the Schedule of Prices.

3. Units & Abbreviations

3.1 Units of measurement, symbols and abbreviations expressed in the Bidding Documents shall comply with the System International Units (SI Units).

4. Rates and Prices

4.1 Except as otherwise expressly provided under the Conditions of Contract, the rates and amounts entered in the Schedule of Prices shall be the rates at which the Contractor shall be paid and shall be the full inclusive value of the works set forth or implied in the Contract; except for the amounts reimbursable, if any to the Contractor under the Contract.

4.2 Unless otherwise stipulated in the Contract Data, the premium, rates and prices entered by the bidder shall not be subject to adjustment during the performance of the Contract.

4.3 All duties, taxes and other levies payable by the Contractor shall be included in the rates and prices.

4.4 The whole cost of complying with the provisions of the Contract shall be included in the items provided in the Schedule of Prices, and where

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no items are provided, the cost shall be deemed to be distributed among the rates and prices entered for the related items of the Works and no separate payment will be made for those items.

The rates, prices and amounts shall be entered against each item in the Schedule of Prices. Any item against which no rate or price is entered by the bidder will not be paid for by the Procuring Agency when executed and shall be deemed covered by the rates and prices for other items in the Schedule of Prices.

4.5 (a) The bidder shall be deemed to have obtained all information as to and all requirements related thereto which may affect the bid price.

*(b) The Contractor shall be responsible to make complete arrangements for the transportation of the Plant to the Site.

1 The Contractor shall provide for all parts of the Works to be completed in every respect. Notwithstanding that any details, accessories, etc. required for the complete installation and satisfactory operation of the Works, are not specifically mentioned in the Specifications, such details shall be considered as included in the Contract Price.

2 **Bid Prices**

5.1 Break-up of Bid Prices The various elements of Bid Prices shall be quoted as detailed by the Procuring Agency in the format of Schedule of Prices. The bidder shall recognize such elements of the costs which he expects to incur the performance of the Works and shall include all such costs in the rates and amounts entered in the Schedule of Prices.

5.2 The total of bid prices in the Schedule of Prices shall be entered in the Summary of Bid Prices.

6. Provisional Sums and Day work

6.1 Provisional Sums included and so designated in the Schedule of Prices if any, shall be expended in whole or in part at the direction and discretion of the Engineer/Procuring Agency. The Contractor will only receive payment in respect of Provisional Sums, if he has been instructed by the Engineer/Procuring Agency to utilize such sums.

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Health Work

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6.2 Day work rates in the contractor's bid are to be used for small additional amounts of work and only when the Engineer have given written instructions in advance for additional work to be paid for in that way.

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SCHEDULE -A TO BID SCHEDULE OF PRICES – SUMMARY OF BID PRICES (Sample)

	Description	Total Amount (Rs)
	A) Building Work Follow Volume-II, Schedule of Price (BOQ)	
	Total Bid Price (The amount to be entered in Para 1 of the Form of Bid) (In words).	

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SCHEDULE -A TO BID

SCHEDULE OF PRICES

Item No.	Description	Quantity	Unit Rate(Rs)	Total Amount (Rs)
	Follow Volume-II, Schedule of Prices BOQ			
Total (*to be carried to Summary of Bid Price*) *Add/ Deduct the percentage quoted above/below on the prices of items based on Composite Schedule of Rates.*				

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SCHEDULE -B TO BID

"SPECIFIC WORKS DATA"

Follow Volume-III, Technical Specifications

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SCHEDULE – C TO BID WORKS TO BE PERFORMED BY SUBCONTRACTORS*

The bidder will do the work with his own forces except the work listed below which he intends to sub-contract.

Items of Works to be Sub-Contracted	Name and address of Sub-Contractors	Statement of similar works previously executed, *(attach evidence)*

1. No change of Sub-Contractors shall be made by the bidder without prior approval of the Procuring Agency.

2. The truthfulness and accuracy of the statement as to the experience of Sub-Contractors is guaranteed by the bidder. The Procuring Agency's judgment shall be final as to the evaluation of the experience of Sub-Contractors submitted by the bidder.

3. Statement of similar works shall include description, location & value of works, year completed and name & address of the clients.

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SCHEDULE – D TO BID

PROPOSED PROGRAMME OF WORKS

Bidder shall provide a programme in a bar-chart or Program Evaluation and Review Technique (PERT) or Critical Path Method (CPM) showing the sequence of work items by which he proposes to complete the works of the entire Contract. The programme should indicate the sequence of work items and the period of time during which he proposes to complete the works including the activities like designing, schedule of submittal of drawings, ordering and procurement of materials, manufacturing, delivering, construction of civil works, erection, testing and commissioning of works to be supplied under the Contract.

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METHOD OF PERFORMING WORKS

The bidder is required to submit a narrative outlining the method of performing the Works. The narrative should indicate in detail and include but not be limited to:

- The sequence and methods in which he proposes to carry out the Works, including the number of shifts per day and hours per shift, he expects to work.
- A list of all major items of construction and plant erection, tools and vehicles proposed to be used in delivering/carrying out the works at site.
- The procedure for installation of equipment and transportation of equipment and materials to the site.
- Organization chart indicating head office & field office personnel involved in management, supervision and engineering of the Works to be done under the Contract.

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SCHEDULE – F TO BID

(INTEGRITY PACT)

DECLARATION OF FEES, COMMISSION AND BROKERAGE ETC PAYABLE BY CONTRACTORS

(FOR CONTRACTS WORTH RS. 10.00 MILLION OR MORE)

Contract No. _____ Dated _____ Contract Value: _____
Contract Title: _____

..... [name of Contractor] hereby declares that it has not obtained or induced the procurement of any contract, right, interest, privilege or other obligation or benefit from Government of Sindh (GOS) or any administrative subdivision or agency thereof or any other entity owned or controlled by it (GOS) through any corrupt business practice.

Without limiting the generality of the foregoing, [name of Contractor] represents and warrants that it has fully declared the brokerage, commission, fees etc. paid or payable to anyone and not given or agreed to give and shall not give or agree to give to anyone within or outside Pakistan either directly or indirectly through any natural or juridical person, including its affiliate, agent, associate, broker, consultant, director, promoter, shareholder

sponsor or subsidiary, any commission, gratification, bribe, finder's fee or kickback, whether described as consultation fee or otherwise, with the object of obtaining or inducing the procurement of a contract, right, interest, privilege or other obligation or benefit in whatsoever form from, from Procuring Agency (PA) except that which has been expressly declared pursuant hereto.

[name of Contractor] accepts full responsibility and strict liability that it has made and will make full disclosure of all agreements and arrangements with all persons in respect of or related to the transaction with PA and has not taken any action or will not take any action to circumvent the above declaration, representation or warranty.

[name of Contractor] accepts full responsibility and strict liability for making any false declaration, not making full disclosure, misrepresenting facts or taking any action likely to defeat the purpose of this declaration, representation and warranty. It agrees that any contract, right, interest, privilege or other obligation or benefit obtained or procured as aforesaid shall, without prejudice to any other rights and remedies available to PA under any law, contract or other instrument, be voidable at the option of PA.

Notwithstanding any rights and remedies exercised by PA in this regard, [_____] agrees to indemnify PA for any loss or damage incurred by it on account of its corrupt business practices and further pay compensation to PA in an amount equivalent to ten time the sum of any commission, gratification, bribe, finder's fee or kickback given by [name of Contractor] as aforesaid for the purpose of obtaining or inducing the procurement of any contract, right, interest, privilege or other obligation or benefit in whatsoever form from PA.

....
[Procuring Agency] [Contractor]

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CONDITIONS OF CONTRACT

TABLE OF CONTENTS CONDITIONS OF CONTRACT

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CONDITIONS OF CONTRACT

1. GENERAL PROVISIONS

1.1 Definitions

In the Contract as defined below, the words and expressions defined shall have the following meanings assigned to them, except where the context requires otherwise:

The Contract

1.1.1 "Contract" means the Contract Agreement and the other documents listed in the Contract Data.

1.1.2 "Specifications" means the document as listed in the Contract Data, including Procuring Agency's requirements in respect of design to be carried out by the Contractor (if any), and any Variation to such document.

1.1.3 "Drawings" means the Procuring Agency's drawings of the Works as listed in the Contract Data, and any Variation to such drawings.

Persons

1.1.4 "Procuring Agency" means the person named in the Contract Data and the legal successors in title to this person, but not (except with the consent of the Contractor) any assignee.

1.1.5 "Contractor" means the person named in the Contract Data and the legal successors in title to this person, but not (except with the consent of the Procuring Agency) any assignee.

1.1.6 "Party" means either the Procuring Agency or the Contractor.

Dates, Times and Periods

1.1.7 "Commencement Date" means the date fourteen (14) days after the date the Contract comes into effect or any other date named in the Contract Data.

1.1.8 "Day" means a calendar day

1.1.9 "Time for Completion" means the time for completing the Works as stated in the Contract Data (or as extended under Sub-Clause 7.3), calculated from the Commencement Date.

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Money and Payments

1.1.10 "Cost" means all expenditure properly incurred (or to be incurred) by the Contractor, whether on or off the Site, including overheads and similar charges but does not include any allowance for profit.

Other Definitions

1.1.11 "Contractor's Equipment" means all machinery, apparatus and other things required for the execution of the Works but does not include Materials or Plant intended to form part of the Works.

1.1.12 "Country" means the Islamic Republic of Pakistan.

1.1.13 "Procuring Agency's Risks" means those matters listed in Sub-Clause 6.1.

1.1.14 "Force Majeure" means an event or circumstance which makes performance of a Party's obligations illegal or impracticable and which is beyond that Party's reasonable control.

1.1.15 "Materials" means things of all kinds (other than Plant) to be supplied and incorporated in the Works by the Contractor.

1.1.16 "Plant" means the machinery and apparatus intended to form or forming part of the Works.

1.1.17 "Site" means the places provided by the Procuring Agency where the Works are to be executed, and any other places specified in the Contract as forming part of the Site.

1.1.18 "Variation" means a change which is instructed by the Engineer/Procuring Agency under Sub-Clause 10.1.

1.1.19 "Works" means any or all the works whether Supply, Installation, Construction etc. and design (if any) to be performed by the Contractor including temporary works and any variation thereof.

1.1.20 "Engineer" means the person notified by the Procuring Agency to act as Engineer for the purpose of the Contract and named as such in Contract Data.

1.2 Interpretation

Words importing persons or parties shall include firms and organisations. Words importing singular or one gender shall include plural or the other gender where the context requires.

1.3 Priority of Documents

The documents forming the Contract are to be taken as mutually explanatory of one another. If an ambiguity or discrepancy is found in the documents, the priority of the documents shall be in accordance with the order as listed in the Contract Data.

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Provincial Buildings Cir
Health Works Sindh, Hydera

1.4 **Law**

The Law of the contract is the relevant law of Islamic republic of Pakistan.

1.5 **Communications**

All Communications related to the Contract shall be in English language.

1.6 **Statutory Obligations**

The Contractor shall comply with the Laws of Islamic Republic of Pakistan and shall give all notices and pay all fees and other charges in respect of the Works.

2. THE PROCURING AGENCY

2.1 **Provision of Site**

The Procuring Agency shall provide the Site and right of access thereto at the times stated in the Contract Data. **Site Investigation Reports** are those that were included in the bidding documents and are factual and interpretative reports about the surface and subsurface conditions at the Site.

2.2 **Permits etc.**

The Procuring Agency shall, if requested by the Contractor, assist him in applying for permits, licences or approvals which are required for the Works.

2.3 **Engineer's/Procuring Agency's Instructions**

The Contractor shall comply with all instructions given by the Procuring Agency or the Engineer, if notified by the Procuring Agency, in respect of the Works including the suspension of all or part of the works.

2.4 **Approvals**

No approval or consent or absence of comment by the Engineer/Procuring Agency shall affect the Contractor's obligations.

3. ENGINEER'S/PROCURING AGENCY'S REPRESENTATIVES

3.1 **Authorized Person**

The Procuring Agency shall appoint a duly authorized person to act for him and on his behalf for the purposes of this Contract. Such authorized person shall be duly identified in the Contract Data or otherwise notified in writing to the Contractor as soon as he is so appointed. In either case the Procuring Agency shall notify the Contractor, in writing, the precise scope of the authority of such authorized person at the time of his appointment.

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3.2 **Engineer's / Procuring Agency's Representative**

The name and address of Engineer's/Procuring Agency's Representative is given in Contract Data. However the Contractor shall be notified by the Engineer/Procuring Agency, the delegated duties and authority before the Commencement of works.

5. DESIGN BY CONTRACTOR

5.1 **Contractor's Design (not applicable)**

The Contractor shall carry out design to the extent specified, as referred to in the Contract Data. The Contractor shall promptly submit to the Engineer/Procuring Agency all designs prepared by him, within fourteen (14) days of receipt the Engineer/Procuring Agency shall notify any comments or, if the design submitted is not in accordance with the Contract, shall reject it stating the reasons. The contractors shall not construct any element of the works designed by him within fourteen (14) days after the design has been submitted to the Engineer/Procuring Agency or which has been rejected. Design that has been rejected shall be promptly amended and resubmitted. The Contractor shall resubmit all designs commented on taking these comments into account as necessary.

5.2 **Responsibility for Design**

The Contractor shall remain responsible for his bided design and the design under this Clause, both of which shall be fit for the intended purposes defined in the Contract and he shall also remain responsible for any infringement of any patent or copyright in respect of the same. The Engineer/Procuring Agency shall be responsible for the Specifications and Drawings.

6. PROCURING AGENCY'S RISKS

6.1 **The Procuring Agency's Risks**

The Procuring Agency's Risks are:

a) war, hostilities (whether war be declared or not), invasion, act of foreign enemies, within the Country;

b) rebellion, terrorism, revolution, insurrection, military or usurped power, or civil war, within the Country;

c) riot, commotion or disorder by persons other than the Contractor's personnel and other employees including the personnel and employees of Sub-Contractors, affecting the Site and/or the Works;

d) ionising radiations, or contamination by radio-activity from any nuclear fuel, or from any nuclear waste from the combustion of nuclear fuel, radio-active toxic explosive, or other hazardous properties of any explosive nuclear assembly or nuclear component of such an assembly, except to the extent to which the Contractor/Sub-Contractors may be responsible for the use of any radio-active material;

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e) Pressure waves caused by aircraft or other aerial devices travelling at sonic or supersonic speeds;

f) use or occupation by the Procuring Agency of any part of the Works, except as may be specified in the Contract;

g) late handing over of sites, anomalies in drawings, late delivery of designs and drawings of any part of the Works by the Procuring Agency's personnel or by others for whom the Procuring Agency is responsible;

h) a suspension under Sub-Clause 2.3 unless it is attributable to the Contractor's failure; and

i) physical obstructions or physical conditions other than climatic conditions, encountered on the Site during the performance of the Works, for which the Contractor immediately notified to the Procuring Agency and accepted by the Procuring Agency.

7. TIME FOR COMPLETION

7.1 Execution of the Works

The Contractor shall commence the Works on the Commencement Date and shall proceed expeditiously and without delay and shall complete the Works, subject to Sub-Clause 7.3 below, within the Time for Completion.

7.2 Programme

Within the time stated in the Contract Data, the Contractor shall submit to the Engineer/Procuring Agency a programme for the Works in the form stated in the Contract Data.

7.3 Extension of Time

The Contractor shall, within such time as may be reasonable under the circumstances, notify the Procuring Agency/Engineer of any event(s) falling within the scope of Sub-Clause 6.1 or 10.3 of these Conditions of Contract and request the Procuring Agency/Engineer for a reasonable extension in the time for the completion of works. Subject to the aforesaid, the Procuring Agency/Engineer shall determine such reasonable extension in the time for the completion of works as may be justified in the light of the details/particulars supplied by the Contractor in connection with the such determination by the Procuring Agency/Engineer within such period as may be prescribed by the Procuring Agency/Engineer for the same; and the Procuring Agency may extend the time for completion as determined.

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7.4 **Late Completion**

If the Contractor fails to complete the Works within the Time for Completion, the Contractor's only liability to the Procuring Agency for such failure shall be to pay the amount as **liquidity damages** stated in the Contract Data for each day for which he fails to complete the Works.

8. TAKING-OVER

8.1 **Completion**

The Contractor may notify the Engineer/Procuring Agency when he considers that the Works are complete.

8.2 Taking our Notice

Within fourteen (14) days of the receipt of the said notice of completion from the Contractor the Procuring Agency/Engineer shall either takeover the completed works and issue a Certificate of Completion to that effect or shall notify the Contractor his reasons for not taking-over the works. While issuing the Certificate of Completion as aforesaid, the Procuring Agency/Engineer may identify any outstanding items of work which the Contractor shall undertake during the Maintenances Period.

9. REMEDYING DEFECTS

9.1 **Remedying Defects**

The Contractor shall for a period stated in the Contract Data from the date of issue of the Certificate of Completion carry out, at no cost to the Procuring Agency, repair and rectification work which is necessitated by the earlier execution of poor quality of work or use of below specifications material in the execution of Works and which is so identified by the Procuring Agency/Engineer in writing within the said period. Upon expiry of the said period, and subject to the Contractor's faithfully performing his aforesaid obligations, the Procuring Agency/Engineer shall issue a Maintenance Certificate whereupon all obligations of the Contractor under this Contract shall come to an end.

Failure to remedy any such defects or complete outstanding work within a reasonable time shall entitle the Procuring Agency to carry out all necessary works at the Contractor's cost. However, the cost of remedying defects not attributable to the Contractor shall be valued as a Variation.

9.2 **Uncovering and Testing**

The Engineer/Procuring Agency may give instruction as to the uncovering and/or testing of any work. Unless as a result of an uncovering and/or testing it is established that the Contractor's design, materials, plant or workmanship are not in accordance with the Contract, the Contractor shall be paid for such uncovering and/or testing as a Variation in accordance with Sub-Clause 10.2.

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10. VARIATIONS AND CLAIMS

10.1 Right to Vary

The Procuring Agency/Engineer may issue Variation Order(s) in writing. Where for any reason it has not been possible for the Procuring Agency/Engineer to issue such Variations Order(s), the Contractor may confirm any verbal orders given by the Procuring Agency/Engineer in writing and if the same are not refuted/denied by the Procuring Agency/Engineer within ten (10) days of the receipt of such confirmation the same shall be deemed to be a Variation Orders for the purposes of this Sub-Clause. .

10.2 Valuation of Variations

Variations shall be valued as follows:

a) at a lump sum price agreed between the Parties, or

b) where appropriate, at rates in the Contract, or

c) in the absence of appropriate rates, the rates in the Contract shall be used as the basis for valuation, or failing which

d) at appropriate new rates, as may be agreed or which the Engineer/Procuring Agency considers appropriate, or

e) if the Engineer/Procuring Agency so instructs, at day work rates set out in the Contract Data for which the Contractor shall keep records of hours of labour and Contractor's Equipment, and of Materials, used.

10.3 Changes in the Quantities.

a) If the final quantity of the work done differs from the quantity in the Bill of Quantities for the particular item by more than 25 percent, provided the change exceeds 1 percent of the Initial Contract Price, the Procuring Agency/Engineer shall adjust the rate to allow for the change and will be valued as per sub clause 10.2.

b) The Engineer shall not adjust rates from changes in quantities if thereby the Initial Contract Price is exceeded by more than 15 percent, except with the prior approval of the Procuring Agency.

c) If requested by the Engineer, the contractor shall provide the Engineer with a detailed cost breakdown of any rate in the Bill of Quantities.

10.4 Early Warning

The Contractor shall notify the Engineer/Procuring Agency in writing as soon as he is aware of any circumstance which may delay or disrupt the Works, or which may give rise to a claim for additional

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payment.

To the extent of the Contractor's failure to notify, which results to the Engineer/Procuring Agency being unable to keep all relevant records or not taking steps to minimize any delay, disruption, or Cost, or the value of any Variation, the Contractor's entitlement to extension of the Time for Completion or additional payment shall be reduced/rejected.

10.5 **Valuation of Claims**

If the Contractor incurs Cost as a result of any of the Procuring Agency's Risks, the Contractor shall be entitled to the amount of such Cost. If as a result of any procuring Agency Risk,
It is necessary to change the works, this shall be dealt with as a Variation subject to Contractor's notification for intention of claim to the Engineer/Procuring Agency within fourteen (14) days of the occurrence of cause.

10.6 **Variation and Claim Procedure**

The Contractor shall submit to the Engineer/Procuring Agency an itemized detailed breakdown of the value of variations and claims within twenty eight (28) days of the instruction or of the event giving rise to the claim. The Engineer/Procuring Agency shall check and if possible agree the value. In the absence of agreement, the Procuring Agency shall determine the value.

11. CONTRACT PRICE AND PAYMENT

11.1 (a) **Terms of Payments**

The amount due to the Contractor under any Interim Payment Certificate issued by the Engineer pursuant to this Clause, or to any other terms of the Contract, shall , subject to Clause 11.3, be paid by the Procuring Agency to the Contractor within 30 days after such Interim Payment Certificate has been jointly verified by Procuring Agency and Contractor, or, in the case of the Final Certificate referred to in Sub Clause 11.5, within 60days after such Final Payment Certificate has been jointly verified by Procuring Agency and Contractor;

Provided that the Interim Payment shall be caused in thirty (30) days and Final Payment in 60 days in case of foreign funded project. In the event of the failure of the Procuring Agency to make payment within 90 days then Procuring Agency shall pay to the Contractor compensation at the 28 days rate of KIBOR+2% per annum in local currency and LIBOR+1% for foreign currency, upon all sums unpaid from the date by which the same should have been paid.

(b) **Valuation of the Works**
The Works shall be valued as provided for in the Contract Data, subject to Clause 10.

11.2 **Monthly Statements**
The Contractor shall be entitled to be paid at monthly intervals:

a) the value of the Works executed less to the cumulative amount paid previously; and

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b) value of secured advance on the materials and valuation of variations (if any).

The Contractor shall submit each month to the Engineer/Procuring Agency a statement showing the amounts to which he considers himself entitled.

11.3 Interim Payments

Within a period not exceeding seven (07) days from the date of submission of a statement for interim payment by the Contractor, the Engineer shall verify the same and within a period not exceeding thirty (30/60) days from the said date of submission by the Contractor, the Procuring Agency shall pay to the Contractor the sum subject to adjustment for deduction of the advance payments and retention money.

11.4 Retention

Retention money shall be paid by the Procuring Agency to the Contractor within fourteen (14) days after either the expiry of the period stated in the Contract Data, or the remedying of notified defects, or the completion of outstanding work, all as referred to in Sub-Clause 9.1, whichever is the later.

11.5 Final Payment

Within twenty one (21) days from the date of issuance of the Maintenance Certificate the Contractor shall submit a final account to the Engineer to verify and the Engineer shall verify the same within fourteen (14) days from the date of submission and forward the same to the Procuring Agency together with any documentation reasonably required to enable the Procuring Agency to ascertain the final contract value.

Within sixty (60) days from the date of receipt of the verified final account from the Engineer, the Procuring Agency shall pay to the Contractor any amount due to the Contractor. While making such payment the Procuring Agency may, for reasons to be given to the Contractor in writing, withhold any part or parts of the verified amount.

11.6 Currency

Payment shall be in the currency stated in the Contract Data.

12. DEFAULT

12.1 Defaults by Contractor

If the Contractor abandons the Works, refuses or fails to comply with a valid instruction of the

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Engineer/Procuring Agency or fails to proceed expeditiously and without delay, or is, despite a written complaint, in breach of the Contract, the Procuring Agency may give notice referring to this Sub-Clause and stating the default. If the Contractor has not taken all practicable steps to remedy the default within fourteen (14) days after receipt of the Procuring Agency's notice, the Procuring Agency may by a second notice given within a further twenty one (21) days, terminate the Contract. The Contractor shall then demobilize from the Site leaving behind any Contractor's Equipment which the Procuring Agency instructs, in the second notice, to be used for the completion of the Works at the risk and cost of the Contractor.

12.2 Defaults by Procuring Agency

If the Procuring Agency fails to pay in accordance with the Contract, or is, despite a written complaint, in breach of the Contract, the Contractor may give notice referring to this Sub-Clause and stating the default. If the default is not remedied within fourteen (14) days after the Procuring Agency's receipt of this notice, the Contractor may suspend the execution of all or parts of the Works.

If the default is not remedied within twenty eight (28) days after the Procuring Agency's receipt of the Contractor's notice, the Contractor may by a second notice given within a further twenty one (21) days, terminate the Contract. The Contractor shall then demobilize from the Site.

12.3 Insolvency

If a Party is declared insolvent under any applicable law, the other Party may by notice terminate the Contract immediately. The Contractor shall then demobilize from the site leaving behind, in the case of the Contractor's insolvency, any Contractor's Equipment which the Procuring Agency instructs in the notice is to be used for the completion of the Works.

12.4 Payment upon Termination

a) any sums to which the Contractor is entitled under Sub-Clause 10.4,

b) any sums to which the Procuring Agency is entitled,

c) if the Procuring Agency has terminated under Sub-Clause 12.1 or 12.3, the Procuring Agency shall be entitled to a sum equivalent to twenty percent (20%) of the value of parts of the Works not executed at the date of the termination, and

d) if the Contractor has terminated under Sub-Clause 12.2 or 12.3, the Contractor shall be entitled to the cost of his demobilisation together with a sum equivalent to ten percent (10%) of the value of parts of the works not executed at the date of termination.

The net balance due shall be paid or repaid within twenty eight (28) days of the notice of

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termination.

13. RISKS AND RESPONSIBILITIES

13.1 Contractor's Care of the Works

After termination, the Contractor shall be entitled to payment of the unpaid balance of the value of the works executed and of the Materials and Plant reasonably delivered to the site, adjusted by the following: Subject to Sub-Clause 9.1, the Contractor shall take full responsibility for the care of the work from the commencement date until the date of the Procuring Agency 's / Engineer's insurance for certificate of compilation under Sub-Clause 8.2. Responsibility shall then pass to the Procuring Agency. If any loss or damage happens to the Works during the above period, the Contractor shall rectify such loss or damage so that the Works conform with the Contract. Unless the loss or damage happens as a result of any of the procuring Agency Risks, the Contractor shall indemnify the Procuring Agency, or his agents against all claims loss, damage and expense arising out of the Works

13.2 Force Majeure

If Force Majeure occurs, the Contractor shall notify the Engineer/Procuring Agency immediately. If necessary, the Contractor may suspend the execution of the Works and, to the extent agreed with the Procuring Agency demobilize the Contractor's Equipment.

If the event continues for a period of eighty four (84) days, either Party may then give notice of termination which shall take effect twenty eight (28) days after the giving of the notice.

After termination, the Contractor shall be entitled to payment of the unpaid balance of the value of the Works executed and of the Materials and Plant reasonably delivered to the Site, adjusted by the following:

a) any sums to which the Contractor is entitled under Sub-Clause 10.4,
b) the cost of his demobilization, and
c) less any sums to which the Procuring Agency is entitled.

The net balance due shall be paid or repaid within thirty five (35) days of the notice of termination.

14. INSURANCE

14.1 Arrangements

The Contractor shall, prior to commencing the Works, effect insurances of the types, in the amounts

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and naming as insured the persons stipulated in the Contract Data except for items (a) to (e) and (i) of the Procuring Agency's Risks under Sub-Clause 6.1. The policies shall be issued by insurers and in terms approved by the Procuring Agency. The Contractor shall provide the Engineer/Procuring Agency with evidence that any required policy is in force and that the premiums have been paid.

14.2 **Default**

If the Contractor fails to effect or keep in force any of the insurances referred to in the previous Sub-Clause, or fails to provide satisfactory evidence, policies or receipts, the Procuring Agency may, without prejudice to any other right or remedy effect insurance insurance for the cover relevant to such as a default and pay the premiums due and recover the same plus a sum in percentage given in Contractor Data from any other amounts due to the Contractor..

15. RESOLUTION OF DISPUTES

15.1 Engineer's Decision

If a dispute of any kind whatsoever arises between the Procuring Agency and the Contractor in connection with the works, the matter in dispute shall, in the first place, be referred in writing to the Engineer, with a copy to the other party. Such reference shall state that it is made pursuant to this Clause. No later than the twenty eight (28) days after the day on which he received such reference, the Engineer shall give notice of his decision to the Procuring Agency and the Contractor.

Unless the Contract has already been repudiated or terminated, the Contractor shall, in every case, continue to proceed with the work with all due diligence, and the Contractor and the Procuring Agency shall give effect forthwith to every such decision of the Engineer unless and until the same shall be revised, as hereinafter provided in an arbitral award.

In Case of any dispute concerning the interpretation and/or application of this contract is to be settled through arbitration, the arbitrator to be appointed by the health department/Procuring agency. The decision taken and/or award given by the sole arbitrator shall be final and binding on the parties.

15.2 Notice of Dissatisfaction

If a Party is dissatisfied with the decision of the Engineer of consultant or if no decision is given within the time set out in Sub-Clause 15.1 here above, the Party may give notice of dissatisfaction referring to this Sub-Clause within fourteen (14) days of receipt of the decision or the expiry of the time for the decision. If no notice of dissatisfaction is given within the specified time, the decision shall be final and binding on the Parties. If notice of dissatisfaction is given within the specified time, the decision shall be binding on the Parties who shall give effect to it without delay unless and until the decision of the Engineer is revised by an arbitrator.

If a contractor is dissatisfied with the decision of the Engineer of the department or decision is not given in time then he can approach Procuring Agency within 14 days, in case of dissatisfaction with decision of Procuring Agency or not decided within 28 days, then arbitration process would be

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adopted as per clause 15.3.

15.3 **Arbitration**

A dispute which has been the subject of a notice of dissatisfaction shall be finally settled as per provisions of Arbitration Act 1940 (Act No. X of 1940) and Rules made there under and any statutory modifications thereto. Any hearing shall be held at the place specified in the Contract Data and in the language referred to in Sub-Clause 1.5.

16 INTEGRITY PACT

16.1 If the Contractor or any of his Sub-Contractors, agents or servants is found to have violated or involved in violation of the Integrity Pact signed by the Contractor as Schedule-F to his Bid, then the Procuring Agency shall be entitled to:

(a) recover from the Contractor an amount equivalent to ten times the sum of any commission, gratification, bribe, finder's fee or kickback given by the Contractor or any of his Sub-Contractors, agents or servants;

(b) terminate the Contract;

(c) recover from the Contractor any loss or damage to the Procuring Agency as a result of such termination or of any other corrupt business practices of the Contractor or any of his Sub-Contractors, agents or servants.

On termination of the Contract under Sub-Para (b) of this Sub-Clause, the Contractor shall demobilize from the site leaving behind Contractor's Equipment which the Procuring Agency instructs, in the termination notice, to be used for the completion of the works at the risk and cost of the Contractor. Payment upon such termination shall be made under Sub-Clause 12.4, in accordance with Sub-Para (c) thereof, after having deducted the amounts due to the Procuring Agency under Sub-Para (a) and (c) of this Sub-Clause.

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CONTRACT DATA

Sub-Clauses of Conditions of Contract

1.1.3 Office of the "Director Health Services Karachi" Drawings, if any

1.1.4 **The Procuring Agency** means
Director Health Services Karachi Division

1.1.5 **The Contractor** means who executes the work

1.1.7 **Commencement Date** means the date of issue of Engineer's Notice to Commence which shall be issued within Seven (07) days of the signing of the Contract Agreement.

1.1.9 **Time for Completion 04 months**

1.1.20 **Engineer from** Office of the Director Health Services Karachi, Nominated Representative,

1.3 **Documents forming the Contract listed in the order of priority:**

(a) The Contract Agreement
(b) Letter of Acceptance.
(c) The completed Form of Bid
(d) Contract Data
(e) Conditions of Contract
(f) The completed Schedules to Bid including Schedule of Prices
(g) The Drawings,
(h) The Specifications
(i) _____
(j) _____

2.1 **Provision of Site:**

3.1 **Authorized person: Director Health Services**

3.2 **Name and address**

Director Health Services Karachi Division
Civic Centre,6th Floor, Hassan Square, Karachi
Phone: +92300-2247244

4.4 **Performance Security:**

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Superintending Engineer
Provincial Buildings Circle
Health Works Sindh, Hyderabad

The Performance Security shall be equal to amount of 5% of the contract price as stated in letter of Acceptance, such security in the form of Pay Order/ Bank Guarantee from a Schedule Bank of Pakistan acceptable to the procuring agency (**OFFICE OF DIRECTOR HEALTH SERVICES KARACHI**), the performance security will be valid for a period upto the completion of project and after the date of issue of Defect Liability Certificate from the Client.

5.1 **Requirements for Contractor's design**

(Not applicable):

7.2 **Programme:**
Time for submission: Within Seven (07) days of the Commencement Date.

Form of programme: *(Bar Chart)*

7.4 Amount payable due to failure to complete shall be 0.1% per day up to a maximum of (10%) of sum stated in the Letter of Acceptance/Award.

7.5 **Early Completion**

(Not applicable)

9.1 **Period for remedying defects/ defect liability period (DLP)**
DLP period will be 06 months

11.1 **Terms of Payments**

a) Mobilization Advance (Not Applicable)

11.3 Percentage of retention: 5% of the amount of Interim Payment Certificate

11.6 Currency of payment: Pak. Rupees

14.1 Insurances:
Type of cover
Third Party-injury to persons and damage to property
Rs.500,000 per occurrence with a number of occurrences unlimited.

Other cover*: **Amount to be recovered** Premium plus _____ percent (%)

1. **Arbitration**** Place of Arbitration: Karachi.

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Superintending Engineer,
Provincial Buildings Circle
Health Works Sindh, Hyderaba

STANDARD FORMS

FORM OF BID SECURITY

(Bank Guarantee)

Guarantee No._____ Executed on _____ (Letter by the Guarantor to the Procuring Agency)

Name of Guarantor (Scheduled Bank in Pakistan) with address:_____ Name of Principal (Bidder) with address:_____

Sum of Security (express in words and figures):_____ _____

Bid Reference No._____ Date of Bid _____

KNOW ALL MEN BY THESE PRESENTS, that in pursuance of the terms of the Bid and at the request of the said Principal, we the Guarantor above-named are held and firmly bound unto the _____, (hereinafter called The —Procuring Agency‖) in the sum stated above, for the payment of which sum well and truly to be made, we bind ourselves, our heirs, executors, administrators and successors, jointly and severally, firmly by these presents.

THE CONDITION OF THIS OBLIGATION IS SUCH, that whereas the Principal has submitted the accompanying Bid numbered and dated as above for _____ (Particulars of Bid) to the said Procuring Agency; and

WHEREAS, the Procuring Agency has required as a condition for considering the said Bid that the Principal furnishes a Bid Security in the above said sum to the Procuring Agency, conditioned as under:

(1) that the Bid Security shall remain valid for a period of twenty eight (28) days beyond the period of validity of the bid;

(a) the Principal withdraws his Bid during the period of validity of Bid, or

(b) the Principal does not accept the correction of his Bid Price, pursuant to Sub-Clause 16.4 (b) of Instructions to Bidders, or

(c) failure of the successful bidder to

(i) furnish the required Performance Security, in accordance with Sub-Clause IB-21.1 of Instructions to Bidders, or

(ii) sign the proposed Contract Agreement, in accordance with Sub-Clauses IB-20.2 & 20.3 of Instructions to Bidders,

The entire some be paid immediately to the said Procuring Agency for delayed

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completion and not as penalty for the successful bidder's failure to perform.

NOW THEREFORE, if the successful bidder shall, within the period specified therefore, on the prescribed form presented to him for signature enter into a formal Contract Agreement with the said Procuring Agency in accordance with his Bid as accepted and furnish within fourteen (14) days of receipt of Letter of Acceptance, a Performance Security with good and sufficient surety , as may be required, upon the form prescribed by the said Procuring Agency for the faithful performance and proper fulfilment of the said Contract or in the event of non-withdrawal of the said Bid within the time specified then this obligation shall be void and of no effect, but otherwise to remain in full force and effect.

PROVIDED THAT the Guarantor shall forthwith pay to the Procuring Agency the said sum stated above upon first written demand of the Procuring Agency without cavil or argument and without requiring the Procuring Agency to prove or to show grounds or reasons for such demand, notice of which shall be sent by the Procuring Agency by registered post duly addressed to the Guarantor at its address given above.

PROVIDED ALSO THAT the Procuring Agency shall be the sole and final judge for deciding whether the Principal has duly performed his obligations to sign the Contract Agreement and to furnish the requisite Performance Security within the time stated above, or has defaulted in fulfilling said requirements and the Guarantor shall pay without objection the sum stated above upon first written demand from the Procuring Agency forthwith and without any reference to the Principal or any other person.

IN WITNESS WHEREOF, the above bounded Guarantor has executed the instrument under its seal on the date indicated above, the name and seal of the Guarantor being hereto affixed and these presents duly signed by its undersigned representative pursuant to authority of its governing body.

_____
Guarantor

(Bank)
Witness:

1 . _____

_____

Corporate Secretary (Seal)

1. Signature _____
2. Name _____
3. Title _____

2. _____

_____

(Name, Title & Address)

Corporate Guarantor (Seal)

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Superintending Engineer,
Provincial Buildings Circle
Health Works South, Hyderabad.

FORM OF PERFORMANCE SECURITY
(Bank Guarantee)

Guarantee No. _____
Executed on _____
Expiry Date _____

(Letter by the Guarantor to the Procuring Agency)

Name of Guarantor (Scheduled Bank in Pakistan) with address: _____

Name of Principal (Contractor) with address: _____

Penal Sum of Security (express in words and figures) _____

Letter of Acceptance No. _____ Dated _____

KNOW ALL MEN BY THESE PRESENTS, that in pursuance of the terms of the Bidding Documents and above said Letter of Acceptance (hereinafter called the Documents) and at the request of the said Principal we, the Guarantor above named, are held and firmly bound unto the _____ (hereinafter called the Procuring Agency) in the penal sum of the amount stated above, for the payment of which sum well and truly to be made to the said Procuring Agency, we bind ourselves, our heirs, executors, administrators and successors, jointly and severally, firmly by these presents.

THE CONDITION OF THIS OBLIGATION IS SUCH, that whereas the principal has accepted the Procuring Agency's above said Letter of Acceptance for _____ (Name of Contract) for the _____ (Name of Project).

NOW THEREFORE, if the Principal (Contractor) shall well and truly perform and fulfill all the undertakings, covenants, terms and conditions of the said Documents during the original terms of the said Documents and any extensions thereof that may be granted by the Procuring Agency, with or without notice to the Guarantor, which notice is, hereby, waived and shall also well and truly perform and fulfill all the undertakings, covenants terms and conditions of the Contract and of any and all modifications of the said Documents that may hereafter be made, notice of which modifications to the Guarantor being hereby waived, then, this obligation to be void; otherwise to remain in full force and virtue till all requirements of Clause 9, Remedying Defects, of Conditions of Contract are fulfilled.

Our total liability under this Guarantee is limited to the sum stated above and it is a condition of any liability attaching to us under this Guarantee that the claim for payment in writing shall

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be received by us within the validity period of this Guarantee, failing which we shall be discharged of our liability, if any, under this Guarantee.

We, _____ (the Guarantor), waiving all objections and defences under the Contract, do hereby irrevocably and independently guarantee to pay to the Procuring Agency without delay upon the Procuring Agency's first written demand without cavil or arguments and without requiring the Procuring Agency to prove or to show grounds or reasons for such demand any sum or sums up to the amount stated above, against the Procuring Agency's written declaration that the Principal has refused or failed to perform the obligations under the Contract, for which payment will be effected by the Guarantor to Procuring Agency's designated Bank & Account Number.

PROVIDED ALSO THAT the Procuring Agency shall be the sole and final judge for deciding whether the principal (Contractor) has duly performed his obligations under the Contract or has defaulted in fulfilling said obligations and the Guarantor shall pay without objection any sum or sums up to the amount stated above upon first written demand from the Procuring Agency forthwith and without any reference to the principal or any other person.

IN WITNESS WHEREOF, the above bounded Guarantor has executed this Instrument under its seal on the date indicated above, the name and corporate seal of the Guarantor being hereto affixed and these presents duly signed by its undersigned representative, pursuant to authority of its governing body.

Guarantor (Bank) Witness:

_____
Guarantor

(Bank)
Witness:

1. _____

_____
Corporate Secretary (Seal)

1. Signature _____

2. Name _____

3. Title _____

2. _____

_____
(Name, Title & Address)

_____
Corporate Guarantor (Seal)

DR SAQIB ALI SHAIKH
Director Health Services
Karachi Division

(DR. RASHID SIRAJ)
MEDICAL SUPERINTENDENT
SINDH GOVT. QATAR HOSPITAL
ORANGI TOWN KARACHI

Executive Engineer,
Circle
Hyderabad.

FORM OF CONTRACT AGREEMENT

THIS CONTRACT AGREEMENT (hereinafter called the —Agreement‖) made on the _____ day of _____ 200 _____ between _____(hereinafter called the "Procuring Agency") of the one part and _____ (hereinafter called the —Contractor‖) of the other part.

WHEREAS the Procuring Agency is desirous that certain Works, viz _____ should be executed by the Contractor and has accepted a Bid by the Contractor for the execution and completion of such Works and the remedying of any defects therein.

NOW this Agreement witnesseth as follows:

1. In this Agreement words and expressions shall have the same meanings as are respectively assigned to them in the Conditions of Contract hereinafter referred to.

2. The following documents after incorporating addenda, if any except those parts relating to Instructions to Bidders, shall be deemed to form and be read and construed as part of this Agreement, viz:

(a) The Letter of Acceptance;

(b) The completed Form of Bid along with Schedules to Bid;

(c) Conditions of Contract & Contract Data;

(d) The priced Schedule of Prices/Bill of quantities (BOQ);

(e) The Specifications; and

(f) The Drawings

3. In consideration of the payments to be made by the Procuring Agency to the Contractor as hereinafter mentioned, the Contractor hereby covenants with the Procuring Agency to execute and complete the Works and remedy defects therein in conformity and in all respects within the provisions of the Contract.

4. The Procuring Agency hereby covenants to pay the Contractor, in consideration of the execution and completion of the Works as per provisions of the Contract, the Contract Price or such other sum as may become payable under the provisions of the Contract at the times and in the manner prescribed by the Contract.

(DR. RASHID SIRAJ)
MEDICAL SUPERINTENDENT
SINDH GOVT. QATAR HOSPITAL
ORANGI TOWN KARACHI

DR SAQIB ALI SHAIKH
Director Health Services
Karachi Division

IN WITNESS WHEREOF the parties hereto have caused this Contract Agreement to be executed on the day, month and year first before written in accordance with their respective laws.

Signature of the Contactor

_____

(Seal)

Signed of the Procuring Agency

_____

(Seal)

Signed. Sealed and Delivered in the presence of:

Witness:

_____

(Name, Title and Address)

Witness:

_____

(Name, Title and Address)

DR SAQIB ALI SHAIKH
Director Health Services
Karachi Division

(DR. RASHID SIRAJ)
MEDICAL SUPERINTENDENT
SINDH GOVT. QATAR HOSPITAL
ORANGI TOWN KARACHI

Hyderabad.

MOBILIZATION ADVANCE GUARANTEE

Guarantee No._____

Executed on _____

(Letter by the Guarantor to the Procuring Agency)

WHEREAS the _____ (hereinafter called the Procuring Agency) has entered into a Contract for

_____ (Particulars of Contract), with

_____ (hereinafter called the Contractor).

AND WHEREAS the Procuring Agency has agreed to advance to the Contractor, at the Contractor's request, an amount of Rs._____ Rupees _____) which amount shall be advanced to the Contractor as per provisions of the Contract.

AND WHEREAS the Procuring Agency has asked the Contractor to furnish Guarantee to secure the advance payment for the performance of his obligations under the said Contract.

AND WHEREAS _____ (Scheduled Bank) (hereinafter called the Guarantor) at the request of the Contractor and in consideration of the Procuring Agency agreeing to make the above advance to the Contractor, has agreed to furnish the said Guarantee.

NOW THEREFORE the Guarantor hereby guarantees that the Contractor shall use the advance for the purpose of above mentioned Contract and if he fails, and commits default in fulfillment of any of his obligations for which the advance payment is made, the Guarantor shall be liable to the Procuring Agency for payment not exceeding the aforementioned amount.

Notice in writing of any default, of which the Procuring Agency shall be the sole and final judge, as aforesaid, on the part of the Contractor, shall be given by the Procuring Agency to the Guarantor, and on such first written demand payment shall be made by the Guarantor of all sums then due under this Guarantee without any reference to the Contractor and without any objection.

DR SAQIB ALI SHAIKH
Director Health Services
Karachi Division

(DR. RASHID SIRAJ)
MEDICAL SUPERINTENDENT
SINDH GOVT. QATAR HOSPITAL
ORANGI TOWN KARACHI

This Guarantee shall come into force as soon as the advance payment has been credited to the account of the Contractor.

This Guarantee shall expire not later than _____

by which date we must have received any claims by registered letter, telegram, telex or telefax.

It is understood that you will return this Guarantee to us on expiry or after settlement of the total amount to be claimed hereunder.

Guarantor (Scheduled Bank)

_____

Guarantor (Scheduled Bank)

Witness:

1. _____

_____

Corporate Secretary (Seal)

1. Signature _____

2. Name _____

3. Title _____

2. _____

_____

(Name, Title & Address)

_____

Corporate Guarantor (Seal)

DR SAQIB ALI SHAIKH
Director Health Services
Karachi Division

(DR. RASHID SIRAJ)
MEDICAL SUPERINTENDENT
SINDH GOVT. QATAR HOSPITAL
ORANGI TOWN KARACHI

Circle
Hyderabad.

INDENTURE FOR SECURED ADVANCE

(For use in cases in which is contract is for finished work and the contractor has entered into an agreement for the execution of a certain specified quantity of work in a given time).

This INDENTURE made the .... day of ..... -----..... ----------.....-20-----"-BETWEEN (hereinafter called "the Contractor" which expression shall where the context so admits or implied be deemed to include his heirs, executors, administrators and assigns) of the one part and THE GOVERNOR OF SINDH (hereinafter called "the Government" of the other part).

WHEREAS by an agreement, dated (hereinafter called the said agreement, the contractor has agreed to perform the under-mentioned works (hereinafter referred to as the said work):

(Here enter (the description of the works).

AND WHEREAS the contractor has applied to the .... —..... -----for an advance to him of Rupees ----------, (Rs. .....) on the security of materials absolutely belonging to him and brought by him to the site of the said works the subject of the said agreement for use in the construction of such of the said works as he has undertaken to execute at rates fixed for the finished work (inclusive of the cost of materials and labour and other charge) AND WHEREAS the Government has agreed to advance to the Contractor the sum of Rupees, (Rs. .....) on the security of materials the quantities and other particulars of which are detailed in Part II of Running Account Bill (E). the said works signed by the contractor

Fin R.Form.17.A on----------..... — and on such covenants and conditions as are hereinafter contained and the Government has reserved to itself the option of marking any further advance or advances on the security of other materials brought by the Contractor to the site of the said works.

NOW THIS INDENTURE WTTNESSETH that in pursuance of the said agreement and in consideration of the sum of Rupees..... ----------.....-.....— ..... (Rs. ------..... -----) on or before the execution of these presents paid to the Contractor by the Government (the receipt whereof the Contractor doth hereby acknowledge) and of such further advances (if any) as may be made to him as aforesaid (all of which advances are hereinafter collectively referred to as the said amount) the Contractor doth hereby assign unto the Government the said materials by way of security for the said amount

And doth hereby covenant and agree with the Government and declare ay follow :

(1) ThatthesaidsumofRupees.....-..... ----------..... ----------(RF. ----------) so advanced by the Government to the Contractor as aforesaid and all or any further sum or sums which may be advanced aforesaid shall be employed by the contractor in or towards expending the execution of the said works and for no other purpose whatsoever.

DR. RASHID SIRAJ
MEDICAL SUPERINTENDENT
SINDH GOVT. QATAR HOSPITAL
ORANGI TOWN KARACHI

DR SAQIB ALI SHAIKH
Director Health Services
Karachi Division

(2) That the materials detailed in the said Running Account Bill (B) which have been

Fin R Form No. 17-A

Offered to and accepted by (he Government as security for the said amount are absolutely by the Contractors own property free from encumbrances of any kind and the Contractor will not make any application for or receive a further advance on the security of materials which are not absolutely his own property and free from encumbrances of any kind and the contractor hereby agrees, at all times, to indemnify and save harmless the Government against all claims whatsoever to any materials in respect of which an advance has been made to him as aforesaid.

(3) That the said materials detailed in the said Running Account Bill (B) and all other

Fin R Form No. 17-A

Materials on the security of which any further advance or advances may hereafter be made as aforesaid (hereinafter called the said materials) shall be used by the Contractor solely in *the* execution of the said works in accordance with the directions of the Divisional Officer----------(hereinafter called the Divisional Officer) and in the terms of the said agreement.

(4) That the Contractor shall make at his own cost all necessary and adequate arrangement for the proper watch, safe custody and protection against all risks of the said material and that until used in construction as aforesaid the said materials shall remain at the site of the said works in the Contractor's custody and at his own risk and on his own responsibility and shall at all times be open to inspection by (he Divisional Officer or any officer authorized by him. In the event of the said materials of any part (hereof being stolen, destroyed or damaged or becoming deteriorated in a grater degree than is due to reasonable use and wear thereof Contractor will forthwith replace the same with other materials of like qualify or repair and make good the same as required by the Divisional Officer and the materials so brought to replace the said materials so repaired and made good shall also be considered as security for the said amount.

(5) 'Hurt the said materials shall not on any account be removed from the site of the said works except with the written permission of the Divisional Officer or an officer authorized by him in that behalf

(6) That the said amount shall be payable in full when or before the Contractor receives payment, from the Government of the price payable to him for the said works under the terms and provisions of the said agreement PROVIDED THAT if any intermediate payments are made to the contractor on account of work done then on the occasion of each such payment the Government will be at liberty to make a recovery from the Contractors Bill for such payment by deducting there from in the value of the said materials (hen actually used in the construction and in respect of which recovery has not been made previously the value for this purpose being determined in respect of each description of material at (he rates at which the amount of the advances made under these presents were calculated.

(7) That if the Contractor shall at any time make any default in the performance or observation in any respect of any of the terms and provisions of the said agreement or of these presents the total amount of the advance or advances that may still be owing to the Government shall immediately on the happening of such default be repayable by the Contractor to the Government together with interest thereon at twelve percent per annum from the date or respective dates of such advance or advances to the date or repayment and with all costs, charges, damages and expenses incurred by the Government in or for the recovery thereof or the enforcement of this security or otherwise by reason of (he default

DR. RASHID SIRAJ
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ORANGI TOWN KARACHI

DR SAQIB ALI SHAIKH
Director Health Services
Karachi Division

of the Contractor and any moneys so becoming due and payable shall constitute a debt due from the Contractor to the Government and the Contractor hereby covenants and agrees with the Government to repay and the same respectively to it accordingly.

(8) That the Contractor hereby charges all the said materials with the repayment to the Government of the said sum of Rupees ..... -..... (Rs.....) and any further sum or sums which may be advanced as aforesaid and all costs charges damages and expenses payable under these present PROVIDED ALWAYS and it is hereby agreed and declared that not withstanding anything in the said agreement and without prejudice to the powers contained therein if and whether the covenant for payment and repayment hereinbefore contained shall become enforceable and the money owing shall not be paid to accordingly.

Once therewith the Government may at any time thereafter adopt all or any of following courses as it may deem best ;

(a) Seize and utilize the said materials or any part thereof in the completion of the said works on behalf of the Contractor in accordance with the provisions in that behalf contained in the said agreement debiting the Contractor with the actual cost of effecting such completion the amount due in respect of advances under these presents and crediting the Contractor with the value of work done as he had carried it out in accordance with the said agreement and at the rates thereby provided. If the balance is against the Contractor, he is to pay the same to the Government on demand.

(b) Remove and sell by public auction the seized materials or any part thereof and out of the moneys arising from the sale retain all the sums aforesaid repayable to the Government under these presents and pay over the surplus (if any) to the Contractor.

(c) Deduct all or any part of the moneys owing out of the security deposit or any sum due to the Contractor under the said agreement.

(9) That except as is expressly provided by the presents interest on the aid advance shall not be payable.

(10) That in the event of any conflict between the provisions of these presents and the said agreement the provisions of these presents shall prevail and in the event of any dispute or difference arising over the construction or effect of these presents the settlement of which has not been hereinbefore expressly provided for the same shall be referred to the Procuring Agency ..... Circle whose..... decision shall be final and the provisions of the Indian Arbitration Act for the time being in force so far as they are applicable shall apply to any such reference.

DR SAQIB ALI SHAIKH
Director Health Services
Karachi Division

(DR. RASHID SIRAJ)
MEDICAL SUPERINTENDENT
SINDH GOVT. QATAR HOSPITAL
...ANGI TOWN KARACHI

In witness where of the* _____ on behalf of the Governor of Sindh and the said..... ..... "..... --have hereunto set their respective hands and seals the day and first above written.

Signed, sealed and delivered by* In the presence of

_____

Seal

1st witness 2nd witness

Signed, sealed and delivered by* In the presence of

Seal

1st Witness 2nd witness

DR SAQIB ALI SHAIKH
Director Health Services
Karachi Division

(DR. RASHID SIRAJ)
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ORANGI TOWN KARACHI

Circle
Hyderabad.

SPECIFICATION

[Note for Preparing the Specifications]

A set of precise and clear specifications is a prerequisite for bidders to respond realistically and competitively to the requirements of the user without qualifying their Bids. The specifications must be drafted to permit the widest possible competition and, at the same time, present a clear statement of the required standards of workmanship, materials, performance of the works. Only if this is done objectives of economy, efficiency, and fairness in procurement will be realized and responsiveness of Bids can be ensured, and the subsequent task of bid evaluation can be facilitated. The specifications should require that materials to be incorporated in the works be new, unused, and of the most recent or current models, and incorporated all recent improvements in design and materials unless provided for otherwise in the contract.

Samples of specifications from similar to previous procurements are useful in this respect. The use of metric units is encouraged. Depending on the complexity of the works and the repetitiveness of the type of procurement, it may be advantageous to standardize the Technical Specifications that should cover all classes of workmanship, materials and equipment although not necessarily to be used in a particular procurement.

Care must be taken in drafting specifications to ensure that they are not restrictive. In the specification of standards for equipment, materials, and workmanship, recognized international standards should be used as much as possible. The specifications shall consider all conditions but not limited to seismic conditions, weather conditions and environmental impact. The specifications should state that equipment, materials, and workmanship that meet other authoritative standards, and which ensure at least a substantially equal quality than the standards mentioned, will also be acceptable. The following clause may be inserted in the Specifications.

Sample Clause: Equivalency of Standards and Codes

Wherever reference is made in the Specifications to specific standards and codes to be met by Works to be furnished and tested, the provisions of the latest current edition or revision of the relevant shall apply, unless otherwise expressly stated in the Contract. Other authoritative standards that ensure equivalence to the standards and codes specified will be acceptable.]

DR SAQIB ALI SHAIKH
Director Health Services
Karachi Division

(DR. RASHID SIRAJ)
MEDICAL SUPERINTENDENT
SINDH GOVT. QATAR HOSPITAL
ORANGI TOWN KARACHI

REHABILITATION & RENOVATION OF SINDH GOVERNMENT QATAR HOSPITAL AT KARACHI (OLD & NEW).

HEALTH SERVICES KARACHI DIVISON, GoS

BILL OF QUANTITIES

MAIN SUMMARY

SR.NO	DESCRIPTION	AMOUNT
A1	**Civil Works (Hospital- Bldg)**	
1	SCHEDULE ITEMS	
a	Civil Works	38,886,888
	Above/ Below Premium _____%	
	Total	
2	NON SCHEDULE ITEMS	
	Civil Works	
	Total	
	Total Civil Works	
A.2	**Plumbing Works**	
1	SCHEDULE ITEMS	
a	Plumbing Works	2,615,263
	Above/ Below Premium _____%	
	Total	
2	NON SCHEDULE ITEMS	
	Plumbing Works	
	Total	
	Total Plumbing Works	
A.3	**Electrical Works**	
1	SCHEDULE ITEMS	
	Electrical Works	5,347,143.00
	Above/ Below Premium _____%	
	Total Electrical Works	
	TOTAL of A1,A2,A3	
	Add 5% SRB	
	GRAND TOTAL	

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ORANGI TOWN KARACHI

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Director Health Services
Karachi Division

BILL OF QUANTITIES

Rehabilitation & Upgradation of Sindh Govt Qatar Hospital (Old & New)

Civil Works

Sno	Item Ref.	Particulars	Qty	Unit	Rate (Rs.)	Amount (Rs.)
		Dismantling / Demolition Work				
1	Item 54b/ Page 22	Scraping, Ordinary distemper, oil bound distemper or paint on walls/ceilings.	58,625	P.Sft	10.30	603,833
2	Item 53/ Page 22	Removing cement or lime plaster.	16,874	P.Sft.	5.39	90,950
3	Item 55/ Page 22	Dismantling glazed or encaustic tiles etc. (For tiles & marbles etc.,)	24,591	P.Sft	31.19	766,987
4	Item 19c /Page 20	Dismantling cement concrete Plain	15,873	Per.Cft.	133.08	2,112,379
5	Item 33a/ Page 21	Removing door with chowket.	90	Per No.	574.26	51,683
		Rehabilitation/Renovation Work				
		Screeding & Water Proofing				
6	Item 16d/ Page 45	Providing and laying 3" thick toping cement concrete (1:2:4) including surface finishing and dividing into panels: (CSR Sr.#16d/42)	63,490	P.Sft	145.00	9,206,050
7	Item 38+38/ Page 43	Providing and laying Two layers of polythene sheet (0.13 mm thick each) for water proofing as per specifiation and instructions of Engineer Incharge.	63,490	P.Sft	48.02	3,048,790
8	Item 13/ Page 41	2 coats of bitumen laid hot using 34 lbs (1.72 Kg/Sqm) per P.Sft over roof and blinded with sand at 1 Cft per % Sf	63,490	P.Sft	47.84	3,037,362
		Plastering & Painting				
		Plaster				
9	Item 11b/ Page 52	Cement plaster 1:4, 1/2" thick.	16,874	P.Sft	39.83	672,083
10	Item 11b/ Page 52	Cement plaster 1:4, 3/4" thick.	21,933	P.Sft	53.82	1,180,450

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Director Health Services
Karachi Division

Superintending Engineer,
Provincial Circle
Health Works, Hyderabad.

Sno	Item Ref.	Particulars	Qty	Unit	Rate (Rs.)	Amount (Rs.)
		Paint				
11	Item 23/ Page 53	Priming coat of chalk under distemper.	22,368	P.Sft	3.59	80,301
12	Item 24c/ Page 53	Distempering. Three coats (1st coat over priming coat)	22,368	P.Sft	17.23	385,399
13	Item 36.A/ Page 54	Preparing the surface and painting with matt finish l/c rubbing the surface with Bathy (silicon carbide rubbing brick) filling the voids with zink / chalk / plaster of paris mixture, applying first coat premix, making the surface smooth and then painting 3 coats with matt finish of approved make etc:	36,607	P.Sft	49.27	1,803,641
14	Chp 11 /4©	Painting doors & windows any type.				
		First Coat	1,155	P.Sft	13.62	15,731
		Each Subsequent Coat	1,155	Psft	9.74	11,250
		Tiles/Marbles				
15	Item 28(viii)/ Page 46	Providing & Laying Full Body Porcelain Tile in Flooring or Facing of Approved Design Set in Gray Cement Motor 1:2 or of 3/4" Thickness l/C Washing & Joints With White Cement Slurry Using Colour Pigment for matching complete as per Spacification. (5/16" thick) in approved size.				
a)		Porcelain Tiles Flooring	2,520	P.Sft	373.84	942,077
b)		Porcelain Tiles Skirting/Dado	2,818	P.Sft	373.84	1,053,481
16	ch8 /Item 66'	Applying chemical polishing on existing mosaic /Marble floooring / dado including cleaning, grinding with carborandum stone / sand paper and applying chemical polish as per requirement	14,618	Psft	114.79	1,678,000
17		Providing and Laying floors of approved coloured glazed tiles1/4" thick floor of approved color & size jointing in white cement and laid over 1:2 cement sand mortor 3/4" thick including grouting with matching color and finishing. (Glazed / Semi glazed / Matt Ceramic Tiles)				
a)	Item 25/ page 46	Ceramic Tile flooring	5,953	Sft	325.40	1,937,106
b)	Item 24/ page 45	Ceramic Tile for skirting /Dado	4,041	Sft	389.36	1,573,403.76
		Door & Windows				
18	Item 7ia/ Page 56	First Class deodar wood wrought joinery in doors and windows etc. panelled or panelled or glazed or fully glazed fixed in position including chowkhat, holdfast, hinges, tower bolt rubber stop cleats /GI clamp, handles and chord with hooks etc. complete (excluding sliding bolts or lock). Wooden Single / Double Shutter Swing Door with vision panel (if required)	546	P.Sft	3,130.83	1,709,433

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ORANGI TOWN KARACHI

DR SAQIB ALI SHAIK
Director Health Services
Karachi Division

Executive Engineer
Health Works Sindh, Hyderabad

Sno	Item Ref.	Particulars	Qty	Unit	Rate (Rs.)	Amount (Rs.)
		Architrave / Beading				
19	Item 60/ Page 61	Providing and fixing with sunk iron screws Wooden Architrave approved design / shape having width not less than 2-1/2 inches as directed by Engineer Incharge.	1,508	P.Rft	136.40	205,716
		Door Lock				
20	Item 21/ Page 58	Providing and fixing approved quality mortice lock.	42	Each	1,039.05	43,640

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Karachi Division

Sno	Item Ref.	Particulars	Qty	Unit	Rate (Rs.)	Amount (Rs.)
21	Item 117/ Page 87	**Door Closer** Providing and fixing approved quality of door closer including fixing on door with screws and adjusting speed on required etc complete.	26	Each	13,188.24	342,894
22	Item 112/ Page 86	**uPVC Door** Providing and fixing in position uPVC channels framing for Door of unplasticized poly vinyl chloride (uPVC) (Flush / Panelled Door) i/c handles stoppers looking arrangement, push bar etc complete Deluxe model etc complete as per direction of Engineer / Incharge.	1,085	P.Sft	3,267.66	3,545,411
		Aluminium Window/ Ventilator				
23	Item 84a/ Page 83	Supplying & fixing in position Aluminum channels framing for sliding windows & ventilators of made with 5 mm thick tinted glass glazing (Belgium) & Aluminum fly screen i/c handles stoppers & locking arrangement etc. complete. (a) Deluxe model (White or other approved color) (For Sliding/Openable Windows & Ventilators)	500	P.Sft.	2,386.73	1,193,365
24	Item 38.A/ Page34	Preparing the surface and painting with weather coat I/c rubbing the surface with rubbing brick / sand Paper, filling the voids with chalk / plaster of Paris and then painting with weather coat of approved make. (Three Coats)	70,871	P.Sft.	39.38	2,790,899.98
					Total Amount of Civil Works Rs.	**40,082,316**
					Less 10% Below on Item No. 15,17, 18,22,23	**(1,195,428)**
						38,886,888

NON-SCHEDULE ITEMS

1	NSI	Providing & applying, Special Anti-Bacterial & Anti Reflection wall paint (Three Coats) including cost of primer & Preparation of base. complete in all respect, at any height in any floor, as directed by the Engineer. In specified area. Cost of scaffolding, ladders and wooden planks for working is deemed to be including in the rates.	25,536	P.Sft.		
2	NSI	Providing and laying Anti-static epoxy floor coating in approved thickness including undercoat of primer, a net of carbon strips, consisting of a base, a filler and a hardener. Complete in all respects as per drawings, specifications and approval of the Engineer.	3,360	P.Sft.		
3	NSI	Strengthening of existing Slab where clear cover has eroded, chiseling required are, cleaning and apply wire brush, apply zinc Rich, Fix net with nails and first apply cement past and cement plaster 1:3 , up to 15ft height and finish the surface as per the existing plaster or as per the direction of engineer incharge. complete in all respect.	7,180	P.Sft		

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Karachi Division

Sno	Item Ref.	Particulars	Qty	Unit	Rate (Rs.)	Amount (Rs.)
4	NSI	Providing and applying cementious waterproofing agent waterproofing treatment to (Surface / Location), including surface preparation, primer, waterproofing membrane/liquid, protective screed (if any), curing, and all materials, labor, tools, and scaffolding required for completion of the work as per specifications.	3,360	Sft		
		Total Non Schedule Items				

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ORANGI TOWN KARACHI

BILL OF QUANTITIES
Sindh Goverment Hospital Qatar Old & New
Electrical Works

Sno	Particulars	Qty	Unit	Rate (Rs.)	Amount (Rs.)
1	Providing & laying (MAIN or SUB MAIN) PVC insulated & PVC sheeted with 4 core copper conductor 600/1000 volts size 150mm2.	50	Rft	11,470.58	573,529
2	Design, fabrication, supply, installation, testing and commissioning of a weatherproof, floor-mounted Low Tension (LT) Distribution Panel (DB) suitable for outdoor installation to serve a 500 kW three-phase load. Panel shall be complete with all necessary protection, metering, buswork, earthing and accessories as described below. 1. Enclosure:Floor-mounted, Weatherproof cabinet, fabricated from CRCA sheet steel (recommended 12–14 SWG), fully spot-welded and seam-sealed. 2. Finish: Epoxy powder coat finish, minimum 80 µm thickness. Colour as per client. 3. Ingress protection: IP54 with integral rain canopy for outdoor exposure. 4. Access & mounting: Removable front doors with lockable handles, hinged, with lifting lugs and base mounting holes. Provide front and rear clearances and ventilation provisions. 5. Internal layout: Adequate separation between incomer, metering, CTs and outgoing feeders; insulated phase barriers and finger-proof covers; cable gland plate with gland positions.	1	Each	350,000.00	350,000
3	Providing & fixing A.C Electric Ceiling fan 56" (good quality)	90	No	14,869.21	1,338,229
4	Providing & fixing Bakelite ceiling rose with two terminals.	90	Each	373.39	33,605
5	Providing & fixing A.C/D.C Electric Wall Bracket fan 18" (good quality)	30	No.	14,695.00	440,850
6	Providing and fixing switches or sockets as per following specification and requirements (5 Amp): a) one gange	35	No.	687.50	24,063
b)	two gange	25	No.	750.00	18,750
c)	four gange	25	No.	937.50	23,438
d)	six gange	10	No.	1,137.50	11,375
e)	2 pin 5 AMP sockets for half point	8	No.	350.00	2,800
f)	5 pin plug socket for multiple use 10-15 amp	8	No.	562.50	4,500
g)	3 pin power plug socket 20 amp	10	No.	750.00	7,500

Prepared.
Health Works

(DR. RASHID SIRAJ)
MEDICAL SUPERINTENDENT
SINDH GOVT. QATAR HOSPITAL
ORANGI TOWN KARACHI

DR SAQIB ALI SHAIKH
Director Health Services
Karachi Division

Sno	Particulars	Qty	Unit	Rate (Rs.)	Amount (Rs.)
7	P/F Exhaust Fan 10" to 12" sweep with wall clamp Metal Body/Plastic Body pak/Royal/Millat/Imported i/c necessary electric connection etc, complete.	12	No.	4,625.00	55,500
8	Providing & fixing Energy Saver 24 Watts approved quality etc, complete (Phillips).	50	No.	625.00	31,250
9	Providing and fixing as per following specifications and requirements, powder coated box,door/ wall mountain with locking arrangement a) MCB (15amp) 01no b) MCB (10amp) 01no c)MCB (2-6 amp) 06 no (1 spare) d) Set of copper busbars 50 Amp 04 no.s	12	Job	48,000.00	576,000
10	P/F LED Surface Mounted panel light 24 watts, 220/240 volts, round or Square, approved type, Standard Supply and fixing.	300	Each	5,026.25	1,507,875
11	P/F LED Flood Security Light, 30 Watts, 220-240 Volts, approved type "Standard", complete supply and fixing.	12	Each	22,527.50	270,330
12	P/F Fan electric, AC, Exhaust, metal body with copper winding 25 cm & 30 cm, 220/230 V, with shutter, Metal duly enamel painted, "Standard" supply and fixing.	20	Each	3,877.50	77,550
				Total Amount Electrical Works Rs.	**5,347,143**

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Director Health Services
Karachi Division

Superintending Engineer,

BILL OF QUANTITIES

Rehabilitation & Upgradation Sindh Govt Qatar Hospital (Old & New)

Plumbing Works

Sno	Particulars	Qty	Unit	Rate (Rs.)	Amount (Rs.)
1	Providing & fixing 1/2" dia, lead connection complete with a 1/2" dia brass stop cock, two brass nuts & lining jointed to lead pipe with plumber wiped solder joints 1/2" inches lead pipe to be of not less than 4lbs per lineal yard (S.I. No. 22/P-6).	90	Each	760.50	68,445.00
2	Providing, Laying uPVC pipes of Class 'B' fixing in trench i/c cutting, fitting and jointing with solvent cement i/c testing with water to a head of 61 meter or 200 ft.				
a	80 mm (3" dia)	850	RFT	289.03	245,675.50
3	Providing & fixing in position nylon connections complete with 1/2" dia brass stop cock with pair of brass nuts and lining joints to nylon connection (S.I. No. 23/P-6).	90	Each	637.65	57,388.50
4	Supplying & fixing jet shower with rod of superior quality with C.P. head 1/2" dia 1/2" dia.	10	Each	3,486.60	34,866.00
5	(b) S/Fixing concealed Tee stop cock of superior quality with c.p head 1/2" dia (S.I.No. 14(A)/P-18).	130	Each	643.50	83,655.00
6	(b) S/Fixing long bib-cock of superior quality with c.p head 1/2" dia (S.I. No. 13(a)/P-19).	130	Each	2,316.60	301,158.00
7	Providing and fixing orisa type white or color glazed earthen ware w.c pan with cost of low level plastic flush tank of 3 gallons capacity of approved quality i/c making requiste numbers of holes in walls , plinth & floor and making good in cement concrete 1:2:4 W.C pan orisa type 23" with plastic tank of low down 3 gallons C.I trap & C.I thumble (Superior Quality) With 4" dia. earthen ware trap and plastic thumble (S.No 3 / P-2)	78	Each	11,282.00	879,996.00
8	Providing & fixing 24" x 18" lavatory basin in white glazed earthen ware complete with and including the cost of W.I or C.I cantilever brackets 6 inches built into wall, painted white in to two coats after a primary coat of red lead paint , a pair of 1/2" dia rubber plug & chrome plate brass chain 1-1/4" dia malloable iron or c.p brass traps malloable iron or brass unions and making requiste number of holes in wall plinth & floor for pipe connection and making good in cement concrete 1:2:4 (Standard pattern) (S.No 8 / P-3)	56	Each	9,495.14	531,727.84

Superintending Engineer,
Provincial Buildings Circle
Health Works Sindh, Hyderabad.

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Sno	Particulars	Qty	Unit	Rate (Rs.)	Amount (Rs.)
9	Add extra for labour for providing and fixing of earthen ware pedestal white or coloured glazed (S.No 9 / P-3)	56	Each	3,276.00	183,456.00
10	Supplying & fixing soap tray of made of plastic of superior quality and design with fine finishing with c.p screws etc complete (S.I. No.6/P-8).	56	Each	292.50	16,380.00
11	Providing & fixing C.P muslim shower with double bib cock & ring pipe (S.I. No.19(a)/P-19).	90	Each	5,475.60	492,804.00

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Executive Engineer,
Hyderabad

Sno	Particulars	Qty	Unit	Rate (Rs.)	Amount (Rs.)
12	Supplying & fixing ball valves (with unsoldered copper ball) 2" dia (S.I. No.8/P-18)	10	Each	1,029.60	10,296.00
				Total Schedule Items	2,905,847.84
				Less 10% Below	(290,584.78)
				G.Total	**2,615,263.06**
	Plumbing Works Non Schedule Rates (B)				
1	Supply & fix UPVC (Dadex or Equivalent or approved by engineer incharge) fitting with 'Z' joint & rubber ring etc.				
a)	Elbow / Bend 75 mm or 3" dia	140	Each		
b)	Tee 75 mm dia	130	Each		
c)	Socket 75 mm dia	100	Each		
d)	UPVC Tee With Door 75 mm dia	80	Each		
2	Providing & laying PPR PN-20 (Dadex or approved by engineer incharge) pipe with all fittings i.e socket, bend tee, elbow where required.(for cold water pipe)				
a)	20mm (3/4") dia PPR	1,500	Rft		
b)	1 mm (1")	980	Rft		
c)	50 mm (2") dia	650	Rft		
3	Supply & fix UPVC Dadex or approved by engineer incharge vent cowel 110mm (3" dia) on top of vent pipe.	70	Each		
4	Providing C.I Manhole Cover & Frame i/c Cost of Material etc. 24"x24" size	20	Nos		
5	Construction of manholes rectangular or circular as described, excavation 24" deep to 48" deep with materials iron steps (in angles 116" centers) 6" thick block masonry walls complete with CC, cover removing and backfilling. 24" x 24" size	20	Nos		
				Total Amount Plumbing Works Rs.	

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ORANGI TOWN KARACHI

Engineer
Circle
Hyderaba

HEALTH DEPARTMENT
GOVERNMENT OF SINDH

SINDH GOVERNMENT QATAR HOSPITAL KARACHI

TECHNICAL SPECIFICATIONS VOLUME-III

REHABILITATION AND RENOVATION OF SINDH GOVERNMENT QATAR HOSPITAL AT KARACHI.

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1. GENERAL AND SITE FACILITIES

1.1 INTRODUCTION

These Specifications shall apply to all such works to be executed involving construction of a building and its allied works under the Contract or otherwise directed by the Engineer. In every case, the Work shall be carried out to the satisfaction of the Engineer and conform to the location, lines, dimensions, cross-sections, etc shown in the Drawings or in the Bill of Quantities (BOQ) or as indicated by the Engineer. The quality of materials, processing of materials as may be needed at the site, salient features of the construction work and quality of finished works shall comply with the requirements set forth in the succeeding Sections and Sub-sections. Where the Drawings and Specifications describe a portion of the work in only general terms and not in complete detail, it shall be understood that only the best general practices are to prevail, materials and workmanship of the best quality are to be employed and instructions of the Engineer are to be fully complied with.
Words importing the singular also mean the plural and vice versa where the context so demands. Similarly, words importing the male also mean female or neuter and vice versa where the context so requires. Words have their normal meaning under the English language unless specifically defined.

1.2 DEFINITIONS

The following words and expressions shall have the meaning hereby assigned to them, except where the context otherwise require. However, in the case of any conflict with the stipulations of the Conditions of the Contract, the expressions and meaning of the Conditions of Contract shall prevail.
'The Employer' is the Director Health Services Karachi Division as PA's Coordinator or any other representative appointed from time to time by the authority and notified in writing to the Contractor to act as the PA's representative for the purpose of this Work.
'The Engineer' shall mean the engineer designated or any other engineer appointed from time to time by the PA and notified in writing to the Contractor to act as 'the Engineer' for the purpose of the Contract.
'The Contractor' shall mean any person or corporate body who is pre-qualified under the Project/ enlisted with the PEC and whose Tender to carry out the Work has been accepted by the Employer and the legal successors in title to such person, but not (except with the consent of the Employer) any assignee of such person.
A **'Sub-Contractor'** shall mean any person or corporate body named in the Contract as a Subcontractor for a part of the Work or any person or corporate body to whom a part of the Work has been subcontracted with the consent of the Engineer and the legal successors in title to such person or corporate body, but not any assignee of any such person or corporate body.
'The Contract' is the contract between the Employer and the Contractor to execute, complete and maintain the Work.
The expression of **'Work'** or **'Works'** are what the Contract requires by the Contractor to construct, install and hand over to the Employer, as defined in the Tender Documents. Unless there be something either in the subject or context repugnant to such construction it shall be construed and taken to mean the works by or by virtue of Contract to be executed, whether temporary or permanent and whether original, altered, substituted or additional.
'Site' means the places provided by the Employer where the Works are to be executed and any other places as may be specifically designated in the Contract as forming part of the Site.
'Tender' means the Contractor's priced offer to the Employer for the execution and completion of the Work and the remedying of any defects therein in accordance with the provisions of the Contract, as accepted by the Letter of Acceptance.
'Letter of Acceptance' means the formal acceptance by the Employer of the Tender.

1.1 SCOPE OF WORK

The Work to be carried out under the Contract shall consist of the various items as generally described in

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the Tender Documents as well as in the BOQ furnished in the Tender Documents.
The Work to be performed shall also include all general works preparatory to the construction of a building and all other related works. The Work shall include works of any kind necessary for the due and satisfactory construction, completion and maintenance of the works to the intent and of the Drawings, BOQ and these Specifications and further Drawings and Orders as may be issued by the Engineer from time to time. Whether specifically mentioned or not in the various Sections of this Specification, the Scope of Work shall include compliance by the Contractor with all conditions of the Contract, all materials, apparatus, plant, equipment, tools, fuel, water strutting, timbering, transport, offices, stores, workshop, staff, labor and the provision for proper and sufficient protective works, temporary fencing and lighting, etc. It shall also include safety of workers, first-aid equipment, suitable accommodation for the staff and workmen with adequate sanitary arrangements, the effecting and maintenance of all insurance, the payment of all wages, salaries, fees, royalties, duties or other charges arising from the erection of works and the regular clearance of rubbish, reinstating and clearing the site as may be required on completion of the Work, safety of the public and protection of the Work and the adjoining land.
The Contractor shall ensure that all actions are taken to have a built-in quality assurance in the planning and execution of the Work. The quality assurance shall cover all stages of works such as setting out, selection of materials, selection of construction methods, selection of equipment and plant, deployment of personnel and supervisory staff, quality control testing, etc. The work of built-in quality assurance shall be deemed to be covered in the Scope of Work.

1.2 SUBMITTAL

The submittal by the Contractor shall include construction programme, all Shop Drawings, reports, samples, test results etc. to conform with all applicable provisions of the General Conditions of the Contract and as required under the various Sections of these Specifications. The purpose of the submittal required herein is to assure that items furnished and installed are, in all matters of consequence, equivalent to the specified items and that proper records are maintained of the changes made in the Specifications, Drawings or in materials used or any deviations made in the construction process.
The Contractor shall forward all submittal to the Engineer under a cover letter stating that the submittal has been carefully reviewed by the Contractor and that on-site conditions or dimensions where necessary and correctness have been verified and checked.
The submittal shall be reviewed by the Engineer to verify that the Contractor's obligations are fulfilled as per the turn intention of the Contract. In checking and approving submittal, the Employer does not relieve the Contractor from responsibilities for construction errors or omissions, which may occur, even though executed in accordance with the approved Shop Drawings. Any such errors or omissions, as is discovered later on, should be corrected by the Contractor irrespective of any approval by the Employer at no additional cost to the Employer. This does not apply to modifications approved as specified herein.
The Contractor shall make submittal of construction requirements at least 10 days prior to actual construction of the component to allow time for checking and re-checking, if necessary. Any works fabricated or installed by the Contractor prior to approval of the Shop Drawings or other required submittal shall be done at his own risk.

1.2.1 CONSTRUCTION PROGRAM

Within 14 days of the date of the Letter of Acceptance, the Contractor shall submit to the Engineer for his approval a Bar Chart/Gantt Chart showing the program sequence in which works have been proposed to be carried out including the procurement and delivery of equipment and materials.
The Contractor shall, whenever required by the Engineer, also provide in writing a general description of the arrangements and methods, which would be adopted for the execution of the Work.
If at any time it would appear to the Engineer that the actual progress of work does not conform to the approved program, the Contractor shall be obliged to produce for the approval of the Engineer the reasons for any changes with a revised program showing the modifications to the previously approved program necessary to complete the Work on schedule. Submission to and approval by the Engineer of such

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program or furnishing of such particulars shall neither relieve the Contractor from any of his duties and responsibilities under the Contract nor it shall prejudice the 'Liquidated Damages' Clause of the Contract.

1.2.2 NOTICE OF OPERATION

The Contractor shall give full and complete written notice of all the important operations, including setting out, to the Engineer sufficiently in advance (not less than 10 days) to enable the Engineer to make such arrangements as the Engineer may consider necessary for inspection and for any other purposes. The Contractor shall not start any important operation without the written approval of the Engineer.

1.2.3 AS-BUILT DRAWINGS

Before the expiry of the period of maintenance, the Contractor shall submit the full sets of As-Built Drawings of the completed works to the Employer. The sets shall comprise of all Discipline Drawings (9 copies) along with soft copies on a CD.
The As-Built Drawing shall clearly show the lines and dimensions of the permanent construction actually made based on the changes to the original design from time to time as ordered by the Engineer or proposed by the Contractor and approved by the Engineer.
The original soft copies of the Tender Drawings and Design Drawings will be provided to the contractor for producing additional copies, if the contractor requires.

1.2.4 SHOP DRAWINGS

The Contractor shall prepare the Shop Drawings at his own costs showing clearly all elements of construction that are required to assure proper shop fabrication or job ins Shop Drawings shall be clearly shown. All material quality, finishes, construction details as specifically related to the project must be shown on the Shop Drawings installation of items requiring.

1.3 TAKING OVER POSSESSION OF SITE

The Contractor shall, upon receiving the Work Order, immediately take possession of the Site and move his men and materials to prepare the Site in order to create conditions for starting the Work as per terms of the Contract, Drawings and Specifications.

1.4 MOBILIZATION

The work of mobilization shall consist of carrying out the following listed actions together with all other requirements of the Contract with regard to commencing the execution of the Work by the Contractor at his own cost.

i. Procurement, assembly, repair and make to running condition of all the contractor-owned constructional plant and equipment by the Contractor at any other site as convenient to him.

ii. Transportation of Contractor-owned constructional plant, equipment and materials from the storage site as mentioned above in (a) to the place of construction.

iii. Assembling and installation of all items of constructional plant, equipment, etc. required for the execution of the Work.

iv. Receiving all constructional plant, equipment and materials to be furnished by the Employer, if any, and collect and transport those to the Work site. All materials shall be properly stored, inventoried and protected until used in to the Work and all plant and equipment shall be tested and made ready for use.

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v. Construction of a suitable Site office building or shed for storage of materials and equipment, workshop, other operational buildings and First-Aid Center attended by competent Medical Assistants.

vi. Maintenance of all temporary roads, fences and sanitary facilities, keep all areas used by the Contractor clean, neat, well-kept and in good repair and provide proper drainage to protect the area from surface run-off and flooding.

vii. Provide all the required electric power, water supply and other utility connections to temporary installations at the Site as may be necessary for the execution of the Work.

viii. Obtain all insurance policies, performance bond and payment guarantee as required under this Contract.

ix. Payment of all fees, permits, licenses, etc. as may be required covering the execution of the Contract.

1.5 MONITORING PROGRESS

The Contractor shall furnish the Engineer, without cost to the Employer, at regular monthly interval and in a form and number of copies determined by the Engineer, with the following:

i. Physical progress for the month under report and the estimated progress for the following month.

ii. Completion schedules (target and actual) based on the approved construction program.

iii. A tabulation of construction equipment listing the major items and pieces of equipment comprising the construction plant as were utilized for performance of the Work during the month under report.

iv. A tabulation of employees countersigned by the Engineer's representative, showing the supervisory staff and the number of several classes of labour employed by the Contractor in the month under report.

v. Any report which may be specifically requested by the Employer and/or by the Engineer.

1.5.1 ATTENDANCE AT SITE MEETINGS

The Contractor shall attend punctually the progress and other on-site meetings as would be requested by the Engineer.

1.5.2 RECEIVING VISITORS

The Contractor shall receive all authorized visitors of the Employer and allow them to visit the Work in the manner as would be requested by the Employer

1.6 CONTRACTOR'S SITE FACILITIES

The Contractor shall, at his own expenses, be responsible for the provision, maintenance, operation and subsequent removal of the following and all other necessary temporary facilities and services on Site those are required to accomplish the Work in a safe and orderly manner as per provisions of the Contract:

i. All temporary stores, warehouses and workshops.

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ii. Adequate number of toilets necessary for all persons engaged for the Work with separate arrangements for women. All sewage from toilets shall be disposed off by means of septic tank and soak pit or by some other acceptable disposal system.

iii. To keep all sanitary facilities clean and their frequent disinfecting.

iv. Fencing, lighting and security.

v. Cranes or other appropriate ways and means for off-loading plant and equipment, placing in temporary storage and moving from storage to equipment locations.

vi. Site transport for the staff.

vii. Electric power for temporary buildings and tools.

viii. Provisions for adequate supply of water of acceptable quality at the Site for use in the Work.

ix. Raw water from Site Tube-wells and provisions for adequate potable water.

In addition to above, the Contractor shall also make available all other necessary temporary facilities and services on Site those are required to accomplish the Work in a safe and orderly manner as per provisions of the Contract.

The Contractor shall submit for the approval of the Engineer Detailed Plans and/or construction Drawings of the temporary buildings, warehouses, workshops and labour camps that he proposes to construct or arrange on lease/rent including the proposals for water and power supply and sewerage facilities. These requirements shall be fulfilled by the Contractor within 10 (ten) days from receipt of the Formal Work Order to commence work (Date of commencement of Work). All buildings and facilities shall be of standard and acceptable to the Engineer.

The labour camps shall be at a location approved by the Engineer and conform to all requirements of the local law. It shall be laid and constructed in accordance with a Drawing prepared by the Contractor and approved by the Engineer.

The Contractor shall be responsible for acquiring the land deemed necessary for the Work beyond the Employer's land and for his temporary buildings, warehouses, workshops, staff quarters, labour camps and any temporary access road. The Contractor shall maintain the Site and all working areas in a safe and hygienic condition and in all matters of health and sanitation shall comply with the requirements of the local Medical Officer of Health or other competent Authority.

1.7 MATERIALS, PLANT, EQUIPMENT AND TOOLS

The Contractor at his own expenses shall provide the materials, plant, equipment and tools products as shown on the Drawings or as specified in the Contract. Necessary haulage and safe storage of materials, supervision of works etc. shall be provided by the Contractor.

1.7.1 EQUAL PRODUCTS AND EQUIVALENTS

Except as specifically required otherwise, the mention of any proprietary materials by trade name is intended to establish a standard of quality, appearance, size and durability. The products of other manufacturers may be used subject to the conditions as stated below.

1.7.2 ADDITIONAL COSTS RELATED TO SUBSTITUTIONS

Any additional costs, or any losses or damages, arising from the substitution of any materials or methods from those originally specified shall be borne by the Contractor, unless such substitution was made at the written request or direction of the Employer.

1.7.3 FAILURE OF EQUAL PRODUCTS

Where products are accepted, based on representation of the Contractor, as approved equals, those shall

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be used subject to the same installation and performance standards as required by the original specification. Approval of a request for substitution shall not modify the Contract requirements except as specifically noted. Subsequent failure of "approved equals" shall be considered first. For any evidence of improper installation or product inequality, the installation shall be repaired or corrected as directed by the Engineer at the full costs of the Contractor.

1.7.4 PLANT, EQUIPMENT AND TOOLS

The Contractor shall furnish all constructional plant, equipment and tools for the proper execution of the Work at his own expenses and keep those in proper working condition. The Contractor shall supply the Employer a list of major items of the constructional equipment and tools that he proposes to use in execution of the Work.

1.8 SUFFICIENCY OF MEANS EMPLOYED

The Contractor shall take upon himself the full and entire responsibilities for the sufficiency of his supervisory and other personnel, plant or equipment or tools, scaffolding, timbering and generally for all means used for the fulfilment of the Contract. In the event of any of these means proving insufficient, the Contractor shall remain fully and entirely responsible for the sufficiency of these means notwithstanding any previous approval or recommendation that might have been given by the Engineer.

1.9 PROTECTION AND SAFETY

1.9.1 GENERAL

The Contractor at all times shall take all necessary measures to the safety of life and property during construction of various parts of a building. International Safety Manuals used in Engineering Construction Project shall be adopted for protection and safety at the construction Site during the period of construction. Nothing stated herein shall be construed to nullify any rules, regulations, safety standards or statutes of the local authority, or those contained in the various Acts of the Government of Pakistan. The specific rules, regulations and Acts pertaining to the protection of the public or workmen from health and other hazards wherever specified by the local Authority etc. or by the Act/Ordinance of the Government shall take precedence over whatever are specified herein.

1.9.2 SAFETY OF WORKMEN

Helmets conforming to and shall be worn by the workmen and other personnel at all times while works are going on.

Safety goggles of accepted standard shall be used by individuals engaged in drilling, cutting, welding and all such works which cause hazard to the eye. The welders and gas cutters shall be equipped with proper protective equipment like gloves, safety boots, aprons and hand shields having filter glass of accepted standard and suitable to the eyes of a particular worker.

1.9.3 SITE PRECAUTIONS

In absence of boundary walls, construction Site shall be delineated by fences.

Warning signs shall be displayed, where necessary, to indicate hazardous areas like high voltage zone, area of no smoking etc. Hand lamps shall be of low voltage, preferably 24V. All electrically operated hand tools shall be provided with double earthing.

The temporary wells, which shall be provided by the Contractor at the construction Site as a part of the toilet facilities, shall be provided with proper covers. The toilet facilities shall be located at a corner of the Site so as to avoid any obstruction. Protection from bad weather and falling object and proper privacy shall be provided to the toilet users.

Temporary toilets shall be dismantled, all wells filled up, and the whole area made level, dressed and restored back to proper grade at the end of the project.

The Contractor at all times shall protect the excavation, trenches and building materials from rain water, groundwater, backing up of drains and from water of any origin. He shall provide all pumping arrangements for removal of surplus water, coverings and other materials as required.

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All rubbish and debris shall be removed from the Site and disposed of at a safe distance as per direction of the Engineer so as not to create any obstruction to Work or give rise to health hazards.
The Contractor shall take all necessary precautions to ensure against fire during construction. The Contractor must make all necessary arrangements for providing adequate protection against fire hazards at the construction site during the period of execution of the Work.
Timber, coal, paints and similar combustible materials shall be separated from each other. A minimum of two dry chemical powder (DCP) type fire extinguishers shall be provided at both open and covered locations where combustible and inflammable materials are stored.
Inflammable liquids like petrol, thinner etc., shall be stored in conformity with the relevant regulations.

1.10 CARE OF WORKS

1.10.1 MOVEMENT OF TRANSPORT AND PLANT

The Contractor shall exercise diligence and care in the movement of all transports and plant within the Work area so as not to cause injury or damage to life or property. The Contractor shall be responsible for restoring any roadway, bridge, culvert etc. damaged by his transports and plant to the satisfaction of the Engineer or the appropriate Authority.

1.10.2 KEEPING WORKS FREE FROM ATMOSPHERIC CONDITION

The Contractor shall construct all temporary works and other works and supply and operate pumping plant and ensures all measures as may be found necessary for the construction of the Work under proper atmospheric condition.
Notwithstanding any approval by the Engineer of the arrangements made, the Contractor shall remain responsible for the sufficiency thereof and shall be liable for keeping the works safe at all-time regardless of the climatic condition at his own expenses. Any loss of production, additional overheads or additional costs of any kind that may result from inclement climatic conditions shall be at the Contractor's risk

1.10.3 MATERIALS ON AND UNDER THE SITE

All soil, turf, gravel, stone, timber, or other materials obtained in the excavations, clearing of the Site of the Work and soil stripping, shall belong to the Employer and must not be removed from the Site without the written permission of the Engineer. Provided the Engineer directs the Contractor, he may use for the construction of the Work, any timber obtained from trees felled at the Site and any of the materials excavated under the Contract, which the Engineer may determine to be fit for such use.

1.11 SURVEY WORKS

1.11.1 PERMANENT BENCH MARK

Before commencing the work, the Contractor shall establish at his own cost, at least 2 (two) permanent Bench Marks (B.M) with permanent pillars at suitable positions as per direction of the Engineer. These B.Ms. shall be incorporated in the Drawings and used for controlling all levels of construction works.

1.11.2 REFERENCE LINE PILLARS

The Contractor shall establish permanent Reference Line Pillars (axis pillars, centre line pillars, etc.) at his own cost for all structures before starting of excavation of foundation pits/trenches as per standard practice and or as per direction of the Engineer. The Contractor shall remain responsible for safeguarding all Survey Monuments, Bench Marks, Beacons, etc. The Contractor, at his own expenses, shall make necessary arrangements to protect the B.M pillars against any disturbances, damages, including their maintenance.
The Engineer will provide the Contractor with the data necessary for setting out of the center line. All dimensions and levels shown on the Drawings or mentioned in the Documents forming part of or issued under the Contract shall be verified by the Contractor on the Site and he shall immediately inform the Engineer of any apparent error or discrepancy, if found by him in such dimensions or levels. The Contractor shall, after or in connection with these staking out of the center line, survey the terrain and

shall submit to the Engineer for his approval, a profile as required by the Engineer.
Instruments and equipment for surveys shall be subject to rigorous inspection by both the Contractor and the Engineer and any items found to be defective in the opinion of the Engineer, shall be promptly replaced, repaired or adjusted as per his direction. A qualified Surveyor or Engineer shall supervise all survey works. The checking of the setting-out of works by the Engineer's staff shall not relieve the Contractor of any of his liabilities or responsibilities under the Contract

1.12 FABRICATED ITEMS INCORPORATED IN THE WORK

Whenever required by the Specifications to fabricate or manufacture and furnish equipment for incorporation in the permanent works, the Contractor shall submit to the Engineer for his approval the names of the manufacturers or fabricators the Contractor proposes to use and also his detailed Shop Drawings for approval before proceeding with the Work. All such Drawings shall be adequately and properly checked before being submitted to the Engineer for approval and shall be so designated.
Any fabricating or manufacturing undertaken during or before the approval of the Drawings, will be at the Contractor's risk. The Engineer shall have the right reserved to ask the Contractor to make any changes in the Design, which may be found necessary in the opinion of the Engineer, for the equipment or component materials to fully meet the requirements and intent of these Specifications without causing any additional costs to the Employer.
Approval of the Contractor's Drawings shall not relieve the Contractor of any part of his obligation to meet all requirements of these Specifications or of the responsibilities for the correctness of his Drawings.
At the time of delivery of the equipment, the Contractor, if requested to do so, shall furnish the Engineer two complete sets of the final approved Drawings.

1.13 INSPECTION AT FABRICATOR'S WORKSHOP

1.13.1 GENERAL

All equipment furnished under these Specifications and all works performed thereon will be subject to inspection by the Engineer or his authorized representative. Inspection at the manufacturer's plant, when located only in Pakistan, may be made with the intention to determine the meeting of requirements of the Specifications in respect of use of equipment and materials. The Contractor shall notify the Engineer a minimum of 15 (fifteen) days in advance of the date and place of equipment/materials to be available for inspection. No equipment or materials shall arrive at the Site until the Engineer's inspection at the manufacturer's plant or Contractor's storage place outside the actual Site has been made, the Engineer's approval has been given, final Drawings have been furnished by the Contractor and the Contractor's responsibilities for furnishing equipment and materials meeting the requirements of the Contract Document are fully complied with. All costs of the Engineer's inspection shall be borne by the Contractor.

1.13.2 TESTS AND INSPECTION RECORD

The record shall identify the Contractor and the Supervision Consultant staff (when applicable) involved, the place, the date and time when the inspection is completed, the sections of the Work and the materials tested or inspected and its state of completion. Reference shall be made to the relevant Working Drawings and the specific aspects or properties, which were checked or measured, shall be recorded.
One copy of each record of inspection shall be submitted to the Engineer and one copy of each record of inspection shall be submitted to the Supervision Consultant (when involved). The Contractor shall maintain records of inspections and tests in an orderly fashion at the Site until the issuance of the Defects Liability Certificate for the whole of the Work, or such earlier time as the Engineer may instruct. The Engineer shall have the rights of access to them at all times After the issuance of the Defects Liability Certificate for the whole of the Work, or such earlier time as the Engineer may instruct, the Contractor shall, as instructed by the Engineer, either dispose of the records or deliver them as directed.

1.13.3 NOTICE OF WORKS OFF-SITE

The Contractor shall give adequate written notices to the Engineer on the preparation or manufacture at a place not within the Site of any pre-fabricated units or parts of units or materials to be used in the Work. Such notices shall state the place and time of the preparation or manufacture, quarrying or extraction. The notice be given sufficiently in advance as to enable the Engineer to make arrangements which he may deem necessary for inspection before the start and at any stage of the Work and not only at the time when the units or parts are completed. Off-Site works shall not commence without the prior approval of the Engineer.

Any unit or parts, prepared or manufactured without giving such prior notice to the Engineer, may be rejected, if the Engineer considers that his inspection was necessary during the time of preparation or manufacture. No inspection by the Engineer shall relieve the Contractor of any of his responsibilities, duties and liabilities under the Contract.

1.13.4 STANDARDS

Except where otherwise specified or authorized by the Engineer, all materials and workmanship shall conform to the latest edition of the relevant Standard Specifications of the ASTM.

Materials meeting other internationally accepted equivalent or higher Standards may be accepted subject to review by the Engineer. The Contractor shall submit in English language any such alternative Standards proposed by him, for approval by the Engineer.

The Contractor shall provide the Engineer 3 (three) sets of each of the Standards, Codes and References to be used in the Contract within 45 (forty-five) days of the Date of Commencement of the Work. In addition, he shall supply 3 (three) copies of any other Standards or Codes subsequently specified or alternatively proposed to be used by the Engineer, the Supervision Consultant (when involved) and the Site Laboratory. All Standards shall be in English. On completion of the Contract, all copies of Standards, Codes and References, so provided, shall become the properties of the Employer.

1.13.5 PROPRIETARY PRODUCTS

Where a proprietary or brand name or the name of a supplier or manufacturer is indicated on the Drawings or in the Specifications, this would be in respect of items, which have not otherwise being adequately described by ASTM or equivalent recognized Standards. Alternative items based on recognized national Standards of the country of origin may be accepted provided that documented proof in the English language is submitted to the Engineer for his approval sufficiently in advance and showing that the alternative proposal is equal or higher in quality and performance than the specified item.

1.13.6 MATERIALS TO BE NEW

All materials used in the permanent works shall be new. No materials, incorporated in the permanent works, shall have previously been used in the temporary works.

1.13.7 ORDERS FOR MATERIALS

Before orders are placed for any materials of any description to be used in the permanent works, the Contractor shall submit to the Engineer the names and addresses of the manufacturers or suppliers proposed. Following approval by the Engineer, the Contractor shall submit to him copies of all orders placed for such materials.

1.13.8 SAMPLES

In accordance with the provisions of the Contract, the Contractor shall, in the way as directed by the Engineer, supply samples of materials to be incorporated in the Work. The Contractor shall submit the samples required for approval in labelled boxes suitable for storage and with sufficient time for testing. Due allowance shall be kept for the fact that if samples are rejected, further samples and testing will be required. The Engineer shall keep the approved samples with him and will compare the supply with the sample before acceptance. He shall reject any materials not conforming to the character and quality of the approved samples.

1.13.9 CERTIFICATES

All manufacturer's certificates of tests, proof sheets, mill sheets etc., showing that the materials have been tested in accordance with the requirements of the relevant ASTM or other approved Standard or this Specification, shall be supplied in English language by the Contractor to the Engineer free of charge.

1.14 TOLERANCES

Unless it has been specified in the different Sections otherwise, all works shall be constructed within the tolerances shown in the Table given below;

Type of Structure	Item	Tolerance
Concrete Structures	Tolerances from the specified position (Structure) Maximum departure of plan position of structure or element	25mm
	Tolerances from the specified dimensions (Structure) Maximum departure in thickness or cross-sectional dimensions of columns, beams, buttresses, wall footings etc., up to and including 500mm thick (except tunnel and shaft linings)	+6mm -3mm
	Ditto – between 500mm and 1000mm thick	+10mm
	Ditto – between 1000mm and 4000mm thick	- 5mm
	Ditto – over 4000mm thick Tolerances from specified position (Surface)	+10mm -8mm
	Maximum departure of vertical, sloping or curved surfaces including joint surfaces	+25mm -10mm
	Maximum departure of horizontal or near-horizontal surfaces including joint surfaces	25mm
	Tolerance on Straightness or Departure from Specified Curve (Surface) General Surface Maximum deviation in horizontal or vertical directions (gradual)	20mm
	Maximum deviation in horizontal or vertical directions (abrupt)	12mm in 2m 6mm
Formwork	Sectional dimension	±5mm
	Plumb	±1 in 1000 of height
	Levels (before any deflections	±3mm

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	has taken place)	
Reinforcement	Length of splice Variation of protective cover Variation in indicated position or reinforcement: ▪ Starter bars ▪ Slabs and Walls ▪ One bar diameter Dimension of bent bars: ▪ Stirrups and ties ▪ Other bars	-25mm ± 1 in 1000 of ht. ± 3mm One bar dia. 0.25 times the indicated spacing. ±5mm ±5mm ±10mm
R.C.C. Piles	Pre-cast driven pile: a) Verticality for vertical pile b) Verticality for raker pile c) Deviation from position shown on the plan for vertical and raker piles after driving. Concrete piles casting tolerances: a) Maximum departure in thickness or crosssectional dimensions. b) Deviation of pile face c) Deviation of cross-section centroid from straight line connecting the centroid of the end faces of the pile. 2. Bored and Cast-in-situ pile: a) Verticality for vertical pile b) Verticality for raker pile c) Deviation from position shown on the plan for vertical and raker pile shaft	1 in 50 1 in 25 1/4th of Least dimension of 75mm whichever is greater. +6mm -0.00 6mm in 3m 10mm 1 in 75 1 in 25 Maximum 75mm in any direction
Timber Piles	Deviation of cross-sectional dimension. Deviation of cross-section centroid from straight line joining end face centroid. Level of top Pile.	-6mm 40mm + 12mm

* In addition to above, other tolerances have also been specified in the different Sections and Subsections in the relevant portion

1.15 RECORDING OF MEASUREMENT

Conditions of the Contract, Technical Specifications and Contract Drawings are to be read in conjunction with the Bill of Quantities (BOQ).

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General directions and descriptions of works and materials are not necessarily be repeated nor summarized in the BOQ. References to the relevant Sections of the Contract documents shall be made before entering the Tender's rate.
The quantities given in the BOQ are only approximate and provisional and are given to provide a common basis for tendering. It does neither expressly nor by implication prescribed that the actual volume of work to be performed will exactly correspond therewith.
Any clarification regarding the BOQ and the Method of Measurement shall be adjudged by the Engineer in accordance with this Standard Specification, its Sub-sections, BOQ and other Tender Documents The works, executed fully complying the Drawings and instructions of the Engineer, will be measured for payment in accordance with the method adopted in the BOQ and the item therein set forth, notwithstanding any custom to the contrary. The net quantities of the finished works in place will always be taken except where otherwise specified.
No allowance shall be made for waste, laps, cuttings, etc. and no deduction will be made for grout nicks, joggle holes or rounded arises and sink age or for fitting iron works, etc.

1.16 PAYMENT

Full account shall be taken of all information contained in the Tender Documents and made available during the tender period as affects, inter-alia, working methods, haulage requirements and sequence of operations. Full allowance shall be made for all these provisions in the rates and sums entered against the various items in the BOQ of the Contract.
The specified payment Sections/Sub-sections of the Contract shall apply to any additional or varied works, which may be required to execute under the Contract except where specifically varied therein.
The basis of payment will be the actual quantities of works ordered and carried out, as measured by the Engineer (based on the As-Built Drawing, BOQ or otherwise as directed by the Engineer) and valued at the rates and prices of the Tender, where applicable, or otherwise at such rates and prices as (in case of non-tendered items) the Engineer may fix within the Terms of the Contract.
No payment will be made on account of the anticipated profit for work covered by the Contract, which is not performed. No adjustment will also be made in the unit rates set out in the Bill of Quantities because of an increase or decrease in the actual quantities from the Estimated quantities indicated therein, unless otherwise stated in the Conditions of Contract.
Notwithstanding any limit, which may be implied by the wording of the individual item and or the explanations in this Section, it is to be clearly understood that the Tender price is for the works finished and completed in every respect. Full account of all requirements and obligations have to be taken, whether expressed or implied covered by all parts of the Contract. The Tender price shall, therefore, include all incidental and contingent expenses (including all taxes and VATs) and risks of every kind necessary to construct, complete and maintain the whole of the Work in accordance with the Contract.
Full allowance is to be made in the Tender price for all costs involved in the following, inter- alia, which are referred to and/or specified herein:

i. All setting-out and survey works.
ii. Temporary access unless separately billed, fencing, guarding, lighting, and all temporary works including their removal on completion.
iii. Paying fees and giving notices to the Authorities.
iv. Reinstatement of the Site.
v. Safety precautions and all measures to prevent and suppress fire and other hazards.
vi. Interference to the works by persons or vehicles being legitimate users of the facilities on or in the vicinity of the Site.

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vii. vii. Protection and safety of adjacent structures so far as they may be affected by the works or temporary works.

viii. viii. Supplying, maintaining and removing the Contractor's own housing for staff and labour, offices, workshop, plant yard, transport, welfare, services in connection therewith and other facilities required by the Contractor on completion of work unless separately billed.

ix. Working in the dry condition except where otherwise permitted by the Specification.

x. Supplying, inspection and testing of materials intended for use in the works including the provision and use of equipment.

xi. Maintaining public roads and footpaths.

xii. Opening quarries and borrow pits including all surveys, site investigations, removal and disposal of overburden, trimming of quarry or borrow pit faces and floors and all measures necessary to render quarries or pits safe and free for draining on completion.

xiii. Providing and transporting to Site all equipment necessary for the execution of the Work, setting to works, operating (including all fuel and consumable stores), removal from the Site all construction equipment upon completion of the Work, costs of all tests and other requirements in respect of such plant and equipment.

xiv. The requirements and all incidental costs and expenses involved to provide all necessary skilled and unskilled labors and supervision.

xv. Protection of all completed works following operations making good damages to any completed works due to any cause whatsoever, clearing all rubbish as they accumulate and leaving the Site in a tidy condition.

xvi. All costs associated with the provision and submission of Progress Reports, Records, Photographs, preparation of the necessary Shop and Working Drawings etc. except those provided in the Bill of Quantities.

xvii. Workmen's compensation and Owner's liability insurance.

xviii. Payments under the item for hiring of land (if there be any) in addition to the Employer's land for temporary works shall be made in accordance with the receipts obtained from the land owners within the limitation of quoted rate only if such provision is made in the BOQ of the Contract.

xix. Payment of royalties for fill materials obtained from privately owned land/carried earth shall remain included within the rates of the relevant items of the Contract. The volume of borrowed materials shall be calculated on the basis of pre-work and post-work measurements. Finished sections as per Drawings will be the basis for post-work measurement while the Work is complete as per Specifications.

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xx. Payment shall mean gross payable amount on the rates of the BOQ including the Performance Security.

xxi. With regard to the Sub-section on 'Contractor's Site Facilities', payment will be made for hiring land for the Contractor's temporary works outside the Employer's property, only if such provisions are kept in the BOQ of the Contract.

xxii. The cost of keeping the works free from water will only be paid for, if referred to in the BOQ of the Contract Documents.

xxiii. No payment shall be made for any tests required under the Specification unless specifically referred to in the BOQ. If the Engineer requires any tests outside the BOQ, the cost of such test shall be agreed with the Engineer before execution and paid for as a supplementary item.

xxiv. No direct payment shall be made for works required under other Sub-sections. The costs for such works shall be deemed included in the related items of the BOQ.

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Section 1: Civil Works

2. CONSTRUCTION MATERIALS

2.1 FIRST CLASS MACHINE MADE BRICKS

First Class Machine Made Bricks shall be thoroughly burnt and shall have plane rectangular faces with parallel sides and sharp straight right-angled edges. They shall be of uniform colour (generally deep red or copper), homogeneous in texture and free from cracks, flaws and nodules of free lime. A fractured surface shall show a uniform compact structure free from limps and grits of holes. Other requirements of the First-Class Machine-Made Bricks shall comply with the following requirements:

Minimum crushing strength	210 kg/cm2.
Maximum water absorption	10% of dry weight
Efflorescence	Nil
Dimensions (+ 5mm)	200mm x 100mm x 50mm

2.2 AGGREGATES

Aggregates shall be hard, strong, durable, dense and free from injurious amount of adherent coatings, clay, lumps, dust, soft or flaky particles, shell, mica, alkali, organic matter and other deleterious substances. The various sizes of particles of which an aggregate is composed of shall be uniformly distributed throughout the mass.

Testing of aggregates shall be in accordance with BS 812 or ASTM C-136.

Approval of a source of aggregate by the Engineer shall not be construed as constituting the approval of all materials to be taken from that source and the Contractor shall be responsible for the specified quantity and quality of all such materials used in the Work. Aggregates shall not be obtained from sources, which have not been approved by the Engineer. The Contractor shall provide means of storing aggregates at each point where concrete is made such that;

i. Aggregates shall be stored on a hard and dry patch of ground covered with a 50mm thick layer of lean concrete.

ii. Each nominal size of coarse aggregate and the fine aggregate shall be kept separated at all times.

iii. Contamination of the aggregates by the ground or other foreign materials shall be effectively prevented at all times.

iv. Each heap of aggregate shall be capable of draining freely.

v. The aggregates shall be handled so as to avoid segregation.

The Contractor shall make available to the Engineer such samples of the aggregate as he may require. Such samples shall be collected at the point of discharge of aggregate to the batching plant/mixer machine. If any such sample does not conform with the Specifications, the aggregate shall promptly be removed from the Site and the Contractor shall carry out such modifications to the supply and storage arrangements as may be necessary to secure compliance with the Specifications.

2.2.1 COARSE AGGREGATE

Coarse aggregate shall be obtained from breaking hard durable rock or gravel or Picked Jhama Bricks, which conform to the requirements of AASHTO Standard Specifications M-80. Coarse aggregate shall be clean, free from dust and other deleterious materials. The grading of the coarse aggregate shall be such that when combined with the approved fine aggregate and cement, it shall produce a workable concrete of maximum density.

Aggregate pieces shall be angular in shape and have granular or crystalline or smooth, but not glossy non-

powdery surfaces.
Maximum allowable limits of deleterious substances that shall not be exceeded for coarse aggregate are shown in the following table:

Material	Mass Precent
Soft fragments	2.00
Clay Lumps	0.25
Material passing the 0.075mm sieve	0.50 for clay 1.50 for fracture dust
Thin or elongated pieces: Flakiness Index (BS 8821992) less than	50 for uncrushed 40 for crushed

The Aggregate Crushing Value shall be less than 25% or the Ten percent Fine Value shall be greater than 150 kN according to BS 882-1992. Grading for nominal size coarse aggregate shall comply with the following ASTM C-33 standard gradations:
20mm nominal size Coarse Aggregate

Sieve Size (mm)	% Passing by Weight
25	100
19	90-100
12.50	20-55
9.50	0-15
4.75	0-5

40mm nominal size Coarse Aggregate

Sieve Size (mm)	% Passing by Weight
50	100
37.5	90-100
19	20-55
9.50	0-15
4.75	0-5

Coarse aggregate subject to five cycles of the Soundness Test, specified in ASTM C88, shall not show a loss exceeding 10% when magnesium sulphate solution is used except where otherwise approved.
The flakiness and elongation indices of the predominant size fractions in each single sized coarse aggregate, determined in accordance with BS 812, shall not exceed 20% and 35% by weight respectively.
Aggregate for use in concrete which is subject to abrasion and impact shall comply with the Test requirements of BS 812 and the Specification of BS 63 Part 1 and BS 63 Part 2 and BS 882 respectively.

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Coarse aggregate shall be tested for drying shrinkage characteristics in accordance with BRS Digest No. 35.
Coarse aggregate shall be stored at Site in such a manner that it is not contaminated by fine aggregate, earth or other foreign matter. Adequate precautions shall be taken to prevent segregation of the coarse aggregate while it is being transported and stacked.

2.2.2 STONE AGGREGATE

The boulders to be used as coarse aggregate in concrete shall be composed of limestone, sandstone, granite, trap rock or rock of similar nature and shall have the following properties:

Minimum compressive strength	490 kg/cm2
Specific gravity	2.4-2.7
Unit-weight	2245-2566 kg/m3
Porosity	2 – 6%
Water absorption	1.5 – 5% by weight

The boulder shall be of uniform light colour as approved and shall be free from thin lamination, adherent coatings and deleterious substances. The wear loss of coarse aggregate of all types shall not exceed 35% by weight when tested by the Los Angeles Abrasion Test.
The boulders shall be supplied in sizes that can be handled manually by one person. Stock piling shall be such as to permit ready identification of the materials and shall be approved by the Engineer. Site for stockpiles shall be clean prior to storing materials. The stockpiles shall be built up in layers not to exceed 1.22m in height and each layer shall be inspected before the next layer is started. The crushed boulder chips shall be stacked in accordance with the specified sizes in different stacks as directed by the Engineer. Height of each stack should not exceed 33% of the minimum base dimension of the stack.

2.2.3 STORAGE OF COARSE AGGREGATE

Aggregate of different sizes or grades and from different sources of supply shall not be mixed. All aggregate shall be stored separately free from contact with earth and other deleterious matter. The coarse aggregate should be stockpiled in different stacks, according to the sieve sizes.
All precautions shall be taken during transport and stockpiling of coarse aggregate to prevent segregation. Segregated aggregate shall not be used until they have been thoroughly re-mixed and the resulting stack is of uniform and acceptable gradation.
Aggregate shall be stock-piled at least 7 (seven) days prior to their anticipated use to permit the Engineer to sample each stock-pile to determine the acceptability of the material for the intended use.

2.2.4 FINE AGGREGATE

Fine aggregates for use in the concrete and masonry work shall be non-saline clean natural sand and have a Specific Gravity not less than 2.6 and conform to the requirements of ASTM C 144. It shall be angular (gritty to touch), hard and durable, free from clay, mica and soft flaky pieces. All sands must be well washed and clean before use.
A well graded sand should be used for cement work as it adds to the density of the mortars and concretes. Sand required for brick work needs to be finer than that for stone work.
Sand which contains 90% of particles of size greater than 0.06mm and less than 0.2mm is fine sand. On the other hand, sand which contains 90% of particles of size greater than 0.6mm and less than 2mm is coarse sand.
Supply methods and stock piling of sand shall be such, as to permit ready identification of the material delivered and shall be approved by the Engineer.

2.2.5 IMPURITIES

Sand shall be clean and free from injurious amount of organic impurities. Deleterious substances shall not exceed the following percentage by weight.

Material Passing No. 200 sieve	2.0
Shale, coat, soft or flaky fragments	1.0

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Sulphur Compounds 0.3
Clay Lumps (wet, on No. 4 sieve) 0.00
Fine aggregate subject to five cycles of the soundness test, specified in ASTM C88 shall not show a loss exceeding 10 mass percent when magnesium sulphate solution is used except where otherwise approved.

2.2.6 GRADING

Sand shall be well graded from coarse to fine within the limits given below or shall conform to the specified Fineness Modulus.

2.2.7 FINE AGGREGATE FOR CONCRETE

Sieve Size (mm)	% Passing by Weight
9.5	100
4	95-100
16	45-80
50	10-30
100	2-10

2.2.8 FINE AGGREGATE FOR MASONRY

Sieve Size (mm)	% Passing by Weight
4	100
8	95-100
16	70-100
30	40-75
50	10-35
100	2-15

2.2.9 SAND FILL

Sand for sand fill shall consist of hard, dense, durable materials free from injurious amounts of clay lumps, lightweight materials or other deleterious substances. Unless otherwise specified on the Drawings, sand fill with gunny bags shall have Fineness Modulus not less than 0.8. Sand fill for the Geo-textile bags shall, unless otherwise approved by the Engineer, comply with the following grading:

mm
d_{90} = 0.60 to 0.30
d_{86} = 0.50 to 0.25
d_{60} = 0.40 to 0.20
d_{50} = 0.35 to 0.20
d_{10} = 0.20 to 0.05

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2.3 CEMENT

Cement used in the works shall be obtained from manufacturers, approved in writing by the Engineer and

shall be Ordinary Portland Cement complying with the requirements of ASTM C150 Type 1 or BS 12 or equivalent standard. Special cements shall conform to the requirements provided in writing by the Engineer.

A certificate showing the place of manufacture and the results of standard tests carried out on the bulk supply from which the cement was extracted must accompany each consignment of cement delivered to the Site.

The Engineer may make any tests, which he considers advisable or necessary to ascertain, if the cement has deteriorated in any manner during transit or storage. Any cement which, in the opinion of the Engineer, is of doubtful quality shall not be used in the Work until it has been re-tested and test result sheets, showing that it complies in all respects with the relevant standard, have been delivered to and accepted by the Engineer.

Cement that becomes lumpy or otherwise deteriorated in transit or storage shall not be used for brick masonry or concrete works. All cement, found unsuitable for use, shall be removed from the Site immediately.

The Engineer shall ask to carry out sampling, inspection and testing of all cement as may consider be necessary. Samples shall be taken as instructed from the Site store or from elsewhere on the Work or from any places where cement is used for incorporation in the Work. The compressive strength and tensile strength of standard cubes and briquettes respectively shall be not less than as follows:

Days	Compressive Strength (N/mm2)	Tensile Strength (N/mm2)
3	12.4	1.0
7	19.3	1.9
28	27.6	2.4

Initial setting time shall be not less than 45 minutes and the final setting time shall be not more than 8 hours. Cement, when tested for fineness, shall have a specific surface of not less than 160m2/kg. Cement when tested for soundness shall not have an expansion of more than 10 mm. The unit weight of cement shall be a minimum of 14.16 KN/m3.

2.3.1 WHITE CEMENT

White Cement shall be made from pure calcite lime stone and have the same physical properties as those of Portland Cement Type 1, ASTM C-150. Atypical composition of White Cement is as follows:

CaO	65%
SiO2	25.5%
Al2O3	5.9%
Fe2O3	0.6%
MgO	1.1%
SO3	0.1%

2.3.2 REJECTION OF CEMENT

The Engineer may reject any cement as the result of any tests thereof notwithstanding the manufacturer's certificate. The Engineer may also reject cement, which has deteriorated owing to inadequate protection or from other causes where the cement is not to his satisfaction. The Contractor shall remove at his cost all rejected cement from the Site without delay.

2.3.3 STORAGE OF CEMENT

Cement shall be delivered at the Site in sound and properly sealed jute/paper bags, each plainly marked with manufactures name or registered mark. Cement shall be well protected from weather by tarpaulins or other approved cover during transit. Weight of individual bag containing cement shall be 50 kg and

weight of all bags shall be uniform. Weight of cement shall be legibly marked on each bag. Bags in broken or damaged condition shall be rejected.
The Contractor shall provide waterproof and well-ventilated god owns at the specified or approved location at the Site having a floor of wood or concrete raised platform at minimum 450mm above the ground so as to protect the cement against moisture from air or from any other source. Sheds shall be large enough to allow a minimum 300mm gap between the stacked cement and the god own walls to store cement in sufficient quantity to ensure continuity of work and to permit each consignment to be stacked separately therein to permit easy access for inspection. All storage facilities shall be subject to approval by the Engineer.
Immediately upon arrival at the Site, cement shall be stored in the god owns with adequate provisions to prevent absorption of moisture. The Contractor shall use the consignments in the order in which they are received. Cement delivered to the Site in drums or bags provided by the supplier or manufacturer, shall be stored in the drums or bags until used in the Work. Any cement in drums or bags, which has been opened, shall be used immediately on opening. Cement shall not be stored in a go down for more than 3 (three) months if bagged or 6 (six) months, if in bulk or a lesser period as directed by the Engineer. After this period is over, any unused cement shall be removed from the Site.

2.4 ADMIXTURE

Admixture shall be used to provide excellent acceleration of gaining strength at early age and major increase in strength at all ages by significantly reducing water demand in a concrete mix, especially suitable for pre-cast concrete and other high early strength requirements. Admixture shall conform to BS 5075 Part 3 and ASTM C 494.

2.5 CONSTRUCTION JOINTS

Construction joints are defined as concrete surfaces upon or against which concrete is to be placed and to which new concrete is to be placed, that have become so rigid that the new concrete cannot be incorporated integrally with that previously placed. Construction joints shall be formed wherever there is a discontinuity in placing concrete in external elements of concrete structures. Formed vertical or inclined construction joints as well as unformed joints, which are due to interruption of concrete placement, shall be made only where located on the Drawings or shown in the pouring schedule or as directed by the Engineer. All exposed faces of construction joints shall be made absolutely straight, leveled or plumbed and normal to the finished surface.
Spacing of construction joints shall be in accordance with good concreting practice as defined in BS 8110 or equivalent and enabling adequate precautions to be taken against shrinkage cracking. Placing of concrete shall be carried out continuously. The joints shall be at right angle to the general direction of the member and shall take due account of shear and other stresses.
All planned reinforcing steel shall extend uninterrupted through joints. Additional reinforcing steel dowels shall be placed across the joints, if and when directed by the Engineer. Such additional steel shall be furnished and placed at the Contractor's expenses.

2.5.1 BONDING

Unless otherwise shown on the Drawing, horizontal joints may be made without keys and vertical joints shall be constructed with shear keys. Surfaces of fresh concrete at horizontal construction joints shall be rough floated sufficiently to thoroughly consolidate the surface and intentionally left in a rough condition. Shear keys shall consist of formed depressions in the surface covering approximately one-third of the contact surface. The forms for keys shall be beveled so that removal will not damage the concrete.
Surfaces of construction joints shall be prepared as early as possible after casting. The preparation shall consist of the removal of all laitance, lose or defective concrete coatings, sand and other deleterious materials. Preparation shall be carried out preferably when the concrete has set but not hardened by jetting with a fine spray of water or brushing with a stiff brush, just sufficient to remove the outer mortar skin and to expose the larger aggregate without it is being disturbed. Where this treatment is impracticable and work is resumed on a surface, which has set, the whole surface shall be thoroughly roughened or scrapped

with suitable tools so that no smooth skin of concrete that may be left from the previous work is visible. The prepared joint face shall be thoroughly cleaned by compressed air and water jets or other approved means and brushed and watered immediately before depositing concrete. The cleaned and saturated surfaces that also include vertical and inclined surfaces, shall first be thoroughly covered with a thin coating of mortar or neat cement grout against which the new concrete shall be placed before the grout has attained its initial set.

The placing of concrete shall be carried continuously from joint to joint. The face edges of all joints, which are exposed to view, shall be carefully finished true to line and elevation.

Construction joints in floors shall be located within the middle third of spans of slabs, beams and girders. Joints in girders shall be offset a minimum distance of two times the width of intersecting beams.

2.5.2 BONDING AND DOWELING TO EXISTING STRUCTURES

When reinforcing dowels grouted into the holes drilled in the existing concrete is required at such construction joints, the holes shall be drilled by methods that will not damage the concrete around the holes. The diameters of the holes shall be 6mm larger than the nominal diameter of the dowels unless shown otherwise on the Drawings. The dowel bars shall be round mild steel bar of the diameter and length as indicated on the Drawings and/or as per the directions of the Engineer. The grout shall be a neat cement paste of Portland cement and water or an epoxy. Immediately prior to placing the dowel bars, the holes shall be cleaned off dust and other deleterious materials, shall be thoroughly saturated with water, have all free water removed and shall be dried to a saturated surface dry condition. Sufficient grout or an epoxy shall be placed inside the holes so as not to remain any void after the dowels are inserted. Grout shall be cured for a period of at least 3 (three) days or until dowel bars are encased in concrete. When an epoxy is used, the mixing and placing shall conform to the manufacturer's recommendations.

2.5.3 FORMS AT CONSTRUCTION JOINTS

When forms at construction joints overlap previously placed concrete, they shall be re-tightened before depositing new concrete. Exposed face edges of all joints shall be neatly formed with straight bulkheads or grade strips, or otherwise properly finished true to line and elevation.

2.6 EXPANSION AND CONTRACTION JOINTS

2.6.1 EXPANSION JOINTS

Expansion joints are intended to accommodate relative movement between adjoining parts of a structure. Compressible filler shall be placed between the joint faces to provide freedom for expansion for the two adjacent concrete masses. Care shall be taken to ensure that the material fills the joint completely and that no concrete or hard material is left in the joint after the second face of the joint has been cast

2.6.2 Material

One of the following specifications shall be used as pre-mould fillers:

i. Specification for Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction, ASTM 1751.

ii. Specification for Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction ASTM D 1752. Type-II (cork) shall not be used when resiliency is required.

iii. Specification for Preformed Expansion Joint Filler for Concrete, ASTM D 994. The bitumen sheet, laid on the horizontal top surface of the expansion joint keys, shall be a 10mm thick material approved by the Engineer.

2.6.3 Metal armour

Expansion joint armor assemblies shall be fabricated from steel with the following materials:

i. Steel bars, plates and shapes shall conform to the requirements of ASTM A 36.

ii. Bolts and nuts shall conform to the requirements of ASTM A 307.

iii. High strength bolts, nuts and washers shall conform to the requirements of ASTM A 325.

iv. Steel castings shall conform to the requirements of ASTM A 486 or ASTM A 27.

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v. Grey iron castings shall conform to the requirements of ASTM A 48.
vi. Sheet metal shall be of commercial quality.

2.6.4 Armour assemblies

All assemblies shall be accurately fabricated and straightened at the workshop, as necessary to conform to the concrete sections. The assemblies shall be installed so that their top surface matches the plane of the adjacent finished concrete surface throughout the length of the assembly. Appropriate methods shall be followed in placing the assemblies to keep them in correct position during the placing of concrete. The opening at expansion joints shall be that designated on the Drawings at normal temperature or as directed by the Engineer for other temperatures. Cares shall be taken to avoid impairment of the clearance in any manner.

2.6.5 CONTRACTION JOINTS

General
Joints placed in structures or slabs to provide for volumetric shrinkage of monolithic unit or movement between monolithic units are defined as contraction joints. Contraction joints shall be constructed so that there will be no bond between the concrete surface forming the joints.
Material
Material placed in contraction joints shall consist of asphalt saturated felt paper or other approved bond-breaking materials

2.7 POURABLE JOINT SEALANTS

Pourable sealants shall be placed along the top edges of contraction or filled expansion joints. It shall conform to the following considerations:
i. Unless otherwise shown on the Drawings and/or ordered by the Engineer, joint sealants shall be a hot poured rubber bitumen compound for horizontal joints and either a bituminous compound or an elastomeric two parts polysulphide sealant for sloping, vertical and soffit joints.
ii. Bituminous compounds shall comply with BS 2499 for horizontal joints and BS 2499 Type A1 for sloping or vertical joints. Polysulphide compound shall comply with BS 4254.
iii. Joint sealants and the requisite priming materials shall be obtained from manufacturers approved by the Engineer. The application of joint sealant shall not be commenced without the Contractor obtains its approval by the Engineer.

2.7.1 COMPRESSIVE FILLER

Unless otherwise specified, the joint filler shall be of resin or bituminous bonded corks such as 'Hydrocor' manufactured by Expandite Ltd. The filler shall be obtained from a manufacturer approved by the Engineer and shall be stored and fixed in accordance with the manufacturer's instructions.
Types
Water stops to be used may be of the following types:

2.7.2 WATER STOPS

Water stops shall be of the type, size and shape shown on the Drawings and/or as directed by the Engineer. They shall be dense, homogeneous and without holes or other defects.

2.7.2.1 POLYVINYL CHLORIDE (PVC) WATER STOPS

Where shown on the Drawings, construction (as required and approved by the Engineer), contraction and expansion joints shall be made watertight by the provision of a continuous Water Stop strip of Poly Vinyl Chloride (PVC) manufactured by the extrusion process from an elastomeric plastic compound, the basic resin of which shall be Poly Vinyl Chloride. Unless otherwise specified or ordered, a two bulb dumbbell section PVC. Water Stop shall be used in construction joints and a three bulb section PVC Water Stop shall be used in expansion joints.
Water Stops shall be of high grade PVC, containing no filler or reclaimed or scrap material. PVC shall comply with the requirements of BS 2571 for PVC Type A, Class 1. The quality of Water Stops shall

comply with the following major requirements:
i. Specific gravity..... 1.30 (maximum)
ii. Hardness .....80 (minimum)
iii. Tensile strength..... 138 kg/cm2 (minimum)
iv. Elongation duro..... 225% (minimum)

2.7.2.2 RUBBER WATER STOPS

Rubber Water Stops shall be manufactured with synthetic rubber made exclusively from neoprene, reinforcing carbon black, zinc oxide, polymerization agents and softeners. The quality shall conform the following major requirements:
Neoprene content..... 70% by volume (minimum)
Hardness..... 50-60 duro
Tensile strength..... 193 kg/cm2 (minimum)
Elongation..... 600% (minimum)
Rubber Water Stops shall be formed with an integral cross section in suitable molds so as to produce a uniform section with a permissible variation in dimension of 0.8mm plus or minus. No splices will be permitted in straight strips. Strips and special connection pieces shall be well cured in a manner such that any cross section shall be dense, homogeneous, and free from all porosity. Junctions in the special connection pieces shall be full molded. During the vulcanizing period, the joints shall be securely held by suitable clamps. The material at the splices shall be dense and homogeneous throughout the cross-section.

2.7.2.3 INSTALLATION

Open Joints
Open joints shall be constructed by the insertion and subsequent removal of a wood strip, metal plate, or other approved material. The insertion and removal of the template shall be accomplished without chipping or breaking the corners of the concrete. When not protected by metal armour, open joints in slabs shall be finished with an edging tool. Upon completion of concrete finishing work, all mortars and other debris shall be removed from the open joints.

Filled Joints
When filled joints are shown on the Drawings or asked by the Engineer, pre-mold type fillers shall be used unless Poly Styrene board is specifically called for. Filler for each joint shall consist of as few pieces of material as possible. Abutting edges of filler material shall be accurately held in alignment with each other and tightly fit or taped as necessary to prevent the intrusion of grout. Joint filler material shall be anchored to one side of the joint by waterproof adhesive or other methods so as to prevent it from working out of the joint but not interfere with the compression of the material.

Sealed Joints
Prior to installation of the pourable joint sealants, all foreign materials shall be removed from the joint. The filler material shall be cut back to the depth shown or approved and the surface of the concrete, in contact with the sealant, be cleaned by light sand blasting. When required, a Poly Ethylene foam strip shall be placed in the joint to retain the sealant and isolate it from the filler material. The sealant materials shall then be mixed and installed in accordance with the manufacturer's directions. Any material that fails to bond the sides of the joint within 24 hours after placement shall be removed and replaced.

Water Stops
Water Stops shall be obtained from a manufacturer approved by the Engineer, and shall be fixed and joined according to the manufacturer's instructions. All strips shall be stored in a place as cool as practicable and shall in no case be exposed to the direct sun light.
Water Stops shall be installed with approximately half of the width of the material embedded in the concrete on either side of the joint. It shall be firmly supported by split stop-end shuttering and in no case shall Water Stop be pierced to assist in fixing. Special care shall be taken to ensure that the concrete is well worked against the embedded parts of the strips and is free from honeycomb. Precautions are to be taken to protect any projected portions of the strips from damage during the progress of the works and

from sunlight and heat.
If, after placing concrete, Water Stops are moved out of position or shape, the surrounding concrete shall be removed, the Water Stop reset, and the concrete replaced at the Contractor's own expenses. Two 9mm diameter reinforcing bars shall be provided to support the Water Stops and shall be securely held in position by the use of spacers, supporting wires, or other approved devices.
Flexible Water Stops shall be fully supported in the formwork, free from nails and clear of reinforcement and other fixtures. Damaged Water Stops shall be replaced and care shall be taken to place the concrete so that Water Stops do not bend or distort.
Splicing of Poly Vinyl Chloride Water Stop shall be performed in accordance with the manufacturer's recommendations. A thermostatically controlled electric source of heat shall be used to make all splices. The heat shall be sufficient to melt but not to char the plastic. Splices shall develop at least 90% of the tensile strength of un-spliced materials and shall withstand bending 180o around a 50mm diameter pin without cracking or separating.
The Contractor, at least before the commencement of concrete work, shall submit to the Engineer for his approval details of the Contractor's proposals for the installation of water stops. These shall show where joints in the Water Stops are to be located and details of the intersections and changes of direction to a scale that shows the position of any joint or shape of any mould section.
As far as possible, jointing of PVC Water Stops on Site shall be confined to the making butt joints in straight runs of Water Stops. Where it is agreed with the Engineer that it is necessary to make an intersection or change of direction of any joint other than a butt joint in a straight run, a preliminary joint, intersection or change of direction piece shall be made and subjected to such tests as the Engineer may require.
Precautions shall be taken so that the Water Stops shall neither be displaced nor damaged by construction operations or other means. All surfaces of the Water Stops shall be kept free from oil, grease, dried mortar or any other foreign matters while the Water Stop is being embedded in concrete. Means shall be used to ensure that all portions of the Water Stop designed for embedding shall be tightly enclosed by dense concrete.

2.7.3 MEASUREMENT

Construction Joints shall not be measured. Expansion and Contraction joints shall be measured in linear meter of the joints considered satisfactory by the Engineer and accepted by him. There will be no additional measurement for joint fillers, sealed joints, Water Stops, miscellaneous metal devices etc.

2.7.4 PAYMENT

Payment for construction joints shall be deemed included in the items of concrete and there will be no extra payment for it. For expansion and Contraction joints the amount of completed and accepted works measured as provided above shall be paid at the Contract Unit Price per linear meter and the payment shall constitute the full compensation for furnishing and placing joint fillers, sealed joints, Water Stops, drains, vents, miscellaneous metal devices including all labour and incidentals for full completion of the Work as per Specifications.

Item of Payment	Unit
Expansion joints Linear	meter / Linear feet
Contraction joints Linear	meter / Linear feet

2.8 FAN AND MOTOR

The outdoor unit shall be equipped with DC inverter motor, capable of modulating frequency / speed as per the ambient temperature and discharge pressure / temperature.

2.9 SAFETY DEVICES

The following safety devices shall be part of the Outdoor unit; Discharge temperature sensor, Overload protector, Hot gas bypass cycle, Evaporator inlet piping sensor for anti-freeze protection, Evaporator outlet piping sensor, Return air temperature sensor, Time delay relay, reverse phase protection and phase

failure protection. The safety devises shall also contain high pressure sensor and low pressure sensor.

2.10 CONTROLS

The unit controls shall include main PCB, inverter PCB, inverter fan PCB, transformer, bridge diode, reactor. The noise filter shall also be incorporated to reduce the electrical noise.
The main PCB shall consist of 3 digit, 7 segment LED display. Automatic addressing of the indoor unit shall be possible with the help of dip switch on the main PCB.
The outdoor unit shall have Black Box Function which can record the full operation history of the units every 3 minutes which can help in precise analysis, decision and fast trouble shooting.
The main PCB shall have a refrigerant checking device which charges the appropriate amount of refrigerant automatically through cycle operation, checks for any refrigerant leakage and over charging.
Each outdoor unit should have alternate cycling of the compressors in order to equalize the run time and increase the life time of the compressor.
A serial connection port shall be available in the outdoor unit to display the cycle view, operating parameters like suction pressure, discharge pressure, voltage, current, ambient temperature, indoor unit refrigerant in/out temperature, room temperature, percentage loading of the invertors compressor, percentage opening of the EEV, and easy start up and Easy trouble shooting and fault alarm
Pump down and pump up operation of the refrigerant should be possible by changing the dip switch location on the outdoor main PCB.

2.11 OIL RECOVERY SYSTEM

Unit shall be equipped with 3 types of oil recovery procedures. i) Oil Separator for every compressor
ii) Oil balancing line (between 2 compressors in a unit).
iii) Oil recovery logic in PCB with the help of which the LEV and the compressor operation is controlled for 3 minutes to recover the oil
back to compressor at an interval of every 6 hours of partial compressor working to ensure stable operation with long refrigerant piping.

2.12 EXECUTION

Supplier shall provide support to the contractor during the commissioning process.
Installation work shall include all rigging, setting, aligning and grouting necessary to prepare equipment and its integral parts for normal continuous operation. All installation work shall be done according to best practice and recommendations of equipment manufacturer.
The technician shall attend and successfully complete the training course at the VRF manufacturer and obtain a certificate of passing the course. The technician shall have the detailed knowledge of the VRF installation, piping installation and commissioning procedures. The electric power supply to the outdoor unit shall be 380-415 V / 3 ph / 50 Hz.

RECOMMENDED COPPER PIPES MATERIAL

Seamless phosphorous deoxidized copper pipe wall thickness: comply with the relevant local and national regulations for the designed pressure 3.8mpa (551psi). We recommend the following table as the minimum wall thickness.

1. Recommended minimum Wall thickness

Outer diameter [mm]	6.35	9.52	12.7	15.88	19.05	22.2	25.4	28.58	31.8	34.9	38.1	41.3
Minimum thickness [mm]	0.8	0.8	0.8	0.99	0.99	0.99	0.99	0.99	1.1	1.21	1.35	1.43

Interconnecting refrigeration pipe work between the indoor and outdoor +Slave 1& 2 recommended to layout on galvanized GI tray. Pipe work sizing, layout, fittings, etc shall be in strict accordance with the

manufacturers design and installation requirements.(Refer Product data book)The pipe work shall be of refrigerant quality copper to half hard temper. Soft tempered pipe work may be used where the pipe diameter is ¼"or 3/8". Long radius bends shall be formed using pipe bender. The use of short radius pre formed bends and elbows should be avoided to minimize pressure drop and possibility of leaks. Pipe work shall be carried out manufacturer's design and installation instructions and in accordance with longest possible of copper wire shall be utilized to minimize joints on site. Appropriate refrigeration installation tools must be utilized to avoid the use of elbows, dry Nitrogen must be in the system brazing (no cold brazing will be allowed)

2. Refrigeration Pipe Insulation

Pipe Insulation thickness

Multi V Insulation (*EPDM) + thickness standard
(Engineering product data management)

Multi V	Thickness (mm) (Normal condition)		Thickness (mm) (Residential)		Thickness (mm) (Bad condition)
			Cooling zone (CASE 1) (ex: room , living)	Non cooling zone (CASE 2) (ex: corridor)	
	Thickness (mm)	EPDM	EPDM	EPDM	EPDM
Gas	6.35	19	13	19	19
	9.52	19	13	19	25
	12.7	19	13	19	25
	15.88	19	13	19	25
	19.05	19	13	19	25
	22.22	19	13	19	32
	25.40	19	19	19	32
	28.58	19	19	19	32
	31.75	19	19	19	32
	38.1	25	19	25	32
	44.45	25	19	25	32
Liquid	6.35	9	9	9	9
	9.52				
	12.7~ 44.45	13	13	13	13

※ Normal condition : 30°C, 85%RH

※ Bad condition : 30°C, 90%RH
(High humidity place: bathroom, swimming pool)

Pressure Testing, Evacuation and Commissioning

After installation of pipe work, and prior to sealing of insulation joints, pipe work shall be pressure tested for R-410A to 28 ~ 38kg/cm2(398~540 psi approx), held for

24 hrs and checked for leaks, vacuumed/dehydrated to 0.5~0.8 Torr or (-752mm Hg) and held at that setting for 1 to 4 hours depending on the pipe length.

Note: If you suddenly press the nitrogen gas to 28 or 38kg/cm2 the heat exchangers of indoor unit will be damaged.

iv) Brazing work

Dry nitrogen must be passed through the pipe work during all brazing of joints to prevent the formation of oxidization scale on the inside surface of the pipes. All pipe work shall be clean, de-hydrated and sealed. Pipe work shall be stored under dry conditions.

Any pipe work found to be stored without the end caps should be rejected. Where sections are cut from a new coil any remaining lengths must be re-sealed. During the installation if the system has to be left unattended for any purpose whatsoever, the openings in the systems must be securely sealed. Y Branch or headers joints shall be used for branching to indoor units. No other fittings are acceptable. The positioning of these joints shall be strictly in accordance to the manufacturer's specification. However the brackets must not be positioned directly on the joints or headers. On horizontal pipe work the bracketing should be over the insulation to allow pipe movement due to contraction and expansions. The vertical pipe work shall be bracketed at no more than 1000mm. The horizontal pipe work shall be bracketed at no more than 1500mm.

2.13 REINFORCEMENT

2.13.1 HIGH STRENGTH DEFORMED ROAD

Reinforcing steel under this type comprises Grade-60 Deformed re-bars. The steel shall conform to ASTM Specification A 617M or A 615M of yield strength not less than 420 MPa (N/mm2). The structural grade shall be made from billets. The ends of the bar shall be machine sheared perpendicular to

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the axis of the bar. The bars shall be free from injurious defects and shall have a workman like finish.

2.13.2 CLEANING AND STORAGE

Steel reinforcement bars and structural steel shall be stored in a way to prevent distortion, corrosion, scaling and rusting. Reinforcement bars and structural steel sections shall be coated with cement wash before stacking, especially in humid areas. In the case of long time storage or storage in coastal areas, reinforcement bars and steel sections shall be stacked at least 200mm above the ground level.
Steel sections shall be stacked upon platforms, skids or any other suitable supports. Bars of different sizes and lengths and structural sections shall be stored separately to facilitate issues in required sizes and lengths without cutting from standard lengths. Ends of bars and sections of each type shall be painted with separate designated colors.
Tag line shall be used to control the load in handling reinforcing bars or structural steel when a crane is used. Heavy steel sections and bundles of reinforcing bars shall be lifted and carried with the help of slings and tackles.
All bars, prior to its use, shall be cleaned with wire brush to make them free from nail scale, loose rust, dirt, paint, oil, grease or other foreign substances.
Bars of reduced sectional area to excessive rust shall be rejected.
All reinforcing steel shall be stored properly under shed not to be contaminated by oil, grease, dirt or mud.
All stacking and storing of bars shall be the Contractor's responsibility and contingent upon his Tender.

2.13.3 PRE-STRESSING STEEL AND ANCHORAGE

Pre-stressing reinforcement shall comprise high strength seven wire strand, high strength steel wire or high strength alloy bars conforming grade and type as shown on the Drawings.
Un-coated seven-wire strand shall conform to the specifications of AASHTO M 203.
Un-coated stress-relieved steel wire shall conform to the specifications of AASHTO M 204.
Un-coated high-strength bars shall conform to the specifications of AASHTO M 275.

2.14 FORMWORK

Formwork is defined to be an enclosure or panel, which contain the fluid concrete and withstand the forces due to its placement and consolidation. Forms in turn be supported on scaffolding.
The work to be performed under this Sub-section includes the furnishing and installing and removing of forms for all cast-in-places concrete work as shown and noted on the Drawings and as specified herein or as directed by the Engineer.
Forms shall be substantial and sufficiently tight to prevent leakage of mortar. Forms shall be of sufficient rigidity to prevent objectionable distortion of the formed concrete surface due to pressure of the concrete and other loads incidental to construction operations. They shall be properly braced or tied together to maintain position and shape. Forms and their supports shall be so designed as not to damage previously placed structure.
Relevant provisions of the American Concrete Institute (ACI) issue of ACI 347 on 'Recommended Practice for Concrete Formwork' or some other generally accepted Standards shall apply for the structural designing of the formwork, except as they may be modified herein.

2.14.1 MATERIALS

Formwork shall be constructed from sound materials of sufficient strength, properly braced, strutted and shored as to ensure rigidity throughout the placing and compaction of the concrete without visible deflection. The materials used to be of wood, steel or other approved materials and shall be mortartight.
Formwork shall be so constructed that it can be removed without shock or vibration to the concrete.
Formwork for concrete, permanently exposed to public inspection, shall be faced with plain 28/26gauge steel sheet fitted over 38mm thick wooden plank panels suitably braced or steel framing faced with minimum 12/14 BWG mild steel sheet. Formwork for cement concrete blocks shall be fabricated from M.S. sheet of sufficient thickness to prevent any distortion.

Where metal forms are used, all bolts and rivets shall be countersunk and well-grounded to provide a smooth plane surface.
Where timber is used, it shall be well seasoned, free from loose knots, projecting nails, splits or other defects that may mark the surface of concrete.
Form ties shall be prefabricated rod, flat band, or wire type, or threaded internal disconnected type, of sufficient tensile capacity to resist all imposed load of freshly placed concrete and having external holding devices of adequate bearing area. Ties shall permit tightening and spreading of forms and shall leave no metal closer than 25mm from surface. Ties shall fit tight to prevent mortar leakage at holes in forms. Removable ties shall be coated with non-staining bond breaker. All ties shall be protected from rusting at all times. No wire ties or wood spreaders shall be permitted. Cutting ties back from concrete face will not be permitted. Ties for exposed Architectural Concrete shall be plastic cone snap ties.

2.14.2 CONSTRUCTION METHOD

The Contractor shall submit for the approval of the Engineer details of the methods and materials proposed for formwork to each section of the Work. Details of all proposed wrought formwork and formwork to produce special finishes are to be submitted for approval in writing to the Engineer before any material is hauled at Site. If the Engineer so requires, samples of formwork shall be constructed and concrete be placed so that the proposed methods and finish effect can be demonstrated.
All joints shall be close fitting to prevent leakage of grout. At construction joints the formwork shall be tightly secured against previously cast or hardened concrete in order to prevent stepping or ridges to exposed surfaces.
Where the Contractor proposes to make the formwork from standard sized manufactured formwork panels, the dimensions of such panels shall be approved by the Engineer before they are used for construction of the Work. The finished appearance of the entire elevation of the structure and the adjoining structures shall be considered when planning the patterns of joint lines caused by the formwork and by construction joints to ensure continuity of horizontal and vertical lines.
Formwork shall be constructed to provide the correct shape, lines and dimensions of the concrete shown on the Drawings. Due allowance shall be made for any deflection, which will occur during the placing of concrete within the formwork. Panels shall have true edges to permit accurate alignment and provide a neat line with adjacent panels and at all construction joints. All panels shall be fixed with their joints either vertical or horizontal, unless otherwise specified or approved.
Formwork shall be provided for the top surfaces of sloping work where the slope exceeds 15o with the horizontal and shall be anchored to enable the concrete to be properly compacted and prevent floating. Cares shall be taken to prevent air being entrapped. Openings for inspection of the inside of the formwork and for the removal of water used for washing shall be provided and so formed as to be easily closed before placing concrete.

2.14.3 FORMWORK FOR EXPOSED CONCRETE SURFACES

All exposed concrete surfaces are to be 'form finish' and shall be cast in any approved formwork and shall be free from honeycomb, fins, projections and air holes. All external angles to form finish concrete surfaces shall be chamfered as directed.
Forms for concrete surfaces exposed to view shall produce a smooth surface of uniform texture and color substantially equal to that which would be obtained with the use of plywood conforming to the National Institute of Standards and Technology Product Standard PSI for Exterior B-B Class I Plywood. Panels lining such forms shall be arranged so that the joint lines form a symmetrical pattern conforming to the general lines of the structure. The same type of form lining material shall be used throughout each element of a structure. Such forms shall be sufficiently rigid so that the undulation of the concrete surface shall not exceed 3mm when checked with a 1.5m long straight edge or template.
The Contractor shall submit shuttering Drawings and details of pattern and the method of forming joints in the exposed (form finish) concrete to the Engineer for his approval. All changes and modification made by the later shall be appropriately incorporated by the former and final approval whereof be obtained from

the Engineer.
Unless otherwise stated on the Drawings, wrought formwork shall be used for all permanently visible concrete surfaces. Wrought formwork shall be such as to produce a smooth and even surface free from perceptible irregularities. Tongues and grooved paneled boards, plywood or steel forms shall have their joints flushed with the surface. The formwork shall be formed with approved standard size panels. The panels shall be arranged in a uniform approved pattern, free from defects likely to be detected in the resulting concrete surface.
In all types of formwork to form finished exposed concrete, only non-staining mold oil shall be used as approved by the Engineer.
The respective usage of the same formwork to cast form-finished exposed concrete shall be as decided by the Engineer and in no case the formwork, not guaranteed to produce the required form-finish to the satisfaction of the Engineer, shall be used.
The exposed concrete shall have a uniform finish. The finish of the concrete when shuttering and formwork are removed will generally be without any blemish and will be such as will not require touch up. Slight touch up for a small spot or two, if necessary shall be carried out skillfully so as to be synonymous with the entire surfaces.
The finished surfaces shall be within the specified tolerances and full cover to the reinforcement steel shall be maintained.

2.14.4 FORMWORK FOR NON-EXPOSED CONCRETE SURFACES

Unless otherwise stated on the Drawings, rough formwork may be used for all surfaces, which are not permanently exposed. Rough formwork may be constructed of plain butt-joined sawn timber. But the Contractor shall ensure that all joints between boards shall be grout-tight.
The finished surfaces shall be within the specified tolerances and full cover to the reinforcement steel shall be maintained.

2.14.5 FORMED SURFACES AND FINISH

The formwork shall be lined with a material approved by the Engineer so as to provide a smooth finish of uniform texture and appearance. This material shall leave no stain on the concrete and so joined and fixed to its backing as not to impart any blemish. It shall be of the same type and obtained from only one source throughout the construction of any individual structure. The Contractor shall make good any imperfection in the finish as required by the Engineer. Internal ties and embedded metal parts will be allowed only with the specific approval of the Engineer.

2.14.6 SIZES OF TIMBER AND OTHER SECTIONS FOR FORMWORK

Scaffolds, formwork and components thereof shall be capable of supporting without failure, at least two times the maximum intended load. The following types of loading shall be considered in designing the formwork:
i. Weight of wet concrete: 20 KN/m3.
ii. Live load due to workmen and impact of ramming or vibrating: 15-40 kPa (light duty for carpenter and stone setters, medium duty for brick layers and plasterers, heavy duty for stone masons).
iii. Allowable bending stress (flexural tensile stress) in soft timbers: 8,000 kPa. The sizes for formwork elements specified in the Table given below are applicable for spans of up to 5m and height of up to 4m. In case of longer span and height, formwork and support sizes shall be determined by calculating the load and approved by the Engineer before use.
Sizes of timber and other sections for formwork

Types of Formwork	Members Size in mm
Flat sheeting for slab bottoms, columns and beam sides	25 to 50
Beam bottoms	75x100 to 150x150

Vertical posts	75x100 to 150x150
Bamboo posts	Minimum 75 dia
Timber posts	Not less than 100 dia at mid-length and 80dia at thin end
Joist and ledgers supporting sheeting of slab	50x100 to 75x200
Studs for supporting vertical wall sheeting	50x100 to 150x150
Columns yokes-horizontal cross, pieces supporting vertical sheeting	50x100 to 100x100

2.14.7 QUALITY OF SHUTTERING

The shuttering shall have smooth and even surface and its joints shall not permit leakage of cement grout. Ply-board shuttering material shall be well seasoned free from projecting nails, splits or other defects that may mark the surface of concrete. It shall not be so dry as to absorb water from concrete and swell and bulge, nor so green or wet as to shrink after erection.

The timber shall be accurately sawn and plain on the sides and the surface coming in contact with concrete.

Wooden formwork with metal sheet lining or steel plates stiffened by steel angles shall also be permitted. Where metal forms are used, all bolts and nuts shall be countersunk and well-grounded to provide a smooth plain surface.

The chamfers, leveled edges and moldings shall be made in the formwork itself. Opening for fixture and other fittings connected with the services shall be provided in the shuttering as directed by the Engineer.

Clamps shall be used, to its practicality, to hold the forms together. Where use of nails is unavoidable, it shall be kept to minimum number and these shall be left projected so that they can easily be withdrawn. Use of double-headed nails shall be preferred.

2.14.8 TOLERANCES

The formwork shall be made so as to produce a finished concrete true to shape, lines, levels, plumb and dimensions as shown on the Drawings subject to the following tolerances unless otherwise specified in this document or Drawings or as directed by the Engineer.

i. Sectional dimension ± 5mm
ii. Plumb ± 1 in 1000 of height
iii. Levels ± 3mm before any deflection has been taken place

Tolerances given above are specified for local aberrations in the finished concrete surface and should not be taken as tolerance for the entire structure taken as a whole or for the setting and alignment of formwork, which should be as accurate as possible to the entire satisfaction of the Engineer. Errors, if noticed in any lift/tilt of the structure after stripping of forms, shall be corrected in the subsequent work to bring back the surface of the structure to its true alignment.

2.14.9 FIXING OF FORMWORK

The formwork shall be arranged in a manner as to readily be dismantled and removed from the cast concrete without shock, disturbance or damage. Where necessary, the formwork shall be so arranged that the soffit form, properly supported on props only, can be retained in position for such period as may be required by maturing conditions or Specification.

The surfaces of formwork shall be free from foreign matters, projecting nails and the like, splits or other defects, and all formwork shall be cleaned and made free from standing water, dirt, shavings, chippings or other foreign matter before concrete is placed.

Before placing concrete, all built-in reinforcement bars, anchoring, steel beams, cables, fixing truss, bolts, pipes or conduits or any other fixtures shall be fixed in their correct positions. The cores and other devices for forming holes shall be held fast by fixing to the formwork or otherwise. Holes shall not be cut in any concrete without the approval of the Engineer.

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All exterior and interior angles on the finished concrete of 900 or less shall be given 12mm – 20mm chamfers unless otherwise shown on the Drawings or directed by the Engineer. When chamfers are to be formed, the fillets shall be accurately cut to size to provide a smooth and continuous chamfer.
No ties or bolts or other devices shall be built into the concrete for the purpose of supporting formwork without the prior approval of the Engineer. The whole or part of any such support embedded in the Reinforced Concrete shall be capable of removal so that no part, remaining embedded in the concrete, shall be nearer than 75mm from the surface. Holes left after removal of such supports shall be neatly filled with well-reamed dry-pack mortar following the procedures described in the relevant Sub-section of this Specification.
All rubbish shall be removed from the interior of the forms before the concrete is placed. After cleaning and prior to placement of reinforcing steel, the formwork in contact with the concrete shall be treated with a suitable non-staining mold oil or suitable approved release agent to prevent sticking of the concrete. Such works shall not discolor or otherwise injure the surface of the concrete. Care shall be taken to prevent the oil from coming in contact with the reinforcement or mixing with the concrete. At construction joints, surface-retarding agents shall be used only where ordered by the Engineer.
All formwork shall be inspected and approved by the Engineer before concrete is placed in it. However, this shall not relieve the Contractor from the requirements as to soundness, finish and tolerances of the concrete specified in this Specification or elsewhere acknowledged as Standard. If, at any period of the work during or after placing the concrete, the forms show signs of sagging or bulging, the concrete shall be removed to the extent directed by the Engineer, the forms brought to the proper position and new concrete placed. No allowance shall be made to the Contractor for such extra works.

2.14.10 REMOVAL OF FORMS

Forms shall not be removed without the approval of the Engineer. In the determination of the time for the removal of forms, consideration shall be given to the location and character of the structure, the weather, the materials used in the mix and other conditions influencing the early strength of the concrete. Extreme cares shall be taken to ensure that the method of removal shall not cause overstressing of the concrete or damage to its surface.
Forms shall be removed in such a manner as to permit the structure to uniformly and gradually take the stresses due to its own weight as not to impair safety and serviceability of the structure. All concrete to be exposed by form removal shall have sufficient strength not to be damaged thereby.
Forms shall not be removed in the cases of footing forms where the removal would endanger the safety of the cofferdams, forms from enclosed cells where access is not provided, deck forms in the cells that do not interfere with the future installation of utilities shown on the Drawings, or other works.
Except for concrete being post-tensioned, no concrete shall be subjected to loading which will induce a compressive stress in it exceeding one-third of its compressive strength at the time of loading, or one-third of the specified characteristic strength whichever is less. It may be possible to use shorter periods before striking forms by determining the strength of the concrete in the structural element.
Forms supporting cast-in-situ concrete in flexure may be struck when the strength of the concrete in the element is 10 N/mm2 or twice the stress to which it will be subjected, whichever is greater provided that striking at this time will not result in an unacceptable deflection. This strength may be assessed by test on cylinder/cube cured under the same conditions as the concrete in the element as far as possible.
Forms on upper sloping faces of concrete shall be removed as soon as the concrete has attained sufficient stiffness to prevent sagging. Any repair or treatment required on such sloping surfaces shall be performed at once.
If the floor is to be used to support construction loads, props should be retained for 28 days unless the Contractor can prove the requisite concrete strength by tests.
The form shall be removed slowly, as the sudden removal of wedges is equivalent to a shock load on the partly hardened concrete.
Materials and plants shall not be stacked on any newly constructed floor unless sufficient support is maintained to withstand such loads without damaging the floor.

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The following table is a guide to the minimum periods that must elapse between the completion of the concreting operations and the removal of formwork. No formwork shall be removed without the permission of the Engineer and such permission shall not relieve the Contractor of his responsibilities regarding the safety of the structure.

Type and position of Formwork	Approximate period (days)
Side of beams, walls and columns (unloaded)	5
Slab soffits (props supporting)	14
Removal of props to slabs	21
Beam soffits (props supporting)	21
Removal of props to beams	28

Notwithstanding the foregoing, the Contractor shall be held responsible for any damages arising from removal of formwork before the structure is capable of carrying its own weight and any incidental loading.

2.14.11 OPENINGS

Temporary and permanent openings in concrete shall be framed neatly with provisions for keys or reinforcing steel as shown on the Drawings or as directed by the Engineer.

2.14.12 DEFECTS IN FORMED SURFACES

Workmanship in formwork along with concrete placing shall be such that concrete shall normally require no repair to surfaces being perfectly compacted and smooth. If any blemish is revealed after removal of formwork, the Contractor shall obtain immediately the Engineer's decision concerning remedial measures to be undertaken. Notwithstanding the specifications and provisions stated under the Sub-section on 'Finish and Finishing' of this Specification, such measures may include but shall not be limited to the following: i. Fins, pinholes, bubbles, surface discoloring and mirror defects may be rubbed down with sacks immediately on removal of the form.

ii. Abrupt and gradual irregularities may be rubbed down with carborundum stone and water after concrete has been fully cured.

iii. Deep honeycombed concrete shall be repaired within 24 hours of striking the formwork by cutting back to sound concrete. The concrete shall be cut back at least 50mm behind face reinforcement. Cut edges shall be regular and not feathered. Recasting shall be with the same concrete as the original casting. The Engineer shall approve the formwork and its method of placing in this case also. iv. Under some circumstances, abrupt and gradual irregularities of shallow honeycombed concrete may be repaired by cutting back and reforming with an approved epoxy resin or mortar in accordance with the manufacturer's instructions.

Regardless of the above repairing measures, any structure containing excessive honeycomb, as would be termed by the Engineer, shall be subject to rejection by the Engineer. The Contractor, on receipt of written orders from the Engineer, shall remove and rebuild such portions of the structure at his own expenses.

2.14.13 HOLES TO BE FILLED

Holes on the concrete surfaces formed by formwork supports or the like shall be filled with dry pack mortar made from one part by weight of ordinary Portland cement and three parts of specified fine aggregate approved by the Engineer. The mortar shall be mixed with sufficient water only to make the materials stick together when being molded in the hands. All construction materials shall conform to the requirements as described previously and under the relevant Sub-sections of the Section on 'Construction Materials' of this Specification.

The Contractor shall thoroughly clean any hole that is to be filled and break out any loose, broken or cracked concrete or aggregate and remove any dry cement from the hole. The surrounding concrete shall be soaked until the whole surface that will come into contact with the dry pack mortar has been covered

and darkened by absorption of the free water by the cement. The surface shall then be dried so as to leave a small amount of free water on it.
The dry pack material shall then be placed and packed in layers having a compacted thickness of not more than 10mm. Compaction shall be carried out by using a hardwood stick and a hammer and shall extend over the full area of the layer. Special cares should be taken to compact the dry pack against the sides of the holes.
After compaction, the surface of each layer shall be scratched before further loose material is added. The holes shall be slightly overfilled. The surface shall be finished by laying a hardwood block against the dry pack fill and striking the block several times.

2.14.14 APPROVAL OF SCAFFOLDINGS AND FORM

Plans, Drawings and structural calculations shall be submitted to the Engineer on time so that no construction of such scaffoldings and forms shall take place before the Engineer's approval is accorded in writing. Such approval shall not relieve the Contractor of his responsibilities for the involved structure. The Engineer shall have reasonable time for his examination of the Contractor's plans and calculations, if scaffoldings are introducing temporary loading on new structures in particular. For this purpose, the Contractor shall not be allowed any extension of time beyond the stipulated period of the Contract. Before concrete is placed, the Engineer shall inspect all formworks and scaffoldings. No concrete shall be placed until inspection is made and approval is given by the Engineer. Such approval shall not relieve the Contractor of any of his responsibilities under the Contract for the successful completion and the soundness of the structure.

2.14.15 MEASUREMENT

Formwork and false work shall not be measured separately but shall be deemed to be an integral part of the concrete items.

2.14.16 PAYMENT

The Contractor's rates for concrete work, inter-alia, shall be inclusive of all costs of all formwork, false work and centering and for their subsequent removal. No additional payment will be made to the Contractor for these works.

2.15 CEMENT CONCRETE BLOCK MASONRY

2.15.1 SCOPE

The work covered by this section of the Specifications consists of furnishing all labour, tools scaffolding, hoisting equipment and masonry materials of every kind; and in performing all operations in connection with procurement, transportation and delivery, erection and building in of all work classified as masonry work and/or included as such herein, i.e., concrete masonry units; masonry mortars; and all related items and appurtenances, including all items supplied by other trades and customarily built-in and/or installed under mason work or required to complete mason work, in strict accordance with the requirements of the Drawings and Schedules, as specified herein, and subject to the Terms and Conditions of the CONTRACT Documents.

2.15.2 CODES AND STANDARDS

Unless otherwise specified or shown, the following codes and standards shall apply:

ASTM C31	Making and curing concrete test specimen in the field.
ASTM C39	Compressive Strength of cylindrical concrete specimen.
ASTM C90	Hollow load bearing concrete masonry units.
ASTM C144	Aggregate for masonry mortar
ASTM C270	Mortar for unit masonry
ASTM C404	Aggregate for masonry grout
ASTM E119	Fire tests of building construction and materials
UBC UL-618	Concrete masonry units, fire resistance index

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2.15.3 SUBMITTALS

- Samples: Submit three samples of each type of block required, and the full range of exposed texture to be used in the completed works. The review will be for texture only.
- Test Reports: Reports for compressive strengths of masonry units, grout and mortar

2.15.4 SUCTION RATE

The CONTRACTOR shall, at his own cost, satisfy the ENGINEER that the suction rate of the block when determined in accordance with Appendix `A' of BS 3921 does not exceed 20g/cm.sq/min., or that the CONTRACTOR is able to adjust it so that it does not exceed this value on SITE.

2.15.5 SOLUBLE SALT CONTENT

For exposed block work, the contents by weight percent of soluble sulfate, calcium, magnesium, potassium and sodium radicals, shall not exceed 0.30, 0.10, 0.03 and 0.03 percent respectively, when ascertained in accordance with BS 3921 at the cost of the CONTRACTOR.

2.15.6 PRODUCTS

2.15.6.1 MATERIALS FOR BLOCKS

Cement, aggregate and water for concrete blocks shall conform to the requirements as specified in the section for Plain and Reinforced Concrete

2.15.6.2 CONCRETE BLOCK MAKING

- The blocks shall be machine molded. The block making machines shall be of the standard approved by the ENGINEER. They shall be operated according to the instructions laid down by the manufacturers.
- The blocks shall be continuously water cured by sprinkling for a minimum of 10 days and covered between sprinkling operations with 4 mils thick polyethylene sheeting. After 10 days' water-curing period the blocks shall be air dried. Under no circumstances will blocks be used in the work until they are completely dry. During curing period no surface of the block will be allowed to dry.
- Cured concrete blocks shall be stored off the ground, stacked on level platforms, which allow air circulation under stacked units. Units shall be covered and protected against wetting.
- Care shall be exercised in the handling of all concrete blocks. No damaged blocks shall be used in the work.
- The blocks cast on different dates shall be stacked separately and must be labeled showing the date on which they are cast

2.15.6.3 PROPERTIES OF BLOCKS

i. Block sizes, unless otherwise indicated on drawings, shall be 16" by 8" by 4", 6", & 8" thickness (Approximately 400 by 200 by 100, 150 & 200 mm). Physical requirements shall comply with relevant ASTM or equivalent approved standards.

ii. For non-load bearing wall the cement, sand and coarse aggregate shall be volume batched in the minimum ratio of one-part cement, three parts sand and six parts coarse aggregate and shall be mixed in a concrete mixer.

iii. For load bearing Hollow/Solid block wall the mix unless otherwise stated shall be proportioned to meet the following strength requirements:

- Solid Load Bearing Concrete Masonry Units shall have a 28 days' compressive strength of not less than 1500 psi (106 kg/cm. sq.) average of 3 units tested or 1200 psi (85 kg/cm. sq.) per individual unit tested.
- Hollow Load Bearing Concrete Masonry Units shall comply with ASTM C90, grade N-1 (moisture controlled), and shall have a 28-days compressive strength of 1350 psi (96 kg/cm. sq.) average of 3 units tested and 800 psi (57 kg/cm. sq.) on individual unit tested. The compressive strengths shall be verified by tests in accordance with UBC section 2404, para 2
- The CONTRACTOR shall provide test results proving the average minimum crushing strength of the blocks prior to the commencement of the construction. Further test results shall be provided as required by the ENGINEER, to ensure that all batches of blocks have the minimum specified crushing strength.
- The test shall be carried out by an authority approved by the ENGINEER. Evidence shall be produced that the block manufacturer has an efficient method of quality control. The ENGINEER will require to periodically test samples of blocks, and the CONTRACTOR shall make any necessary arrangements.
- Hollow concrete block units wherever specified shall have cores with cross sectional area at least equal to the percent of gross area of block given below:

8 in. (200 mm)	38 percent
6 in. (150 mm.)	30 percent
4 in. (100 mm)	No requirement

- Minimum shell wall thickness be 1-1/4 in. (32 mm).
- Permissible tolerance in size of block shall be 1/8 in (3 mm) each way.
- Special shapes for lintels, corners, jambs, sash, cleanouts, control joints and headers, bonding and other particular needs shall be provided where required.

2.15.6.4 MORTAR CONSTITUENTS

- Cement: Cement shall conform to ASTM C-150, type II low alkali non-staining without air entrainment

- Sand (Aggregate): Sand and its grading shall comply with the requirements of ASTM C-144, 100% passing the U.S. equivalent No. 16 sieve. Sand that has been in contact with seawater shall not be used unless it has been thoroughly washed to the satisfaction of the ENGINEER.
- Water: Water shall conform to the specifications set forth in Section of Plain and Reinforced Concrete.
- Lime: Hydrate lime shall conform to ASTM C-207 type S. If it is not available, use quick lime according to ASTM C-5.

2.15.6.5 MORTAR PROPORTIONS AND MIXING

- Cement, Lime and Sand shall be mixed in proportion, by volume, as follows:
- Type (1) 1:1:6 (Cement: Lime: Sand)
- Type (2) Alternatively use 1:4 (Cement: sand) mix subject to the prior approval of the ENGINEER.
- Mix only as much mortar in a mortar mixer as can be used in one hour for Type-1 and 30 minutes for Type-II after water has been first mixed into the batch.
- Do not re-temper the mortar.
- Where cement lime mortar is used, sand and lime shall be mixed first and cement to be added later on.
- Compressive strength of mortar specimen tested in accordance with ASTM C39 shall not be less than 2500 psi (210 Kg/cm sq.)

2.15.6.6 REINFORCING AND ANCHORS

i. All masonry walls shall be reinforced. At least one vertical and one horizontal reinforcing member shall be provided for every 16 sq.ft of wall elevation or as per structural drawings.

ii. Block masonry anchors and ties required to connect masonry with structural member unless shown otherwise on drawings, shall be 3/8" dia. (10-mm dia) bars every 4-5th course, anchored 6" in each jointing element.

iii. Additional details of anchors, if any, are shown on drawings.

iv. Alternate compatible anchoring system may be used subject to the approval of the ENGINEER.

v. All reinforcing steel shall conform to ASTM A 615 grade 40 deformed bars as specified in section 3310 plain and reinforced concrete.

2.15.6.7 ERECTION / WORKMANSHIP

Blocks shall be laid true to line, level and laid in accurately spaced courses in stretcher bond with vertical joints of each course located at center of units in alternate courses below. Each course shall be properly bonded at corners and intersections of walls. Courses of block shall be kept plumb throughout, and

corners reveals shall be true and in plumb.
Standard width of mortar joints for both horizontal and vertical joints shall be 1/2" (12.5 mm) maximum. Mortar joints in walls shall have full mortar coverage on vertical and horizontal faces between the blocks. Mortar joints on wall including struck joints, shall be thoroughly compacted and pressed tight against the edges of the blocks with proper tools. Block terminating against soffits of beam or slab construction shall be wedged tight with wedges and the joint shall be packed solidly with mortar between the top of the block and the bottom of slab or beam. Expansion joints shall be kept free from mortar or other debris. Unless otherwise shown on the drawings or specified by the ENGINEER, the spaces around door frames and other material or built in items shall be solidly filled with mortar. Spaces around the door and window holdfasts shall be filled in with 3 ksi concrete. Work required to be built in with masonry including door frame anchors, wall plugs, dovetail anchors and accessories shall be built in as the erection progresses. The block work shall be carried up in uniform manner and no portion shall be carried more than 3. ft (1 meter) above the adjoining one at any time. All masonry shall be kept strictly true and square and the whole properly bonded together and leveled round each floor.
Sleeves, chases and holes etc. shall be built in as construction proceeds. Chasing of completed walls or the formation of holes shall only be carried out with the approval of the ENGINEER.
Walls of blocks indicated as being non-load bearing shall not be constructed on the in-situ concrete floor slab unit until the floor shuttering is struck and the concrete has obtained sufficient strength to support their weight. Toothing into load bearing walls shall not be permitted.

2.15.7 CURING

Masonry wall shall be cured by keeping it moist with water for at least 10 days after its construction. ENGINEER may direct additional curing if required.

2.15.8 SCAFFOLDING

CONTRACTOR shall provide safe scaffolding of adequate strength for use of workmen at all levels and heights at his own expense. Scaffolding which is unsafe in the opinion of the ENGINEER shall not be used until it has been strengthened and made safe for use of workmen. Cost of scaffolding etc., shall be included by the CONTRACTOR in the unit rate for masonry items.
Damage to masonry from scaffolding or from any other object shall be repaired by the CONTRACTOR at his own cost.

2.15.9 TOLERANCES

All block work shall be erected plumb and true to line and level with the maximum variation in any story height or any length of wall being 1/8" (3 mm) in 10 feet (3 meter). The maximum tolerance in the length, height or width of any single masonry unit shall be +/- 1/8" (3 mm).

2.15.10 MEASUREMENT & PAYMENT

Unless otherwise specifically stated in the Bill of Quantities or herein, all items shall be deemed to be inclusive of, but not limited to the following:

i. Labor and all costs in connection therewith.
ii. Materials, goods and all costs in connection therewith e.g. conveyance; delivery; unloading; storing; returning packing; handling; hoisting; lowering; making curing etc.
iii. All fixtures and all costs in connection therewith for precast works.
iv. Fitting and fixing materials and goods in position.
v. Use of plant and scaffolding.
vi. Cutting and patching work required for installation of built-in-work.
vii. Waste of materials.

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viii. Square cutting.

ix. Establishment charges, overhead charges and profit.

x. All other expenses, charges and taxes specified in Conditions of Contract

Works shall be measured net as fixed in position as per Drawings and instructions of the ENGINEER. Each measurement shall be taken to the nearest 1/2" (12.5 mm). This rule shall not apply to any dimensions stated in descriptions.
Masonry work will be paid for according to the actual net area of masonry work in square feet (Sq. m.) for the required thickness or the actual net volume of masonry work in cubic feet (C.M.) as described in the Bill of Quantities. All the openings left in the masonry walls will be deducted.
Providing and fixing all joint reinforcing bars, reinforcing bar anchors and dovetail anchors shall be deemed to be included in the unit rate for masonry work.
Due to different thickness of the slab in different areas or rooms or for any other reason whatsoever, if the chiseling of the masonry is required the CONTRACTOR shall do so at his own cost. Where for any reason whatsoever, the height of the wall is short of ceiling height, the remaining height shall be made good with (f'c = 3000 psi) concrete. This concrete shall neither be measured nor be paid under item of concrete but will be paid for under the item of masonry of the walls. In case where lintel heights are such that the CONTRACTOR has to chisel the masonry or provide cast-in-place concrete to make up the height of the course, no payment will be made for chiseling, but where such cast-in-place concrete is provided, payment for the same will be made at the unit rate for masonry.

2.16 CONCRETE WORK

2.16.1 CONCRETE FOR STRUCTURES

2.16.1.1 DESCRIPTION

This work shall consist of construction of all Portland Cement Concrete in structures, with or without reinforcement, which shall involve furnishing, placing, finishing and curing of concrete. All items of concrete work shall include elements of structures constructed by cast-in-place and pre-cast methods using either plain or reinforced concrete or any combination thereof and shall conform to the specifications and requirements of the different Sub-sections of this item of work. All structures shall be built in a workman like manner to the lines, grades and dimensions shown on the Drawings or as directed by the Engineer.
All concrete works shall be carried out in accordance with BS 8110 or ASTM C-685 and as specified by the Engineer.
All sampling and testing of constituent materials shall be carried out in accordance with the provisions of the appropriate British or American Standard and all sampling and testing of fresh and hardened concrete shall be carried out in accordance with the provisions of BS 1881 "Method of Testing Concrete" or similar under ASTM C 39.

2.16.2 REINFORCEMENT FOR RCC

2.16.2.1 DESCRIPTION

Works covered by this item shall consist of supplying and placing of steel reinforcement in different types of concrete structures including board cast-in-situ piles and pre-cast concrete piles but not includes reinforcement for pre-stressed concrete. The works shall conform to the specifications, the types, sizes and positions of reinforcement requirements shown on the Drawings and this specification.

2.16.2.2 MATERIALS REINFORCEMENT

Reinforcing bars discussed under this Section shall be made of Mild Steel or High yield Steel, plain or deformed, for all Reinforced Concrete Works but excluding Pre-stressing Concrete.
Bars shall be rolled and produced from steel in the form of new and clean billets directly reduced from

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ingot of properly identified heats of open hearth, basic oxygen or electric arc furnace steel or lots of acid besmear steel.
Reference Standards
Deformed reinforcement
Deformed and Plain Billet Steel Bars for Concrete Reinforcement – ASTM A 615
Rail Steel Deformed and Plain Bars for Concrete Reinforcement – ASTM A 616
Axle Steel Deformed and Plain Bars for Concrete Reinforcement – ASTM A 617
Low Alloy Steel Deformed Bars for Concrete Reinforcement – ASTM A 706
Deformed Steel Wire – ASTM A 496
Welded Deformed Steel Wire Fabric – ASTM A 497
Zinc Coated (Galvanized) Steel Bars – ASTM A 767
Epoxy – Coated Reinforcing Steel – ASTM A 775
Plain reinforcement
ASTM A 615 M, ASTM A 616 M, ASTM A 617 M, ASTM A 185
Smooth steel wire
Cold – Drawn Steel Wire - ASTM A 82
Cold – worked steel reinforcement
IS 1786: 1985, BS 4461: 1978
Mild steel plain round bar
This is a type of bar plain and round in shape of a structural or intermediate grade with yield strength of not less than 280 MPa (N/mm2) i.e. 40 grade.
Deformed bars
Reinforcing steel under this type comprises Mild Steel Grade 40 and High Strength Grade 60 Deformed re-bars with yield strength of not less than 280 MPa (N/mm2) in case of Grade 40 and with yield strength of not less than 410 MPa (N/mm2) in case of Grade 60.
Other bars
Steel welded wire, fabric plain reinforcement conforming to ASTM A 185 may be used, except that for wire with specified yield strength fy exceeding 410 MPa (N/mm2), fy will be the stress corresponding to a strain of 0.35 percent.
Smooth steel wire conforming to ASTM A 82 may be used in concrete except that for a wire with a specified yield strength fy exceeding 410 MPa (N/mm2), fy will be the stress corresponding to a strain of 0.35 percent.
Fabricated deformed steel bar mats conforming to ASTM A 184 and deformed steel wire complying with ASTM A 496 may be used. Deformed wire for concrete reinforcement shall not be smaller than a nominal diameter of 5.72mm, and for a wire with specified yield strength (fy) exceeding 410 MPa (N/mm2), fy shall be the stress corresponding to a strain of 0.35 percent.
Welded deformed steel wire fabric conforming ASTM A 497 may be used for a wire with specified yield strength exceeding (fy) 410 MPa (N/mm2), fy will be the stress corresponding to a strain of 0.35 percent.

2.16.2.3 CHEMICAL COMPOSITION

The structural grade shall be made from billets. The ends of the bar shall be machine sheared perpendicular to the axis of the bar. The bars shall be free from injurious defects and shall have a workman like finish.
The chemical composition should conform to the requirements of ASTM 706-82

2.16.2.4 PROCESS

The steel shall have been made by one or more of the following processes:

i. open-hearth
ii. basic oxygen
iii. electric furnace

iv. acid besmear

2.16.2.5 DIMENSIONAL REQUIREMENTS

The nominal diameter, cross sectional areas and perimeter of a deformed bar are equivalent to that of a plain bar having the same standard weight per unit length. Dimensional requirements of such bars have been shown in the Table given below:

Bar Designation No.*	Nominal Dimensions**			Nominal weight, lb/ft [Nominal mass, kg/m]
	Diameter, in. [mm]	Cross Sectional Area, in.² [mm²]	Perimeter, in. [mm]	
3 [10]	0.375 [9.5]	0.11 [71]	1.178 [29.9]	0.376 [0.560]
4 [13]	0.500 [12.7]	0.20 [129]	1.571 [39.9]	0.668 [0.994]
5 [16]	0.625 [15.9]	0.31 [199]	1.963 [49.9]	1.043 [1.552]
6 [19]	0.750 [19.1]	0.44 [284]	2.356 [59.8]	1.502 [2.235]
7 [22]	0.875 [22.2]	0.60 [387]	2.749 [69.8]	2.044 [3.042]
8 [25]	1.000 [25.4]	0.79 [510]	3.142 [79.8]	2.670 [3.973]
9 [29]	1.128 [28.7]	1.00 [645]	3.544 [90.0]	3.400 [5.060]
10 [32]	1.270 [32.3]	1.27 [819]	3.990 [101.3]	4.303 [6.404]
11 [36]	1.410 [35.8]	1.56 [1006]	4.430 [112.5]	5.313 [7.907]
14 [43]	1.693 [43.0]	2.25 [1452]	5.32 [135.1]	7.65 [11.38]
18 [57]	2.257 [57.3]	4.00 [2581]	7.09 [180.1]	13.60 [20.24]

*Bar numbers are based on the number of eighths of an inch including in the nominal diameter of the bars [bar numbers approximate the number of millimeters of the nominal diameter of the bar]

** The nominal dimension of a deformed bar are equivalent to those of a plain round bar having the same weight [mass] per foot [meter] as the deformed bar.

2.16.2.6 TENSILE PROPERTIES

The tensile properties of the Grade 40 and Grade 60 steel have been shown in the Table given below:

Item	Requirements	
	Grade 40 [300]*	Grade 60 [420]
Tensile strength, min, psi [MPa]	70,000 [500]	90,000 [620]
Yield strength, min, psi [MPa]	40,000 [300]	60,000 [420]
Elongation in 8 in. [203.2 mm], min, %		
Bar Designation No.		
3 [10]	11	9
4, 5 [13, 16]	12	9
6 [19]	12	9
7, 8 [22, 25]	-	8
9, 10, 11 [29, 32, 36]	-	7
14, 18 [43, 57]	-	7

* Grade 40 [300] bars are furnished only in sizes 3 through 6 [10 through 19].

2.16.2.7 BEND TEST REQUIREMENT

The pin diameter required for performing bend tests shall conform to ASTM A 615. The following table contains such requirements:

Bar Designation No.	Pin Diameter for Bend Tests *	
	Grade 40 [300]	Grade 60 [420]
3, 4, 5 [10, 13, 16]	3.5d	3.5d
6 [19]	5d	5d
7, 8 [22, 25]	-	5d
9, 10, 11 [29, 32, 36]	-	7d
14, 18 [43, 57] (90°)	-	9d

* Test bends 180° unless noted otherwise.

d = Nominal diameter of specimen

Permissible variation

For lots from standard weights + 5% for 6mm dia

+ 3.5% for 10mm dia and above

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Individual Length + 6% for all sizes

Length of the bar shall be maximum possible, but each bar shall not be less than 12m in length or 45.36 kg in weight whichever is greater.

2.16.2.8 ASTM CODE REQUIREMENTS FOR DEFORMATIONS

Deformations shall be spaced along the bar at substantially uniform distances. The deformations on the opposite sides of the bar shall be similar in size and shape.

The deformations shall be placed with respect to the axis of the bar so that the included angle is not less than 45°. Where the line of deformation forms an included angle with the axis of the bar from 45° to 70° inclusive, the deformations shall alternately reverse in direction on each side, or those on one side shall be reversed in direction from those on the opposite side. Where the line of deformation is over 70°, a reversal in direction is not required.

Average spacing or distance between deformations on each side of the bar shall not exceed 17 (seventeen) times of the nominal diameter of the bar.

Overall length of deformations shall be such that the gap between the ends of the deformations on the opposite sides of the bar shall not exceed 12.5% of the nominal perimeter of the bar. Where the ends terminate in a longitudinal rib, the width of the longitudinal rib shall be considered as the gap. Where more than two longitudinal ribs are involved, the total width of all longitudinal ribs shall not exceed 25% of the nominal perimeter of the bar. Furthermore, the summation of gaps shall not exceed 25% of the nominal perimeter of the bar. Nominal perimeter of the bar shall be 3.14 times the nominal diameter (db).

Spacing, height and gap of deformations as to be conformed have been shown in the following table:

Deformation requirements, in. [mm]

Bar designation	Maximum average spacing	Minimum average height	Maximum gap (Chord of 12.5% of Nominal Perimeter)
3 [10]	0.262 [6.7]	0.015 [0.38]	0.143 [3.6]
4 [13]	0.350 [8.9]	0.020 [0.51]	0.191 [4.9]
5 [16]	0.437 [11.1]	0.028 [0.71]	0.239 [6.1]
6 [19]	0.525 [13.3]	0.038 [0.97]	0.286 [7.3]
7 [22]	0.612 [15.5]	0.044 [1.12]	0.334 [8.5]
8 [25]	0.700 [17.8]	0.050 [1.27]	0.383 [9.7]
9 [29]	0.790 [20.1]	0.056 [1.42]	0.431 [10.9]
10 [32]	0.889 [22.6]	0.064 [1.63]	0.487 [12.4]
11 [36]	0.987 [25.1]	0.071 [1.80]	0.540 [13.7]
14 [43]	1.185 [30.1]	0.085 [2.16]	0.648 [16.5]
18 [57]	1.58 [40.1]	0.102 [2.59]	0.864 [21.9]

Note: Any bar that fails to satisfy the aforementioned all requirements is to be treated as plain reinforcement

2.16.3 BINDING WIRE

Reinforcement binding wire shall be the best black annealed mild steel wire and not less than 1.6mm in diameter in approximation/18 - 22 BWG or 26 BWG galvanized iron wire.

2.16.4 WIRE MESH

Wire mesh shall conform to the requirements of AASHTO Standard Specification M 55 Welded Steel Wire Fabric for Concrete Reinforcement.

2.16.5 ORDERING MATERIAL

The name of the proposed supplier of the reinforcement shall be submitted as soon possible to the Engineer for his approval. The Contractor shall submit necessary information concerning the supplier as requested by the Engineer.

Copies of orders placed shall be submitted to the Engineer.

The manufacturer shall submit all requested relevant data on the steel, i.e. breaking strength, yield strength, characteristics on elongation, chemical composition etc., to the Engineer for his approval.

No steel shall be delivered without a certificate guaranteeing the yield stress.

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The steel shall be stored and marked in a way that it enables identification of the steel corresponding to each certificate later on.

2.16.6 TESTS

Test results in addition to those to be submitted by the Contractor and specified above shall be required. The Contractor shall cut out samples as directed by the Engineer.
The samples shall be tested according to the Engineer's instructions by an approved Testing Institution. Approximately three samples shall be tested from each 10 tons of reinforcement delivered at the Site. Expenses incurred in connection with cutting, carrying and testing the samples shall be borne by the Contractor at his own costs.

2.16.7 CONSTRUCTION METHODS OF REINFORCING BAR

Storage and care
All reinforcing steel when received at the Site, prior to its use, shall be stacked off the ground on platforms, skids or any other support and shall be kept free from dirt, oil and grease. All cares shall be taken to prevent the steel reinforcement from any mechanical injury and surface loss resulting from its exposition to weather conditions that produce rust. It shall be clean and kept free from loose rust and loose mill scale at the time of fixing in position and subsequent pouring of concrete. However, reinforcement steel may not be rejected on the ground of bonded rust, surface seams, surface irregularities and mill scale so long minimum dimensions, cross-sectional area and tensile properties of a hand wire brushed specimen meet the specified physical requirements for the size and grade of steel.
Reinforcement shall be handled and stored in a manner that will prevent bending out of the desired shape and any accumulation of dirt, oil and paint. When placed in the works, it shall be free from dirt, oil, grease, paint, mill scale and loose or thick rust.
Bar reinforcement shall be shipped in standard bundles, tagged and marked in accordance with the Codes of Practice of the Concrete Reinforcing Steel Institute.
Fabrication
All bars shall be fabricated following Specifications, methods and procedures stated below. Fabrication tolerances shall be in accordance with ACI 315.
Cutting and bending
All reinforcement bars shall be cut and bent cold to the specified shape and pertinent dimensions shown on the Drawings using a proper bar bender, operated by hand or power to attain proper radii of bends. The equipment used and methods followed for this purpose shall get the approval of the Engineer.
Bars shall not be bent or straightened in a manner that will injure the material.
Bars partially embedded in concrete shall not be field bent unless otherwise shown on the Drawings or directed by the Engineer.
Errors in alignment of reinforcement partially embedded in hardened concrete shall not be corrected by bending in place, except as permitted by the Engineer.
Bars bent during transportation or handling shall be straightened before being used in work. It shall not be heated to facilitate bending.
Fabrication tolerances shall be in accordance with ACI 315.
All plain bars shall have standard hooks at the end, which shall meet the following requirements unless otherwise specified on the Drawings. When the dimensions of hooks or the diameter of bends are not prescribed, they shall be in accordance with ACI 318 'Building Code requirements for Reinforced Concrete'. Some of the standard requirements have been specified below:

i. 180° turn plus an extension of at least 4 bar diameters but not less than 60mm at the free end of the bar.
ii. 90° turn plus an extension of at least 12 bar diameters at the free end of the bar.
iii. For stirrup and the anchorage only:

- For 16 mm dia bar and smaller : 90° bend plus an extension of at least 6 bar diameters or 75mm whichever is greater at the free end of the bar.
- For 20mm and 25mm dia bar : 90° bend plus an extension of at least 12 bar diameters or 150mm whichever is greater at the free end of the bar.
- For 25mm dia bar and smaller : 135° bend plus an extension of at least 6 bar diameters at the free end of the bar.
- For closed ties and continuously wounded ties : 135° bend plus an extension of at least 6 bar diameters, but not less than 75mm.

The minimum diameter of bend measured on the inside of the bar, for standard hooks other than for stirrups and ties in sizes 10mm Φ thorough 16mm Φ, shall not be less than the values shown in the table given below.

Minimum diameters of Bend

Bar size	Minimum diameter of bend
10mm ≤ d_b ≤ 25mm	$6d_b$
25mm ≤ d_b ≤ 40mm	$8d_b$
40mm ≤ d_b ≤ 55mm	$10d_b$

* db is the nominal diameter of bar, mm

For stirrups and tie hooks, inside diameter of bend shall not be less than 4 bar diameters for 16mm Φ bar and smaller. For bars larger than 16mm Φ, diameter of bend shall be in accordance with the specifications shown in the above table.

Bends for other bars, where full tension in the bar may occur, shall be made around a pin having a diameter not less than 20 bar diameters. Hooks shall conform to American Concrete Institute Standard. Building Code Requirements for reinforced concrete ACI 316-89, or as shown on the Drawings or as directed by the Engineer.

Placing, supporting and fastening

All bar reinforcement shall be accurately placed, supported and secured in position as shown on the Drawings using approved spacer blocks and chairs prior to any concrete pouring. Displacement tolerance may be allowed within the permissible tolerance limit as shown in the table given below unless otherwise specified by the Engineer. The reinforcement shall be checked and approved by the Engineer before pouring of concrete.

Tolerance for Placing Reinforcement

	Tolerance for depth (d)	Tolerance for Minimum Concrete Cover
d ≤ 200mm	± 10mm	- 10mm
d ≤ 200mm	± 12mm	- 12mm

Notwithstanding the above provisions, tolerance for the clear distance to formed soffits shall be minus 6mm and tolerance for cover shall not exceed minus one-third the minimum concrete cover required in the design Drawings or specifications.

Tolerance for longitudinal location of bends and ends of reinforcement shall be ± 50mm, except at discontinuous ends of members where tolerance shall be ± 12mm.

Welding of crossing bars shall not be permitted for assembly of reinforcement unless authorized by the Engineer.

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The Contractor shall be responsible for the accuracy of cutting, bending and placing of the reinforcement. Reinforcement will be inspected for compliance with the requirements as to grade, size, shape, length, splicing locations, overlapping length and position after it has been placed.
Before the reinforcement is placed, the surfaces of the bars and the surfaces of any metal bar supports shall be cleaned of heavy rust, loose mill scale, dirt, grease and other objectionable foreign substances. Heavy flaky rust, which can be removed in firm rubbing with hessian or equivalent treatment, shall be considered objectionable. After being placed, the reinforcing bars shall be maintained in a clean condition until they are completely embedded in the concrete.
Reinforcement shall be accurately placed in the position shown on the Drawings and/or as directed by the Engineer and shall be securely held by blocking against the forms, by supporting on concrete or approved metal or plastic chairs or by using metal hangers and by wiring together at intersections using annealed wire of specified diameter with the ends turned in to the main body of concrete. Bars shall be tied at all intersections except where spacing is less than 300mm in any direction when alternate intersections shall be tied. Wire ties shall be securely tied and folded so that they do not project beyond the planes formed by the reinforcing bars. The adequacy of the supports and ties to secure the reinforcement properly shall be subject to the approval of the Engineer.
Reinforcement supports shall be strong enough to withstand the imposed loads without movement of the reinforcement. They shall be positively attached to the reinforcement and of such size and number as to maintain the specified cover.
There shall be a clear distance of at least 25mm between the bars and any adjacent embedded metal works. The Contractor shall ensure that there is no disturbance of the reinforcing bars in concrete that has already been placed.
Reinforcement binding wire shall be best black annealed mild steel wire and not less than approximately 1.6mm in diameter/18 - 22 BWG galvanized iron wire.
Cover blocks required for ensuring that the reinforcement is correctly positioned shall be as small as possible, consistent with their purpose, or a shape and material acceptable to the Engineer and designated so that they will not overturn when the concrete is placed. The concrete cover blocks or space blocks shall be made of concrete having 1 part cement, 1 part sand and 2 part coarse aggregate. The coarse aggregate would be 6mm downgraded. The blocks would be cast in mould and continuously cured for 21 days before use. Wire shall be cast in the block for the purpose of tying it to the reinforcement. The wire must not be closer than 30mm from the concrete surface. The use of small stones or wood blocks shall not be permitted.
If concrete cylinder blocks are used for proper spacing of vertical bars in column, the height shall be 2.54cm and radius shall be equal to the distance of the centre line of the bar from column face.
Top reinforcement in slabs shall be maintained in position by means of chairs made out of ferrous metal and shall conform to industry practice as described in the Manual on 'Standard Practice of the Concrete Reinforcing Steel Institute'. The diameter and quantity being sufficient to ensure security of the reinforcement shall be used to support access ways, working platforms, or the placing equipment or for conducting of an electric current.
Platforms for the support of workers and equipment and machines shall be placed directly on the forms without any disturbance of the reinforcing steel during concrete placement.
Before any steel reinforcement is embedded in the concrete, any loose mill scale, loose rust and any oil, grease or other deleterious matter shall be removed. Partially set concrete, which may adhere to the exposed bars during concrete placing operations, shall also be removed.

2.16.8 LATERAL REINFORCEMENT FOR COLUMNS

Spirals
Spiral reinforcement for columns shall conform to the following:

i. Spirals shall consist of evenly spaced continuous bar or wire of such size and so assembled as to permit handling and placing without distortion from designed dimensions.

ii. Size of spirals shall not be less than 10mm diameter for cast-in-place construction.

iii. The minimum and maximum clear spacing between spirals shall be 25mm and 75mm respectively.

iv. Anchorage of spiral reinforcement shall be provided by 1.5 extra turns of spiral bar or wire at each end of a spiral unit.

v. Splices in spiral reinforcement shall be lap splices of 48 spiral diameter, but not less than 300mm.

vi. Spirals shall extend from the top of footing or slab in any story to the level of the lowest horizontal reinforcement in members supported above.

vii. Spirals shall extend above termination of spiral to bottom of slab or drop panel, where beams or brackets do not frame in to all sides of a column.

viii. Spirals shall extend to a level at which the diameter or width of capital is 2 times that of the column, in case of columns with capitals.

ix. Spirals shall be held firmly in place and true to line.

Ties

Tie reinforcement for compression members shall conform to the following: i. All bars shall be enclosed by lateral ties, at least 10mm diameter in size for longitudinal bars 30mm diameter or smaller, and at least 12mm diameter in size for 35mm diameter to 55mm diameter and bundled longitudinal bars. ii. Vertical spacing of ties shall not exceed 16 longitudinal bar diameters or 48 tie diameters, or the least dimension of the compression members.

iii. Ties shall be arranged such that every corner and alternate longitudinal bar shall have lateral support provided by the corner of a tie with an included angle of not more than 135°. No vertical bar shall be farther than 150mm clear on each side along the tie from such a laterally supported bar. Where longitudinal bars are located around the perimeter of a circle, a complete circular tie is allowed.

iv. The lowest tie in any story shall be placed within one-half the required tie spacing from the top most horizontal reinforcement in the slab or footing below. The uppermost tie in any story shall be within one-half the required tie spacing from the lowest horizontal reinforcement in the slab or drop panel above.

v. Where beams or brackets provide concrete confinement at the top of the column on all (four) sides, the top tie shall be within 75mm of the lowest horizontal reinforcement in the shallowest of such beams or brackets.

Lateral reinforcement for beams

Compression reinforcement in beams shall be enclosed by ties or stirrups satisfying the size and spacing limitations as stated above. Such ties or stirrups shall be provided throughout the distance where compression reinforcement is required.

Lateral reinforcement for flexural framing members subject to stress reversals or to torsion at supports shall consist of closed ties, closed stirrups, or spirals extending around the flexural reinforcement. Closed ties or stirrups shall be formed in one piece by overlapping standard stirrup or tie end hooks around a longitudinal bar, or formed in one or two pieces laps, spliced with a lap of development length

2.16.9 SPACING OF REINFORCEMENT

The minimum clear spacing between parallel bars in a layer shall be equal to one bar diameter, but not less than 25mm.

Where parallel reinforcement is placed in two or more layers, bars in the upper layers shall be placed directly above those in the bottom layer with clear distance between layers not less than 25mm.

For compression members, the clear distance between longitudinal bars shall be not less than 1.5 bar

diameters or 35mm.
Clear distance limitation between bars shall apply also to the clear distance between a contact lap splice and adjacent splices or bars.
In walls and one-way slabs, the maximum bar spacing shall be three times the wall or slab thickness (h) but not more than 450mm.
For two-way slabs, maximum spacing of bars shall be 2h but not more than 450mm.
For temperature steel only, maximum spacing shall be 5h but not more than 450mm.

2.16.10 SPLICING

General
All reinforcement shall be furnished in the full lengths indicated on the Drawings unless otherwise permitted by the Engineer. Except for splices shown on the Drawings and splices for No. 5 or smaller bars, splicing of bars shall not be permitted without the written approval of the Engineer. Splices shall be staggered as far as possible.
Where the Drawings do not detail laps that will be necessary, the Contractor shall furnish working Drawings to the Engineer for his approval.
If such additional lap splices are approved, the extra weight occasioned by such lap splices shall not be included in the measurement of reinforcement for payment unless provided for in these Specifications.
Lapped splices
All splices for high yield strength steel bars shall have a lap length as shown on the Drawings or if not shown therein shall be in accordance with the American Concrete Institute Building Code Requirements for Reinforced Concrete (ACI 318-89).
All splices for mild steel shall have a lap length as shown on the Drawings or if not shown therein, of not less than 40 diameters of the smaller bar when hooks are used and 50 diameters for bars without hooks.
Lap splices shall not be used for 35mm diameter bars and larger, except when bars of different diameters are lap spliced in compression, the splice length shall be the larger development length of the larger bar, or the splice length of the smaller bar.
Lap splices of bundled bars shall be based on the lap splice length required for individual bars within the bundle, increased in accordance with development of bundled bars. Individual bar splices within a bundle shall not overlap. Entire bundles shall not be lap spliced.
Bars spliced by non-contact lap splices in flexural members shall not be spaced transversely farther apart than one-fifth the required lap splice length, nor 150mm.
Lap splices shall generally be located at points of minimum tension in bars. Except where otherwise shown on the Drawings, lap splices shall be made with the bars placed in contact and securely wired together.
Welded splices
Welding on Site shall be avoided wherever possible, but where suitable safeguards and techniques are employed and provided that the types of steel including high-yield steels to SS 2 have the required welding properties, it may be undertaken with the acceptance of the Engineer. Before welding any reinforcement, the Contractor shall supply to the Engineer a Welding Procedure Specification (WPS) and an example of the weld for the type of steel, connection and weld being proposed. If suchevidence is not available, the Contractor shall demonstrate satisfactory performance by means of testing as agreed by the Engineer. Unless satisfactory performance of the proposed welded connection is established by either of the two methods described above, approval for use of the welded connection shall not be given.
In addition, and as required by the Engineer, the competence of the operators shall be demonstrated prior to and periodically during welding operations by submission of independent Welder Qualification Records (WQR) for each welder to be used on Site.
Welding may be used in fixing reinforcement in position, for example, by welding between crossing or lapping reinforcement, or between bars and other steel members.
Welded intersections shall not be spaced farther apart than 300mm in the direction of calculated stress, except for wire fabric used as stirrups.

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Technical Specifications

Structural welding shall not be carried out unless specifically shown on the Drawings.
Notwithstanding the above, the Engineer will not permit tack welding of bars, which will be subject to fluctuating stresses in the completed structure.
Welding shall conform to the Structural Welding Code, Reinforcing Steel, AWS D 1.4 of the American Welding Society and applicable special provisions.
Welded splices shall be butted and welded to develop in tension at least 125 percent of specified yield strength fy of the bar. A full mechanical connection shall develop in tension or compression, as required, at least 125 percent of specified yield strength fy of the bar. Welded splices and mechanical connections not meeting the above requirements are allowed where area of reinforcement is at least twice that required by analysis shall meet the following: i. Splices shall be staggered at least 600mm and in such manner as to develop at every section at least twice the calculated tensile force at the section but not less than 140 N/mm2 for total area of reinforcement provided.
ii. Spliced reinforcement may be rated at the specified splice strength, in computing tensile force developed at each section. Non-spliced reinforcement shall be rated at that fraction of fy defined by the ratio of the shorter actual development required to develop the specified yield strength (fy).
Splices of deformed bars in tension
The minimum length of lap for tension splices shall be as required for Class A or B splice, but not less than 300mm, where the classification shall be as follows:
Class A splice..... 1.0Ld
Class B splice..... 1.3Ld
* Ld is the development length
Lap splices of deformed bars in tension, shall be Class-B splices except that Class-A splices are allowed when the area of reinforcement provided is at least twice that required by analysis over the entire length of the splice, and one-half or less of the total reinforcement is spliced within the required lap length.
Where area of reinforcement provided is less than twice that required by analysis, welded splices or mechanical connections used shall meet the following requirements. This is also applicable in case of splices in tension tie members those shall be made with a full welded splice or full mechanical connection. i. Welded splices shall be butted and welded to develop in tension at least 125 percent of specified yield strength fy of the bar.
ii. A full mechanical connection shall develop in tension or compression, as required, at least 125 percent of specified yeild strength fy of the bar.
Welded splices or mechanical connections used where area of reinforcement provided is at least twice that required by analysis shall meet the following: i. Splices shall be staggered at least 600mm and in such manner as to develop at every section at least twice the calculated tensile force at the section but not less than 140 N/mm2 for total area of reinforcement provided. ii. Spliced reinforcement may be rated at the specified splice strength, in computing tensile force developed at each section. Non-spliced reinforcement shall be rated at that fraction of fy defined by the ratio of the shorter actual development length to ld required to develop the specified yield strength fy.
Splices in adjacent bars shall be staggered at least 750mm.
Splices of deformed bars in compression The minimum length of lap for compression splice shall be 0.07 fy.db for fy equal to 410 N/mm2 or less or (0.13 fy – 24)db for fy greater than 410 N/mm2, but not less than 300mm. For f'c (specified compressive strength of concrete, N/mm2) less than 20 N/mm2, length of lap shall be increased by one-third.
When bars of different diameters are lap spliced in compression, the splice length shall be the larger of the development length of the larger bar, or the splice length of the smaller bar. Welded splices or mechanical connections used in compression shall also satisfy the following requirements: i. Welded splices shall be butted and welded to develop in tension at least 125 percent of the specified yield strength fy of the bar.
ii. A full mechanical connection shall develop in tension or compression, as required, at least 125 percent of the specified yield strength fy of the bar.
End bearing splices

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i. Compression splices for bars required to transmit compressive stress only, may consist of end bearing of square cut ends held in concentric contact by a suitable device.
ii. Bar ends shall terminate in flat surfaces within 1.5° of a right angle to the axis of the bars, and shall be fitted within 3° of full bearing after assembly.
iii. End bearing splices shall be used only in members containing closed ties, closed stirrups or spirals.
Special splice requirements for columns.
Lap splices, butt-welded splices, mechanical connections, or end-bearing splices shall be used with the limitations as stated below. A splice shall satisfy the requirements for all load combinations for the column.
Lap splices in columns
i. Lap splices shall conform to the first two requirements stated above under the Sub-section on 'Splices of Deformed Bars in Compression' and where applicable to (d) or (e) below where the bar stress due to factored loads is compressive.
ii. Where the bar stress due to factored loads is tensile and does not exceed 0.5fy in tension, lap splices shall be Class B tension lap splices, if more than one half of the bars are spliced at any section, or Class A tension lap splices, if half or fewer of the bars are spliced at any section and alternate lap splices are staggered by ld (development length).
iii. Where the bar stress due to factored loads is greater than 0.5fy in tension, lap splices shall be Class B tension lap splices.
iv. If spiral reinforcement confines the splice, the lengths required may be multiplied by 0.75, but lap length shall not be less than 300mm.
Welded splices or mechanical connectors in columns
Welded splices or mechanical connectors in columns shall also meet the following requirements. i. Welded splices shall be butted and welded to develop in tension at least 125 percent of specified yield strength fy of the bar. ii. A full mechanical connection shall develop in tension or compression, as required, at least 125 percent of specified yield strength fy of the bar.
End bearing splices in columns
End bearing splices complying with the requirements stated above under Sub-section on "End Bearing Splices' may be used for column bars stressed in compression provided that the splices are staggered or additional bars are provided at splice locations. The continuing bars in each face of the column shall have a tensile strength at least 0.25fy times the area of the vertical reinforcement in that face.
Splices of plain bars
For plain bars, the minimum length of lap shall be twice that of deformed bars.
Mechanical anchorage
Any mechanical device capable of developing the strength of reinforcement without damage to concrete is allowed as anchorage.
Mechanical device may be used only when its adequacy can be proven by test results to the satisfaction of the Engineer.
Development of reinforcement may consist of a combination of mechanical anchorage plus additional embedded length of reinforcement between the point of maximum bar stress and the mechanical anchorage.

2.16.11 SUBSTITUTIONS

Substitutions of different size bars shall be permitted only with specific authorization by the Engineer and at no additional cost to the Employer. If bars are substituted, they shall have a cross sectional area equivalent to the design area or larger.
The Contractor shall also provide, also in the case of substitutions, at his own expenses and to the approval of the Engineer, such necessary detailing of the reinforcement as he requires for the execution of the work to the Engineer's satisfaction.

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2.16.12 CONCRETE COVER TO REINFORCEMENT

Unless specified on the Drawings, the clear concrete cover to reinforcement shall be as tabulated below:

Description of Concrete Element	Clear Cover (mm)	
	Normal Exposure	Saline Water
Wall and footing		
a) Contact with earth	60	75
b) Expose to weather and water	50	60
Piles		
a) Cast-in-place	75	100
b) Pre-cast	40	50
Beam, Girder, Column	40	50
Building roof and floor slab	25	25

2.16.13 PROTECTIVE COATING

All exposed reinforcing steel at construction joints shall be protected with a brush coat of neat cement mixed to a consistency of thick paint within one week after the placing of the initial concrete, unless it is definitely known that the steel will be embedded within 30 days. This coating shall be entirely removed, by light tapping with a hammer or other tools, not more than one week before the placing of the final pour.

2.16.14 BUNDLED BARS

i. Groups of parallel reinforcing bars bundled in contact to act as one unit, shall be limited to four in any one bundle.
ii. Bundled bars shall be enclosed within stirrups or ties.
iii. Bars larger than 35mm diameter shall not be bundled in beams.
iv. Individual bars within a bundle terminated within the span of flexural members shall terminate at different points with at least 40 times the nominal diameter of bar staggered.
v. Where spacing limitations and minimum concrete cover are based on nominal bar diameter, a unit of bundled bars shall be treated as a single bar of a diameter derived from the equivalent total area.
vi. Minimum concrete cover shall be equal to the equivalent diameter of the bundle, but need not be greater than 50mm.

2.16.15 INSPECTION

The Contractor shall notify the Engineer when the steel has been placed in position and ready for concrete placing. No concrete shall be placed until the Engineer inspected the steel and given his approval in writing.

2.16.16 MEASUREMENT

The quantity of reinforcement to be measured under this Section shall be the computed weight in kilogram of material used and accepted as shown on the Drawings provided that the quantity shall not include the reinforcement in any item of works. In computing the weight to be measured, the theoretical weights of bars of the cross section shown in this Specification shall be used.
The computed weight shall not include the extra materials incurred, when bars larger than those specified are used or the extra materials necessary for splices, when bars shorter than those specified are used even with the permission of the Engineer. It shall not also include the weight of any devices used to support or fasten the reinforcement in correct position.

2.16.17 PAYMENT

This work measured as provided above, shall be paid for at the Contract unit price per kilogram of

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reinforcement for the particular Bill of Item. The payment shall be considered to be the full compensation for furnishing, fabricating, splicing and placing of the reinforcing steel, supports and binding wire, cutting and bending, all labours, equipment, tools and incidentals necessary to complete the works prescribed in this Section.

No separate payment shall be allowed for chairs, laps, splices, separators etc. The costs of these shall be considered included in the unit rate.

Item of Payment	Unit
Mild steel reinforcing bars	Kilogram
High yield steel reinforcing bars	Kilogram

2.17 WELDING

2.17.1 GENERAL

All welding shall be performed by certified welders and in accordance with the American Welding Society (AWS) D1.1 'Structural Welding Code' or similar approved standard.

The principal forms of welding metals are as follows:

i. Electric arc welding

ii. Gas welding

The electric arc welding process is the most important and is most extensively used for mild steels ranging from light articles with a wall or thickness of 16 gauge to heavy fabrications. This is a process whereby the metal of the two members to be welded is fused together through hit generated by an electric arc. Fusion should be complete over the whole area of the joint surface.

Gas welding is done using oxy-acetylene flame and is not adapted to structural steel works, but is generally used for small jobs. The flame produced by burning oxy-acetylene is fed through a blowpipe, which is ignited at its tip. The flame is played on the two pieces to be welded until the metal becomes hot enough to fuse together adding additional metal to the joint as necessary by melting in to it a suitable electrode.

Unless otherwise specified, all welding shall be performed following the Shielded Metal Arc Process with low hydrogen electrodes for manual welding.

The Contractor shall be responsible for the quality of the welding performed by his welding organization. All welding by the Contractor shall be carried out by the electric arc method using coated electrodes or other means whereby the air is excluded from the molten metal and where applicable, automatic machines with correct procedure control shall be used.

2.17.2 WORKMANSHIP AND VISUAL QUALITY REQUIREMENTS

In addition to conforming with the procedural and quality requirements set forth in the Structural Welding Code and/or these Specifications, all manual welding shall meet the following requirements for workmanship and visual quality.

i. Each weld shall be uniform in width and size throughout its full length and each layer of welding shall be smooth, free of slag, cracks, pinholes and undercut and shall be completely fused to the adjacent weld beads and base metal. In addition, the cover pass shall be free of coarse ripples, irregular surface, non-uniform bead pattern, high crown, deep ridges or valleys between beads and shall blend smoothly and gradually into the surface of the base metal.

ii. Butt Welds shall be slightly convex, of uniform height and shall have full penetration.

iii. Fillet Welds shall be of specified size with full throat and with each leg of uniform length.

iv. Repair, chipping or grinding of welds shall be done in such a manner as not to gouge, groove, or reduce the base metal thickness.

2.17.3 WELDING REPAIRS

All weld defects which are determined unacceptable, shall be removed by chipping, grinding, arc or flame

gouging, following which the area shall be properly prepared for welding, repaired by an approved qualified welding procedure and re-tested as necessary. The Contractor shall establish the cause of all defects and show that such defects have been corrected before welding will be permitted. All repairing shall be done by and at the expenses of the Contractor.

2.17.4 PEENING

The Contractor shall not be allowed to peen welds without prior approval of the Engineer.

2.17.5 ELECTRODES

All electrodes shall be purchased in sealed containers and shall be thoroughly dry when used. Electrodes, taken from sealed containers, shall be used within four hours. Electrodes not used within four hours shall be stored in electrode storage ovens. The electrode storage oven temperature shall be in accordance with the electrode manufacturer's recommendations. Electrodes with wet or damaged coatings shall not be used.

A simple test indicates the quality of an electrode or welding or welding wire can be made by laying the wire flat on a clean surface and applying the welding flame to it for a distance of about 8 - 10cm by moving the flame backward and forward until the wire becomes red and then slowly melting the wire, moving the flame in such a manner so that the wire melts only half-way through its diameter. If the flame is withdrawn as soon as the rod metal begins to melt, the impurities can readily be seen being thrown off in the form of sparks, or a boiling action in the case of inferior metal. When cold, an inferior metal will contain numerous spongy, volcano-like irregularities. A good metal welding rod will melt and flow evenly without any disturbing actions.

Cracks may occur in welding alloy steels owing to the rapidity with which these harden. This may largely be avoided by preheating the parent metal at 300oC or above in advance of welding to lower the normal cooling rate.

The maximum diameters of electrodes for welding have been shown in the following table:

Average thickness of plate or section	Maximum gauge or diameter of electrode to be used
Less than 5mm	3.2mm – 10 SWG
5mm to Less than 8mm	4mm – 8 SWG
8mm to Less than 10mm	5mm – 6 SWG
10mm to Less than 16mm	6mm – 4 SWG
16mm to Less than 25mm	9mm
25mm and over	9mm

The maximum width of any bead of welding, other than a cover pass, shall not exceed 3 times the diameter of the electrode being used.

Subject to the approval of the Engineer, electrodes shall be carefully selected in order to provide metal welds with mechanical properties similar to those of the metal being welded, except that for welding higher strength steel to lower strength steel, the electrodes shall be chosen to provide metal welds with mechanical properties comparable to those of the lower strength material.

2.17.6 CUTTING AND EDGE PREPARATION

Members of structural steel and miscellaneous metal works, which are to be joined by welding shall be cut accurately to size and where required, shall be rolled or pressed to the proper curvature in accordance with dimensions shown. The edges of these members shall be sheared, flame-cut or machined to suit the required type of welding and to allow thorough penetration. The cut surfaces shall expose sound metal, free from laminations, surface defects caused by shearing or flame-cutting operations, or other injurious defects. The surface to be welded shall be free from rust, grease, paint and other foreign matter for a distance of at least 150mm back from the edge of the weld.

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2.17.7 GRINDING WHEELS

Grinding wheels, which leave a deposit detrimental to subsequent welding will not be permitted. Grinding wheels, which are determined by the Engineer to be detrimental to welding shall not be used.

2.17.8 QUALIFICATION OF WELDERS AND WELDING OPERATORS

All welders and welding operators assigned to the work shall have passed the qualification test for welding operators as specified in the AWS Structural Welding Code. If, as determined by the Engineer, the work of any welder appears questionable, such welder will be required to pass additional qualification tests to determine his ability to perform the type of work on which he is engaged. Such additional qualification tests for welders and the physical tests of the welded specimens shall be made in the presence of the Engineer. If required, the Contractor shall furnish to the Engineer a certified copy of reports of the results of physical tests of specimens welded in the qualification tests. Fulfillment of such qualification shall be at the expenses of the Contractor.

2.17.9 WELDING METHODS

General

Methods which are essentially required to be followed while welding are as follows:

i. Welds should be made in the flat position as far as practicable.

ii. Freedom of movement of one member should be allowed as far as possible.

iii. The work should be securely held in position by means of spot welds, service bolts, clamps or jigs before commencing welding so as to prevent any relative movement due to distortion, wind or other causes.

iv. The parts to be welded must be thoroughly cleaned and proper flux used. Any paint or rust and loose mill scales, etc. should be removed from the surfaces to be welded and surrounding materials for a distance of at least 12mm from the weld. A coating of boiled linseed oil may be permitted. Steel to be welded should not be painted or oiled until after erection, unless all ends to be welded are left bare.

v. The sequence of welding should be such that when possible the members, offering the highest resistance to compression, are welded first.

Extreme care shall be taken to ensure that correct welding sequences and procedures are observed to avoid any strains and internal stresses arising in welding.

Welding of stainless steel

Unless otherwise specified, all welding shall conform with AWD D1.1. Electrodes used for welding of stainless steel shall be Series E308 and electrodes used for welding of stainless steel to carbon steel shall be Series E309.

Welders and welding operators assigned to the work shall have passed the qualification test for welding operators as specified above under 'Qualification of Welders and Welding Operators' of this Sub-section.

Welding of reinforcement

Electric Arc Butt-welding is most suitable for bars of diameter greater than 20mm and lap welding for smaller diameters and lap welding with longitudinal beads for 6mm to 40mm diameters. However, reinforcement, specified to be welded, shall be welded by any process the Contractor can demonstrate by bend and tensile tests, which will ensure that the strength of the parent metal is not reduced and that the weld possesses a strength no less than that of the parent metal. The welding procedure established by the successful weld tests shall be maintained and no departure from this procedure shall be permitted.

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Following the establishment of a satisfactory welding procedures, each welder to be employed on the work shall carry out welder performance qualification tests on reinforcing bars of the same metal and size as those on the works.
Welds in positions other than those shown on the Drawings and/or as directed by the Engineer shall not be permitted.

2.17.10 DEFECTS IN WELDED JOINTS

The usual defects in welded joints are:

i. Lack of penetration or fusion of the metal to the bottom of the joint or welded members

ii. Laps in the metal of the weld not properly fused together. Defects are most likely to occur at the root of the weld and in this position they are liable to have the maximum effects in reducing the strength of the weld.

2.17.11 INSPECTION AND TESTING OF WELDS

The metal in a good weld when cold should show its original color. If the metal has a rusty or dull red color or appears crystallized, it is an indication that the heat has become too high and the metal has been burnt. A good weld will show an evenness of ripples or waves and well-formed beads with good fusion along the edges of the welds. There should be no unfilled cavities, small pockets of slags or burnt metal and small air or gas pockets. The strength of a welded joint may be taken only about 75 per cent of the stress usually allowed for common works, although tests have shown that if the welding is properly done it is possible to develop the full strength of the members jointed. The following tests shall be carried out on the procedure, qualification, test plates and production test plates:

i. Tensile and bend tests: all welds shall be subject to visual inspection.

ii. The procedures of visual examination shall conform to the requirements of the ASME Boiler and Pressure Vessels Code.

The following defects are unacceptable unless otherwise noted:

i. Dimensional defects such as insufficient throat or leg length, excess convexity, excess or insufficient reinforcement.

ii. Undercuts, overlap, blowholes, slag inclusion, seams and excess weave.

iii. Any crack or liner indication. Plates with laminations discovered during gas cutting, welding or any other time shall be rejected, unless approval to repair the plate is obtained from the Engineer. Welds may also be subject to anyone or a combination of the examinations as may be required to establish the soundness of welds. The inspection procedures for testing of all welds shall be prepared on the above basis by the Contractor and submitted to the Engineer for approval before any fabrication work is started.

2.17.12 MEASUREMENT AND PAYMENT

Welding shall not be measured and no direct payment shall be made. All costs of welding shall be deemed included in the related items of the Bill of Quantities unless otherwise it has been specifically mentioned in the BOQ.

2.18 EXCAVATION AND BACK-FILL FOR STRUCTURES

2.18.1 DESCRIPTION

2.18.2 MATERIALS

This item of work shall consist of excavation in any type of soil/material for the foundation of structures, disposal of excavated materials, construction and removal of cofferdams, sheeting and other temporary works in protecting the stability and safety of the excavated foundations, pumping, de-watering/bailing water from foundations, back-filling of completed structures with suitable backfill.
No separate payment shall be made for the excavation and back-fill for structures when the works will involve use of cofferdams. The costs of this temporary work shall be deemed included as part of the Tender sum.
The Work shall be carried out at the locations and according to the lines, levels, grades and dimensions shown on the Drawings, stated in the BOQ and/or as directed by the Engineer.

2.18.3 EXCAVATED MATERIAL

The Engineer shall classify all excavated materials either as suitable for fill or as waste.
Approved suitable excavated materials free from large lumps, wood or other objectionable materials shall be placed as back-fill above the level of pile except where other materials are shown on the Drawings, stated in the BOQ and/or required by the Engineer

2.18.4 ORDINARY FILL

Ordinary fill consists of earth having Liquid Limit not exceeding 50 and Plasticity Index not exceeding 20, as determined by AASHTO T89 & T90, and shall be used as back-fill material above the level of pile caps and areas except where other materials are shown on the Drawings, stated in the BOQ and/or required by the Engineer.

2.18.5 SAND

Unless otherwise stated on the Drawings or in the BOQ or ordered by the Engineer, back-fill material below the top level of pile caps shall consist of sand free from chemical contamination with not more than 10% of the material passing the No. 200 sieve (U.S. size). All other specifications should conform to what have been illustrated under the relevant Sub-section of this Specification. The sand to be used shall be approved by the Engineer prior to placing.

2.19 BLINDING CONCRETE

Blinding concrete shall be placed as backfill as shown on the Drawings, stated in the BOQ and/or ordered by the Engineer. The material shall conform to the specifications stated below:

2.19.1 CEMENT

Cement shall conform to the requirements of ASTM specification C 150 Type 1 or similar approved standard for normal Portland cement.
Cement shall be free from any hardened lumps and foreign matter. It shall have a minimum of 90% of particles by weight passing the 75-micron sieve, an initial setting time in excess of 45 minutes and a final setting time of not more than 375 minutes.
All other specifications should conform to what have been illustrated under the relevant Sub- sections of this Specification.

2.19.2 COARSE AGGREGATE

Except otherwise stated, coarse aggregate shall consist of hard, durable angular fragments of crushed stone and/or crushed natural gravel conforming all other specifications illustrated under the relevant Sub-section of this Specification.

2.19.3 FINE AGGREGATE

All specifications should conform to what have been illustrated under the relevant Sub-section of this Specification.

2.19.4 WATER

Water shall be subject to the approval of the Engineer and shall be reasonably clear, free from oil, alkali, salts, acid and organic substances and other deleterious materials or objectionable quantities of suspended materials. All other specifications shall be in accordance with the requirements illustrated under the relevant Sub-section of this Specification

2.19.5 CONSTRUCTION METHODS

2.19.5.1 EXCAVATION

The Contractor shall notify the Engineer before commencing excavation of the foundation trenches so that the cross-section, elevations and measurements of the undisturbed ground may be taken. The natural ground adjacent to the structure shall not be disturbed without taking any permission from the Engineer. Trenches and foundation pits for structures shall be excavated to the lines, grades and elevations as shown on the Drawings or as directed by the Engineer. The elevations of the bottom of the foundations shown on the Drawings are approximate only and the Engineer may order such changes as deemed necessary to provide a secured foundation.

Where unstable soil is encountered at the bed level, it should be brought to the notice of the Engineer and all such unstable soil shall be removed as directed and replaced with suitable materials to provide adequate support for the structure.

On acceptance of the materials forming the bottom of any excavation by the Engineer subsequently becoming unacceptable to him due to exposure to weather condition or due to flooding or have become puddled, soft or loose during the work process, the Contractor shall remove such damaged, soft, or loose materials and make additional excavation as per requirement. Such additional excavation shall be held as excess excavation and the cost of the excess excavation and subsequent replacement with a suitable back-fill shall be at the expenses of the Contractor.

Any erroneous excavation or excess excavation for the conveniences of the Contractor, or over excavation performed by the Contractor for any purpose or reasons shall be at the expenses of the Contractor. If the excavation for foundations exceeds the depths specified, the Contractor shall bring it back to the specified levels with sand, mass concrete or other approved materials conforming Standard Specifications at the Contractor's own expenses.

Excavation shall be sufficiently large to provide necessary working space, shuttering and any other Temporary Works required during construction.

Boulders, roots and any other objectionable materials encountered in excavation, shall be removed. The excavated foundation shall be cleared of all loose materials and cut to a firm surface.

When the footing is to rest on the ground and not on piles, special cares shall be taken not to disturb the bottom of the excavation and excavation to final grade shall be deferred until immediately before the footing is placed. If foundation fill material is required, it shall be placed and compacted in layers not more than 150mm thick or as directed by the Engineer. The dry density on compaction within 300mm below the top level shall not be less than 100% maximum dry density as determined in accordance with AASHTO T99 or ASTM D698.

In excavating foundation trenches, the last 150mm layer shall not be excavated until immediately before commencing the construction work except that the Engineer shall instruct otherwise. Any damages to the work due to the Contractor's operation shall be repaired at the expenses of the Contractor.

The Contractor shall be solely responsible for the safety and stability of the excavation and shall provide all protective supports, bracing, sheet piles, shoring etc. as required. Shoring should be adequate to provide enough safety to all the adjacent structures and land.

Excavated materials, classified as suitable for fill, shall be stockpiled. Waste materials and suitable fill

materials in excess of requirement, shall be disposed of by the Contractor outside the limits of the Site.
The foundation material shall be cleared of all loose and displaced materials and cut to a firm surface, either leveled, stepped or serrated, as specified or shown on the Drawing or directed by the Engineer leaving a smooth solid bed to receive foundation.
No footing, bedding material or structure shall be placed on any foundation until the Engineer has inspected and approved the depth of excavation and the foundation materials.

2.19.5.2 POOR FOUNDATION MATERIAL

When, in the opinion of the Engineer, the bottom of any excavated foundation is of soft or otherwise unsuitable material, the Contractor shall remove the unsuitable material and fill with sand or blinding concrete at the direction of the Engineer. The sand or concrete shall be placed following the procedures specified for back-filling. Sand shall be clear, all passing a No.4 sieve (U.S. size).
When the ground between the piles is too soft to support the green concrete, the Contractor shall submit his proposal for a bottom form to the Engineer for his approval. Extra excavation and foundation-fill or concrete-fill in such case will not be paid separately.
If the bottom form is carried out by strengthening the ground in the aforementioned way, the Contractor shall, if requested, submit calculations showing that the pile cap will not be harmed during hardening due to differential settlement between the piles and the strengthened ground.

2.19.5.3 DISPOSAL OF EXCAVATED MATERIAL

All excavated materials, so far accepted by the Engineer as suitable, shall be utilized as back-fill or embankment-fill. The surplus materials shall be termed as waste.
Excavated materials, suitable for use as back-fill, shall be deposited by the Contractor in spoil heaps at points convenient for re-handling of the materials during the back-filling operations.
Excavated materials shall be deposited in such places and in such a manner as not to cause damage to roads, services or properties either within or outside the project area and so as to cause no impediment to the drainage of the Site or surrounding areas. The location of spoil heaps shall be subject to the approval of the Engineer.
Waste materials shall be disposed of in accordance with the instruction of the Engineer.

2.19.5.4 PUMPING AND BAILING

The foundation shall be kept free from water at all times during the construction period. The ground water level shall be maintained at a minimum of 0.9m below the lowest designed excavation level.
Pumping and bailing from any foundation shall be done so as to preclude the possibility of the movement of water through or alongside any concrete being placed. No pumping or bailing will be permitted during the placing of concrete and for at least 24 hours thereafter, unless it is done from a suitable sump separated from the concrete work by a watertight wall or from well points.
The Contractor shall be solely responsible and include in his rates all costs in designing the de-watering system, providing all equipment and accessories required for de-watering. The rates shall also include cost for transportation, furnishing, installation, safe operation and maintaining of the system including operators, mechanics, the supply of power, fuel, lubricants, spares, repairing, etc. throughout and the removal of the equipment at the end of the construction period under this Contract.
Excavations shall be as dry as possible prior to and during placing concrete. Placing of concrete under water will only be permitted if indicated on the Drawings or approved by the Engineer.

2.19.5.5 BACK-FILLING

All excavated spaces shall be back-filled around the permanent structure to original ground level. Prior to placing back-fill, all trash, metal, debris, lumber, bricks, soft materials and similar objectionable foreign materials shall be removed from the area to be back-filled. No back-fill shall be placed against any structure without the prior permission of the Engineer.
Any protective support, bracing or shoring shall be removed, as the back-filling progresses in such a manner as to prevent caving-in.

Back-fill shall be of approved materials that will produce a dense and well-compacted filling. The material shall be free from large lumps, organic or extraneous materials.
Ordinary fill placed as back-fill shall be laid and compacted. The moisture content of the fill materials, before compaction, shall be within + 5% of the Optimum Moisture Content. Each layer of materials shall be compacted uniformly using approved compaction equipment and procedures. The materials shall be compacted to achieve not less than 90% Maximum Dry Density (STD) beneath the bottom level. The dry density, after compaction within 300mm below the top level, shall not be less than 95% Maximum Dry Density as determined in accordance with AASHTO T99 or ASTM D698 and soaked CBR (4 days) should be greater than 4% at 95% Maximum Dry Density. The compacted layer shall be approved by the Engineer before the Contractor can commence a new layer.
Sand back-fill shall be placed and thoroughly compacted in layers of not more than 150mm. Sand should be clear, all passing a No. 4 U.S. Standard Sieve and conforming generally to ASTM C 144 for fine aggregate with F.M. not less than 1.2 or as required by the Engineer.
Layers of filling shall be tested as directed by the Engineer. Each compacted layer shall not be covered until the Engineer is satisfied that the specified degree of compaction has been achieved.
In placing back-fill, the materials shall be placed in, as far as possible, to approximately the same height on each side of the structure. If conditions require appreciable higher back-filling on one side, the additional materials shall not be placed until permission is given by the Engineer on being satisfied by himself that the structure has enough strength to withstand any created pressure.
In general, no structure shall be subject to the pressure of back-filling until 3 (three) days on expiry of the period designated for removal of forms. This period shall be extended if abnormal curing conditions exist
Adequate provisions shall be made for drainage during placing back-fill.

2.19.5.6 COFFERDAM

The term "cofferdam" denotes any temporary or removable structure, constructed to hold the surrounding earth, water or both, out of the excavation whether such structure is constructed of earth, timber, steel, concrete or any combination of these. The term includes earth dikes, timber cribs, sheet piling, removable steel shells and all bracings and it shall be understood to include excavation enclosed by pumping wells and well points.
Cofferdams shall be constructed so as to control water to preclude sliding and caving-in of the walls of the excavation.
The interior dimensions of cofferdams shall be such as to give sufficient clearance for the construction and removal of any required forms and the inspection of the interior and to permit pumping.
If possible, cofferdams shall be so designed that no cross bracing shall be left in place. If this is not possible, bracing left in place shall be of structural steel. The end of such structural members that would be exposed when the structure is completed shall be boxed back at least 50mm behind the face. The resulting holes shall be completely filled with concrete.
In general, sheet-piling cofferdams shall extend well below the bottom of the footings and shall be well braced and made maximum watertight.
When conditions are encountered which, in the opinion of the Engineer, render it impossible to dewater the foundation before placing of brickwork or concrete, the Engineer may require the construction of a concrete foundation or seal. This shall be placed as directed by the Engineer. The foundation shall then be de-watered and the footing placed.
When foundation piles are to be driven inside a cofferdam and it is judged impossible to de-water the cofferdam before placing concrete, the excavation may be extended below the design level to a depth sufficient to allow for swell of the materials during pile driving operations. Any materials that rise above the design level shall be removed.
Where it is possible to de-water the cofferdam, the foundation materials shall be removed to exact grade after the foundation piles are driven.
The natural streambed adjacent to the cofferdam shall not be disturbed without the permission of the Engineer. Any excavation adjacent to the cofferdam shall be back-filled to the original ground level to the

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satisfaction of the Engineer.
Unless otherwise provided, cofferdams shall be removed on completion of the structure without disturbing or marring the finished work. The Engineer may order the Contractor to leave any part or the whole of the cofferdam in place and this shall not entitle the Contractor to claim for any additional payments.
The Contractor shall submit Drawings showing his proposed methods of cofferdam construction. However, the Contractor shall remain fully responsible for the adequacy of the design for strength and stability and for the safety of the people working therein.

2.19.6 MEASUREMENT

The volume of excavation and back-fill shall be measured in cubic meter.
The quantity of excavation for structures to be measured for payment shall include excavation for all structures. Back-filling with previously excavated materials shall not be measured or paid for separately but shall be deemed included within the rate for excavation.
Volumes to be excavated for blinding concrete shall not be measured and the price for the excavation thereof shall be included in the above measured item for excavation and back-fill.
Back-fill with concrete or sand, where directed by the Engineer, including concrete seals shall be measured separately as the volume within the plan outline and top and bottom surfaces. Concrete or sand, placed to back-fill excavation beyond the excavation required, will not be measured for payment.
If sand fill is ordered over top level of pile cap, the fill shall be the specified filling volume measured on the Drawings up to the profiles agreed upon in writing by the Engineer.
Removal of cofferdams, slides, silting or filling, if required, shall neither be measured nor paid for

2.19.7 PAYMENT

The work measured shall be paid for at the Contract unit prices per cubic meter as shown in the Bill of Quantities. The payment shall be the full compensation for all excavations and back-filling for structures including supply of all materials, labor, equipment, tools and incidentals necessary to the successful completion of the work.
The payment shall also be the full compensation for excavation and subsequent back-filling of working space around the foundation structure for shoring and other protective supports, for construction and removal of cofferdams, for de-watering and for disposal of surplus excavated materials by hauling to any distance at approved locations.
Should it be necessary, in the opinion of the Engineer, to lower the footings to an elevation below the level shown on the Drawings, payment for the excavation and backfill for structures required below plan level down to and including an elevation 1.5m below plan level for any individual footing will be made at a unit price equal to 115% of the Contract unit price and payment for the excavation from an elevation greater than 1.5m below plan level down to and including an elevation 3m below plan level will be made at a unit price equal to 125% of the Contract unit price for "Excavation and Back-filling for Structures". No additional extra compensation will be allowed for any required cofferdam adjustments arising from such lowering of footings.
In case where the extra depth required for any footing or footings exceeds 3m, a supplementary agreement shall be made covering the quantities recovered from depths in excess of 3m below the plan grade.
Payment for Back-filling shall be included in the pay item for "Excavation and Back fill for Structures" except for sand fill and concrete fill. These fill types shall be measured as provided above and paid for at the concerned Contract unit prices. However, no compensation shall be made for less Back-filling with excavated materials or more surplus to waste in the pay item of "Excavation and Back-filling for Structures".
All payments for the Back-filling and compaction of those areas, which were removed as structural excavation shall be included in the appropriate unit rates as shown below:

Item of Payment	Unit

Excavation and back-fill for structures	Cubic meter / Cubic feet
Concrete back-fill for structures	Cubic meter / Cubic feet
Sand back-fill for structures	Cubic meter/ Cubic feet

2.20 EARTH FILLING AND SAND FILLING

EARTH FILLING

2.20.1 DESCRIPTION

This work shall consist of filling any place by furnishing, placing, compacting and shaping suitable earth material of acceptable quality obtained from approved sources to make up levels to the lines, levels, grades, dimensions and cross sections in accordance with these specifications and as shown on the Drawings and/or as instructed by the Engineer.

2.20.2 MATERIALS

All fill materials shall be free from roots, sods or other deleterious materials. All fill materials shall be stockpiled outside the working areas. Materials shall be tested and approved by the Engineer. The selected fill so stockpiled, shall satisfy the following criteria:

i. Liquid limit of fraction passing 425-micron sieve shall not exceed 50% as determined by AASHTO T89.

ii. Plasticity index of fraction passing 425-micron sieve shall not exceed 20% as determined by AASHTO T90.

iii. The dry density after compaction in layers more than 300mm below top level shall not be less than 90% of the maximum dry density as determined in accordance with AASHTO T99 or ASTM D698.

iv. The dry density after compaction within 300mm below the top level (or such greater depth if shown on the plans and drawings) shall not be less than 95% maximum dry density as determined in accordance with AASHTO T99 or ASTM D698.

v. Soaked (4 day) CBR greater than 4% at 95% MDD. The moisture content at the time of compaction shall be the optimum moisture content ± 5%. Sampling to be carried out as per ASTM D 75 and D 3665.

2.20.3 CONSTRUCTION METHODS

Prior to placing any fill upon any area, all clearing and grubbing operations shall be completed following the procedures stated below.

The original ground surface should be prepared by scarifying, watering, aerating and compacting. The dry density after compaction shall not be less than 90% of MDD (STD).

Filling in swamps or water shall be carried out as indicated on the Drawings and as described in these Specifications. The Contractor shall, when ordered by the Engineer, excavate or displace swampy ground and backfill with suitable materials. Such backfill shall be river or beach sand unless otherwise directed by the Engineer.

The materials that are borrowed from canals or other waterlogged areas for use as fill material, being saturated, shall initially be stockpiled to drain the excess water before placing it in the designated areas

CLEARING

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Technical Specifications

Clearing shall consist of the removal and disposal of everything above foundation level except those the Engineer directs are to be left undisturbed. The materials to be cleared shall include but not necessarily be limited to trees, stumps, logs, bush, undergrowth, grass, crops, loose vegetable matter and structures unless provided elsewhere.

All tree stumps shall completely be removed within the limits of earthwork.

Clearing shall also include the removal of existing fences, remnants of buildings, etc

GRUBBING

Grubbing shall be confined to major roots beneath the excavations. In agricultural areas where the ground has been formed into ridges of dikes, the ground shall be roughly leveled or graded to form a surface suitable for filling and to the satisfaction of the Engineer.

OWNERSHIP OF CLEARED MATERIALS

All cleared materials shall, unless otherwise provided for in the Contract, be the property of the Department.

SPREADING AND COMPACTION OF EARTH FILL

Earth carried from outside shall be placed on the land to be developed in horizontal layers and each layer shall not exceed a loose thickness that is required to obtain a compacted thickness of 150mm. The earth of each basket is to be placed near to the earth placed before it and spread systematically. The Contractor shall not be allowed to throw earth in heaps.

The materials to be compacted shall be deposited in horizontal layers on the land to be developed with a loose thickness as stated above. The clods of earth shall be broken down to a maximum size of 25mm by striking the clods with the back of a spade or by using wooden drag or ladder or by any other suitable means before the next basket of earth is thrown close to it. Distribution of materials shall be made in such a way that the compacted materials will become homogeneous and free from lenses, pockets, streaks or other imperfections. Excavating and placing operations shall be such that the materials, when compacted, will be blended sufficiently to secure the best practicable degree of compaction, impermeability and stability and for this purpose the preceding compacted layer shall be scarified before placing a new layer.

All fill materials shall generally be compacted mechanically. However, under some special circumstance and when specifically allowed under the BOQ, the fill may be allowed to be compacted manually.

If the density measurement checks fall below the specified density level, re-compacting shall be required irrespective of the field compaction trial results. The Contractor shall be carried out such works

Earth fill materials, which does not contain sufficient moisture requirement for compaction in accordance with the requirements of this Sub-section shall be reworked and watered as per direction of the Engineer. The Contractor shall carry out this work at his own expenses.

Earth fill materials containing excess moisture shall be reworked and dried prior to or during compaction. Drying of wet materials shall be performed by methods proposed by the Contractor and approved by the Engineer at the expenses of the Contractor.

Compaction of every layer shall have to be approved by the Engineer. In the event the Contractor fails to obtain the approval of the Engineer of a fill layer, the materials above the unsatisfactory layer shall be removed and the unsatisfactory layer shall be re-compacted to satisfy the specifications at the expenses of the Contractor.

MANUALLY COMPACTED FILL

Fill shall be placed and compacted in layers for 150mm maximum compacted thickness, uniformly spread and compacted over the fill area of each layer. If for any reason, progress in compaction of the fill is interrupted for any unreasonable time, the surface area of the fill shall be scarified or ploughed before compaction continues. Each layer shall be compacted, using controlled manual compaction methods to achieve at least 85% of the Standard Proctor maximum dry density.

Compaction of every layer shall have to be approved by the Engineer. In the event the Contractor fails to obtain the approval of the Engineer of a fill layer, the materials above the unsatisfactory layer shall be removed and the unsatisfactory layer shall be re-compacted to satisfy the specifications at the expenses of the Contractor.

Under special circumstances and if directed by the Engineer, the Contractor shall excavate 5 to 10 trial

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pits each of size 2m long, 1m wide and 2m depth or to a depth of the improved land (whichever is less) at random spacing to test the degree of compaction. The size of voids encountered shall not exceed 5 cm in diameter and the number of voids shall be less than 10 per square meter.

PROCEDURES FOR MANUAL COMPACTION

The earth shall be compacted manually using concrete drop hammers each weighing 6 kg to 7 kg, fitted with a shaft of about 1.5m long. Ramming shall reduce the voids and shall continue until no further shrinkage of earth is possible by ramming.

Before commencing ramming, the moisture content of the soil shall be increased or decreased as per requirement by sprinkling the soil with water or by allowing natural drying of the soil as applicable so as to ensure that the materials shall have a moisture content of not less than 5% or greater than 5% dry of the optimum moisture required for the purpose of compaction. Both wetting and drying may be aided by furrowing the fill and then re-spreading when the moisture content is suitable.

If the moisture content exceeds the aforementioned tolerance, the compaction operations shall not proceed until the material is wetted or allowed to dry out, as the case may be to obtain optimum moisture content within the permitted tolerances. However, there may be an exception with a specific approval of the Engineer. No adjustment in price shall be made on account of any operations of the Contractor related to wetting or drying the materials or on account of any delays occasioned thereby.

The preceding operations shall continue layer after layer until the top of the filling is reached.

MECHANICAL COMPACTION

In the case of mechanical compaction, area of development, designated on the Drawings or by the Engineer, shall be compacted to the lines and grades shown on the Drawings or established by the Engineer. The Contractor's operations in importing materials, designated for use, shall be such as will result in an acceptable gradation of material when placed as determined by the Engineer.

Just prior to and during placement operations, the materials shall have a moisture content of not greater than 5% wet or less than 5% dry of the optimum moisture required for the purpose of compaction, as determined by Test No. 12 of BS 1337 and approved by the Engineer. The materials shall be so worked as to have uniform moisture content throughout the entire layer.

If the moisture content exceeds the aforementioned tolerance, the compaction operations shall not proceed until the materials are wetted or allowed to dry out, as the case may be to obtain the optimum moisture content within the permissible tolerances. However, there may be an exception with a specific approval of the Engineer. No adjustment in price shall be made on account of any
operations of the Contractor related to wetting or drying the materials or on account of any delays occasioned thereby.

When the material has been conditioned and placed as specified or directed, it shall be compacted with appropriate motorized vibratory compaction equipment or tampers of adequate weight and size as approved by the Engineer. Each layer shall be compacted to obtain at least 98% compaction of the maximum dry density. If the test results show that the density has not met the requirement, the Contractor shall have to carry out further compaction until the required density is achieved. The insitu dry density of the compacted fill shall be determined by the Sand Replacement Method described in Test No. 15 of BS 1377 or by other similar approved tests at locations as ordered by the Engineer.

2.20.4 MEASUREMENT

Measurements for earth filling works shall be taken for payment in cubic meters on cross sections compacted and accepted in place. The volume to be measured will be the net volume of required and accepted filling, actually constructed and completed in accordance with the Specifications, to the lines, levels and cross sections required as per the Drawings or such other dimensions as directed by the Engineer. This stipulation of volume determination will be regardless of the method of excavation, filling, re-sectioning and backfilling at structures or type of materials.

The cross sections to be used shall be measured by pre-work (after clearing and stripping) and post- work field surveyed sections. Pre-work sections of the portion of the work allotted to the Contractor, computed through survey works, shall be signed by the Contractor before executing the works for retention by the

Engineer.

2.20.5 PAYMENT

The unit rate paid per cubic meter for earth filling shall be in accordance with the Contract unit price, which payment shall constitute the full compensation for furnishing all materials and providing all labor, tools and equipment and works as specified. The rate shall also include costs of all other items related therewith and all incidentals, which may need to be completed to execute the work strictly in accordance with the Specifications and/or as per the directions of the Engineer.

Costs of all works and the cost of lead, lift or carriage shall be included in the unit rates for the relevant item of earth filling works of the BOQ of the Contract. Unless otherwise specified, no royalties will be paid for the purchase of earth from a private land regardless of its distance from the Site. No additional payment shall be made for purchasing a land and excavating the fill outside the rate agreed in the Contract for the item of earth filling works.

No direct or separate payment shall be made for works required under the other sub-items of this item. Costs for such works shall be deemed to have included in the related items of the BOQ.

Payment shall only be made when all works have been completed in accordance with the designed sections satisfying all specifications and accepted by the Engineer.

Item of Payment	Unit
Earth filling	Cubic meter/ Cubic feet

SAND FILLING

2.20.6 DESCRIPTION

This work shall consist of filling in foundation trenches, inside plinth or at any other places by furnishing, placing, compacting and shaping suitable sand of acceptable quality and F.M. to make up levels to the lines, levels, grades, dimensions and cross sections in accordance with these specifications and as shown on the Drawings or BOQ and/or as instructed by the Engineer

2.20.7 MATERIALS

Materials shall be of natural sand free from vegetable matters, from soft particles and from clay. F.M. of sand shall be in accordance with the stipulations of the BOQ or as per the direction of the Engineer.

All fill materials shall be stockpiled outside the working areas. Materials shall be tested and approved by the Engineer. The selected sand fill so stockpiled, shall satisfy the following criteria:

i. The fraction passing the 425-micron sieve shall have a Plasticity Index not greater than 10 (AASHTO, Soil Classification A-2-4).

ii. The material shall have a soaked CBR value not less than 8% when compacted to 98% of maximum dry density as to be determined by AASHTO T-99.

2.20.8 CONSTRUCTION METHODS

GENERAL

Prior to placing any sand fill upon any area, all clearing and grubbing operations shall be completed.

Within the limits of sand filling, tree stumps shall completely be removed.

The original ground surface should be prepared by scarifying, watering, aerating and compacting.

SPREADING AND COMPACTION OF SAND FILL

Sand fill shall be placed on the desired place in horizontal layers and each layer shall not exceed a loose thickness that will be required to obtain a compacted thickness of 150mm. Sand in each basket is to be placed near to the sand placed before it and spread systematically. The Contractor shall not be allowed to throw sand in heaps.

The compacted materials should become homogeneous and free from lenses, pockets, streaks or other imperfections. Placing operations shall be such that the materials, when compacted, will be blended

sufficiently to secure the best practicable degree of compaction, impermeability and stability and for this purpose the preceding compacted layer shall be scarified before placing a new layer.
All fill materials shall generally be compacted mechanically. However, under some special circumstance and when specifically allowed under the BOQ, the fill may be allowed to be compacted manually.
If the density measurement checks fall below the specified density level, re-compacting shall be required irrespective of the field compaction trial results The Contractor shall carry out such works at his own expenses.
Sand fill materials not containing sufficient moisture requirement for compaction in accordance with the requirements of this Sub-section, shall be reworked and watered as per the direction of the Engineer. The Contractor shall carry out this work at his own expenses.
Sand fill materials containing excess moisture shall be reworked and dried prior to or during compaction. Drying of wet materials shall be performed by methods proposed by the Contractor and approved by the Engineer at the expenses of the Contractor.
Compaction of every layer shall have to be approved by the Engineer. In the event the Contractor fails to obtain the approval of the Engineer of a fill layer, the materials above the unsatisfactory layer shall be removed and the unsatisfactory layer shall be re-compacted to satisfy the specifications at the expenses of the Contractor.
PROCEDURE FOR MANUAL COMPACTION
Sand shall be compacted manually by using concrete drop hammers each weighing 6 kg to 7 kg, fitted with a shaft of about 1.5m long. Ramming shall reduce the voids and shall continue until no further shrinkage of sand is possible by ramming.
Before commencing ramming, the moisture content of sand shall be increased or decreased as per requirement by sprinkling water or by allowing natural drying of sand as applicable so as to ensure that the materials shall have a moisture content of not less than 3% or greater than 3% dry of the optimum moisture required for the purpose of compaction respectively.
The compaction operations shall not proceed until the material is wetted or allowed to dry out, as may be required, to obtain optimum moisture content within the tolerances as permitted above. However, there may be an exception with a specific approval of the Engineer. No adjustment in price shall be made on account of any operations of the Contractor in wetting or drying the materials or on account of any delays occasioned thereby.
The preceding operations shall continue layer after layer until the top of the filling is reached.
MECHANICAL COMPACTION
In the case of mechanical compaction, area of filling, designated on the Drawings or by the Engineer, shall be compacted to the lines and grades shown on the Drawings or established by the Engineer. The Contractor's operations in importing materials, designated for use, shall be such as will result the desired F.M.
Just prior to and during compacting operations, the materials shall have a moisture content of not greater than 3% wet or less than 3% dry of the optimum moisture required for the purpose of compaction, as determined by Test No. 12 of BS 1337 and approved by the Engineer. The materials shall be so worked as to have uniform moisture content throughout the entire layer.
If the moisture content is less than optimum by more than 3% or is greater than optimum by more than 3%, the compaction operations shall not proceed until the material is wetted or allowed to dry out, as may be required, to bring the optimum moisture content within the tolerances. However, there may be an exception with a specific approval of the Engineer. No adjustment in price shall be made on account of any operations of the Contractor in wetting or drying the materials or on account of any delays occasioned thereby.
When the material has been conditioned and placed as specified or directed, it shall be compacted with appropriate motorized vibratory compaction equipment or tampers of adequate weight and size as approved by the Engineer. Each layer shall be compacted to obtain at least 98% compaction of the maximum dry density (STD). If the test results show that the density has not met the requirement, the Contractor shall have to carry out further compaction until the required density is achieved.

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2.20.9 MEASUREMENT

Measurement shall be taken for payment on the compacted volume of completed and accepted works in cubic meter. The cross sections to be used will be the areas bound by the original ground (existing) shaped or leveled, the sides and the bottom of the foundation or the floor.

2.20.10 PAYMENT

Payment for sand filling shall be made at the Contract unit price per cubic meter measured as provided above which price shall constitute the full compensation for furnishing all materials with their storage, placing, leveling and shaping, wetting or drying, compacting the fill materials and providing all equipment, tools and all incidentals necessary to complete the work true to the Specifications and/or as per the directions of the Engineer.

Payment shall only be made when all works have been completed in accordance with the designed sections satisfying all Specifications and accepted by the Engineer.

Item of Payment	Unit
Sand filling	Cubic meter / Cubic feet

2.21 RUSTLESS TYING WIRE

Rustles tying wire of 18 SWG shall be obtained from approved manufacturers and shall, as regards strength, comply with the requirements specified. The Contractor shall, at his own costs, provide binding wires of required specifications.

2.22 GUNNY BAGS

The gunny bags used in the permanent works shall be new, 50/75 kg capacity bags similar to those normally used. The Contractor shall submit sample bags to the Engineer for his approval

2.23 WIRE GAUGE

2.23.1 WIRE GAUGE GENERAL

Gauge for fly proofing shall be of the quality uniformly woven webbing of 23 meshes per square centimeter. The wire for the gauge shall be of best quality 22 SWG brass or copper wire or any other approved materials.

2.23.2 OTHER MATERIALS

Gauge known as "plastic gauge" may also be used as and when required by the Engineer.

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SECTION 2: FINISHING WORKS

3. FINISHING MATERIALS

3.1 FLOOR

3.1.1 NON-SKID FLOOR TILES

3.1.1.1 DESCRIPTION

Works covered under this item shall consist of supplying, fitting and fixing approved foreign/local made homogeneous quartz/embossed, non-skid floor tiles or special quality fibrous floor tiles laid on cement mortar base of proportion in accordance with the applicable Drawings, requirements of the BOQ, and these Specifications and/or as directed by the Engineer.

3.1.1.2 MATERIALS

Tiles
Tiles shall be either homogeneous quartz/embossed non-skid or special quality fibrous. The tiles shall be local/foreign made and of the sizes as shown on the Drawings, described in the Schedule of Works and/or as directed by the Engineer. They should be free from all warpage blemishes and dimensional defects.
Mortar
Mortar for installation shall consist of 1-part cement and 2 parts sand (FM 1.2). The specification for cement and sand shall conform to those stated under the relevant Sub-sections of the Section on 'Construction Materials' of this Specification and/or as directed by the Engineer.
Grout
All grout for tile joints be prepared with white cement or colored with inert pigments as and where specified. The specification for white cement shall conform to those stated under the relevant Sub-sections of the Section on 'Construction Materials' of this Specification and/or as directed by the Engineer..
Water
Water shall be clean, free from injurious quantities of oil, alkali, salts and organic materials or other deleterious substances and shall not contain any visibly solid materials. All requirements shall be similar to what have been stated under the relevant Sub-section of the Sections on 'Concrete Work' and 'Construction Materials' of this Specification. The Contractor shall get the water tested by comparing with water of known satisfactory quality, if requested by the Engineer.

3.1.2 CONSTRUCTION METHODS

The Contractor shall submit three sets of samples of all types of tiles to the Engineer for his approval before procuring the materials. One set will be kept in the office of the Engineer, one set at the Site office and the remaining set will be returned to the Contractor.
The Contractor shall prepare sample tile work and he should obtain its approval from the Engineer. Before such approval is received, no full-scale work shall start. The design of the floor layout shall conform to what have been shown on the Drawing and/or as directed by the Engineer.
The tiles shall be laid over previously roughened and wetted patent stone floor. The panels shall be of the size as shown on the Drawings and/or as indicated in the relevant item of the BOQ and/or as directed by the Engineer.
The sub-floor on which the tiles will be laid, shall be prepared in the same way as have been stated under the Sub-section on 'Patent Stone Floor' of this Section, but it will exclude the portion of neat cement finishing.
The tiles are to be fitted and fixed on the floor on a base of 20mm thick cement mortar prepared with 1 part ordinary Portland cement and 2 parts sand of FM 1.2. The mortar bed shall be cut through horizontally and vertically every 425mm to 600mm.
If the surface needs leveling, a scratch cost of plaster shall be applied, leveled and scratched for key and be allowed to dry out for 12 hours before installing tiles. The setting mortar shall be applied evenly and a

neat cement paste to a thickness of about 2mm shall be troweled to the back of the tiles. The tiles will then be set on firmly tapped into place to ensure full contact. The joints shall be in specified pattern and shall not exceed 2mm in width. The joints shall be raked with grout prepared with white cement and colored pigment and damp-cured for at least 3 days.
The tiles shall be soaked in water for at least 6 hours before laying. Installation shall be controlled by strings, pages, spacers, levels or other suitable methods so as to ensure their correct laying and uniform leveled joints.

3.1.3 MEASUREMENT

Measurement shall be taken for payment in square meter of finished tiled surface in place completed in accordance with the Specifications stated herein and/or as per the provisions of the BOQ and/or as shown on the Drawings and/or as directed by the Engineer. Only the completed works as accepted by the Engineer will be eligible for payment.

3.1.4 PAYMENT

The amount of completed and accepted works measured as provided above shall be paid at the Contract unit price per square meter, which shall constitute the full compensation for furnishing all materials, equipment and labor, including transport, storage and handling of materials, cleaning, preparing and laying bed with cement mortar and cutting and laying the tiles with neat cement paste, grouting and curing tiles ranking our joints, high quality finishing and all other works and all incidentals necessary to complete the Work as per requirements described under this item of work, the requirements of the BOQ, as shown on the Drawings and as directed by the Engineer. However, this item shall not include the costs for the item on Artificial Stone Floor.

Item of Payment	Unit
Non-skid floor tiles	Square meter / Square feet

3.1.5 CERAMIC TILES

3.1.5.1 GENERAL

RELATED DOCUMENTS

i. Related Drawing and Detail.

SUMMARY

ii. This Section includes the following:

- Ceramic Tiles.

DEFINITIONS

iii. **Module Size:** Actual tile size (minor facial dimension as measured per ASTM C 499) plus joint width indicated.

iv. **Facial Dimension**: Actual tile size (minor facial dimension as measured per ASTM C 499).

v. Facial Dimension: Nominal tile size as defined in ANSI A137.1

3.1.5.2 PERFORMANCE REQUIREMENTS

i. Static Co-efficient of Friction: For tile installed on walkway surfaces, provide products with the following values as determined by testing identical products per ASTM C 1028:

- Level Surfaces: Minimum 0.6.

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ii. Load-Bearing Performance: Provide installations rated for the following load-bearing performance level based on testing assemblies according to ASTM C 627 that are representative of those indicated for this Project:

- Heavy: Passes cycles 1 through 12. Use where indicated in finishing Schedules.
- Moderate: Passes cycles 1 through 10. Use for other applications indicated on Schedule where heavy duty is not indicated.

3.1.5.3 SUBMITTALS

I. Product Data: For each type of tile, mortar, grout, and other products specified.

II. Shop Drawings: For the following:

- Tile patterns and locations.
- Widths, details, and locations of expansion, contraction, control, and isolation joints in tile substrates and finished tile surfaces.

III. Locate precisely each joint and crack in tile substrates, record measurements on shop drawings, and coordinate them with tile joint locations, as approved by Consultant.

IV. Tile Samples for Initial Selection: Manufacturer's color charts consisting of actual tiles or sections of tiles showing the full range of colors, textures, and patterns available for each type and composition of tile indicated. Include Samples of accessories involving color selection.

V. Samples for Verification: Of each item listed below, prepared on Samples of size and construction indicated. Where products involve normal color and texture variations, include Sample sets showing the full range of variations expected.Each type and composition of tile and for each color and texture required, at least 400 mm square, mounted on braced cementitious backer units, and with grouted joints using product complying with specified requirements and approved for completed work in color or colors selected by Consultant.

□ Full-size units of each type of trim and accessory for each color required.

□ Stone thresholds in 150-mm lengths.

Master Grade Certificates: For each shipment, type, and composition of tile, signed by tile manufacturer and Installer.

VI. Product Certificates: Signed by manufacturers certifying that the products furnished comply with requirements.

VII. Installer Experience: List of five projects (minimum) of a similar nature carried out successfully by the installer with the same product.

VIII. Installer Experience: List of five projects (minimum) of a similar nature carried out successfully by the installer with the same product Qualification Data: For firms and persons specified in the

"Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names of Consultants and Employers, and other any information required by Consultant.

IX. Test Reports: Material test reports from qualified independent testing laboratory indicating and interpreting test results relative to compliance of tile and tile setting and grouting products with requirements indicated.

X. Setting Material Test Reports: Indicate and interpret test results for compliance of tile-setting and -grouting products with specified requirements.

3.1.6 QUALITY ASSURANCE

i.Quality System: Comply with ISO 9001/9002 Quality System as a minimum. Incorporate all the standard procedures supplied by the Consultant and the Employer.
ii. Installer Qualifications: Engage an experienced installer who has completed tile installations similar in material, design, and extent to that indicated for this Project and with a record of successful in-service performance.
iii. Source Limitations for Tile: Obtain each color, grade, finish, type, composition, and variety of tile from one source with resources to provide products from the same production run for each contiguous area of consistent quality in appearance and physical properties without delaying the Work.
iv. Source Limitations for Setting and Grouting Materials: Obtain ingredients of a uniform quality for each mortar, adhesive, and grout component from a single manufacturer and each aggregate from one source or producer.

4. Source Limitations for Other Products: Obtain each of the following products specified in this Section from one source and by a single manufacturer for each product:
5. Stone thresholds. Waterproofing. Cementitious backer units. Joint sealants.
6. Mockups: Before installing tile, construct mockups for each form of construction and finish required to verify selections made under Sample submittals and to demonstrate aesthetic effects and qualities of materials and execution. Build mockups to comply with the following requirements, using materials indicated for completed Work.

- Locate mockups in the location and of the size indicated or, if not indicated, as directed by Consultant.
- Notify Consultant 7 days in advance of the dates and times when mockups will be constructed.
- Demonstrate the proposed range of aesthetic effects and workmanship.
- Obtain Consultant's approval of mockups before proceeding with final unit of Work
- Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.

Approved mockups in an undisturbed condition as judged solely by the Consultant at the time of Substantial Completion may become part of the completed Work, otherwise demolish mockups, remove rubbles from site and install permanent works.

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Pre-installation Conference: Conduct conference at Project site to comply with requirements of Project Management and Coordination.

3.1.7 DELIVERY, STORAGE, AND HANDLING

i. Deliver and store packaged materials in original containers with seals unbroken and labels intact until time of use. Comply with requirement of ANSI A137.1 for labeling sealed tile packages.

ii. Prevent damage or contamination to materials by water, freezing, foreign matter, and other causes.

iii. Handle tile with temporary protective coating on exposed surfaces to prevent coated surfaces from contacting backs or edges of other units. If coating does contact bonding surfaces of tile, remove coating from bonding surfaces before setting tile.

3.1.8 PROJECT CONDITIONS

Environmental Limitations: Do no install tile until construction in spaces is completed and ambient temperature and humidity conditions are being maintained to comply with referenced standards and manufacturer's written instructions.

3.1.9 EXTRA MATERIALS

Deliver extra materials to Employer. Furnish extra materials described below that match products installed, are packaged with protective covering for storage, and are identified with labels describing contents.

- Tile and Trim Units: Furnish quantity of full-size units equal to 3 percent of amount installed, for each type, composition, color, pattern, and size indicated.

3.1.10 PRODUCTS GENERAL

GENERAL

- Provide tile complying with Standard Grade requirements, unless otherwise indicated.
- Retain below with appropriate definitions in referenced part 1 article.
- For facial dimensions of tile, comply with standard requirements unless otherwise indicated.
- Tiles are to be highest grade of production in manufacturer's quality grading system. Iv

ANSI Standards for Tile Installation Materials: Provide materials complying with ANSI standards referenced in "Setting Materials" and "Grouting Materials" articles.
Colors, Textures, and Patterns: Where manufacturer's standard products are indicated for tile, grout, and other products requiring selection of colors, surface textures, patterns, and other appearance characteristics, provide specific products or materials complying with the following requirements:

- Provide Consultant's selections from manufacturer's full range of colors, textures, and patterns for products of type indicated.

Factory Blending: For tile exhibiting color variations within the ranges selected during Sample submittals, blend tile in the factory and package so tile units taken from one package show the same range in colors as those taken from other packages and match approved Samples.
Mounting: Where factory-mounted tile is required, provide back- or edge-mounted tile assemblies as

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standard with manufacturer, unless another mounting method is indicated.
Factory-Applied Temporary Protective Coating: Where indicated under tile type, protect exposed surfaces of tile against adherence of mortar and grout by pre-coating them with a continuous film of petroleum paraffin wax, applied hot. Do not coat unexposed tile surfaces.

3.1.11 TILE PRODUCTS

Wall Tile: Provide flat tile complying with the following requirements:
Module Size: As indicated on Drawings.
Water Absorption: Less than 6% to ASTM C373.

- Thickness: minimum 3 mm to 5 mm.
- Face: Plain with modified square edges or cushion edges. Background/Base: 15mm thick 1:4 cement/sand render on concrete or concrete blockworks.

Bedding: Thin cement based adhesive to be approved
Grouting material: Epoxy grout Nitotile 489 as supplied by Fosroc or equal approved to be used in accordance with manufacturer recommendations. Colour to architects approval.
Movement joints: All internal corners; Width: 6mrn.

3.1.12 MISCELLANEOUS MATERIALS

i. Trowel able Underlayment's and Patching Compounds: Latex-modified, Portland-cementbased formulation provided or approved by manufacturer of tile- setting materials for installations indicated.

ii. Temporary Protective Coating: Provide product indicated below that is formulated to protect exposed surfaces of tile against adherence of mortar and grout; is compatible with tile, mortar, and grout products; and is easily removable after grouting is completed without damaging grout or tile. □ Petroleum paraffin wax, fully refined and odorless, containing at least 0.5 percent oil with a melting point of 49 to 60 deg C per ASTM D 87.

iii. Tile Cleaner: A neutral cleaner capable of removing soil and residue without harming tile and grout surfaces, specifically approved for materials and installations indicated by tile and grout manufacturers.

3.1.13 MIXING MORTARS AND GROUT

i. Mix mortars and grouts to comply with referenced standards and mortar and grout manufacturers' written instructions.

ii. Add materials, water, and additives in accurate proportions.

iii. Obtain and use type of mixing equipment, mixer speeds, mixing containers, mixing time, and other procedures to produce mortars and grouts of uniform quality with optimum performance characteristics for installations indicated.

3.1.14 EXECUTION EXAMINATION

Examine substrates, areas, and conditions where tile will be installed for compliance with requirements

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for installation tolerances and other conditions affecting performance of installed tile.

- Verify that substrates for setting tile are firm; dry; clean; free from oil, waxy films, and curing compounds; and within flatness tolerances required by referenced ANSI A108 series of tile installation standards for installations indicated.

3.2 PORCELAIN

3.2.7 GENERAL

RELATED DOCUMENTS: Related Drawing and Detail.
SUMMARY: This Section includes the following:

- Porcelain Tiles.

DEFINITIONS

i. Module Size: Actual tile size (minor facial dimension as measured per ASTM C 499) plus joint width indicated.
ii. Facial Dimension: Actual tile size (minor facial dimension as measured per ASTM C 499).
iii. Facial Dimension: Nominal tile size as defined in ANSI A137.1.

3.2.8 PERFORMANCE REQUIREMENTS

Static Coefficient of Friction: For tile installed on walkway surfaces, provide products with the following values as determined by testing identical products per ASTM C 1028:

- Level Surfaces: Minimum 0.6.

Load-Bearing Performance: Provide installations rated for the following load-bearing performance level based on testing assemblies according to ASTM C 627 that are representative of those indicated for this Project:
Heavy: Passes cycles 1 through 12. Use where indicated in finishing Schedules.
Moderate: Passes cycles 1 through 10. Use for other applications indicated on Schedule where heavy duty is not indicated.

3.2.9 SUBMITTALS

Product Data: For each type of tile, mortar, grout, and other products specified.
Shop Drawings: For the following:

- Tile patterns and locations.
- Widths, details, and locations of expansion, contraction, control, and isolation joints in tile substrates and finished tile surfaces.
- Locate precisely each joint and crack in tile substrates, record measurements on shop drawings, and coordinate them with tile joint locations, as approved by Consultant.

Tile Samples for Initial Selection: Manufacturer's color charts consisting of actual tiles or sections of tiles showing the full range of colors, textures, and patterns available for each type and composition of tile indicated. Include Samples of accessories involving color selection.
Samples for Verification: Of each item listed below, prepared on Samples of size and construction indicated. Where products involve normal color and texture variations, include Sample sets showing the full range of variations expected.

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- Each type and composition of tile and for each color and texture required, at least 400 mm square, mounted on braced cementitious backer units, and with grouted joints using product complying with specified requirements and approved for completed work in color or colors selected by Consultant.
- Full-size units of each type of trim and accessory for each color required.
- Stone thresholds in 150-mm lengths. v. Master Grade Certificates: For each shipment, type, and composition of tile, signed by tile manufacturer and Installer.

Product Certificates: Signed by manufacturers certifying that the products furnished comply with requirements.
Installer Experience: List of five projects (minimum) of a similar nature carried out successfully by the installer with the same product.
Installer Experience: List of five projects (minimum) of a similar nature carried out successfully by the installer with the same product Qualification Data: For firms and persons specified in the "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names of Consultants and Employers, and other any information required by Consultant.
Test Reports: Material test reports from qualified independent testing laboratory indicating and interpreting test results relative to compliance of tile and tile setting and grouting products with requirements indicated.
Setting Material Test Reports: Indicate and interpret test results for compliance of tile-setting and -grouting products with specified requirements.

3.2.10 QUALITY ASSURANCE

Quality System: Comply with ISO 9001/9002 Quality System as a minimum. Incorporate all the standard procedures supplied by the Consultant and the Employer.
Installer Qualifications: Engage an experienced installer who has completed tile installations similar in material, design, and extent to that indicated for this Project and with a record of successful in-service performance.
Source Limitations for Tile: Obtain each color, grade, finish, type, composition, and variety of tile from one source with resources to provide products from the same production run for each contiguous area of consistent quality in appearance and physical properties without delaying the Work.
Source Limitations for Setting and Grouting Materials: Obtain ingredients of a uniform quality for each mortar, adhesive, and grout component from a single manufacturer and each aggregate from one source or producer.
Source Limitations for Other Products: Obtain each of the following products specified in this Section from one source and by a single manufacturer for each product:

- Stone thresholds.
- Waterproofing.
- Cementitious backer units.
- Joint sealants.

Mockups: Before installing tile, construct mockups for each form of construction and finish required to verify selections made under Sample submittals and to demonstrate aesthetic effects and qualities of materials and execution. Build mockups to comply with the following requirements, using materials indicated for completed Work.

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- Locate mockups in the location and of the size indicated or, if not indicated, as directed by Consultant.
- Notify Consultant 7 days in advance of the dates and times when mockups will be constructed.
- Demonstrate the proposed range of aesthetic effects and workmanship.
- Obtain Consultant's approval of mockups before proceeding with final unit of Work.
- Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work. 1) Approved mockups in an undisturbed condition as judged solely by the Consultant at the time of Substantial Completion may become part of the completed Work, otherwise demolish mockups, remove rubbles from site and install permanent works.

Pre-installation Conference: Conduct conference at Project site to comply with requirements of Project Management and Coordination.

3.2.11 DELIVERY, STORAGE, AND HANDLING

i. Deliver and store packaged materials in original containers with seals unbroken and labels intact until time of use. Comply with requirement of ANSI A137.1 for labeling sealed tile packages.

ii. Prevent damage or contamination to materials by water, freezing, foreign matter, and other causes.

iii. Handle tile with temporary protective coating on exposed surfaces to prevent coated surfaces from contacting backs or edges of other units. If coating does contact bonding surfaces of tile, remove coating from bonding surfaces before setting tile.

3.2.12 EXTRA MATERIALS

Deliver extra materials to Employer. Furnish extra materials described below that match products installed, are packaged with protective covering for storage, and are identified with labels describing contents.

- Tile and Trim Units: Furnish quantity of full-size units equal to 3 percent of amount installed, for each type, composition, color, pattern, and size indicated.

3.2.13 PRODUCTS GENERAL

- Provide tile complying with Standard Grade requirements, unless otherwise indicated.
- Retain below with appropriate definitions in referenced part 1 article.
- For facial dimensions of tile, comply with standard requirements unless otherwise indicated.
- Tiles are to be highest grade of production in manufacturer's quality grading system.

ii. **ANSI Standards for Tile Installation Materials**: Provide materials complying with ANSI standards referenced in "Setting Materials" and "Grouting Materials" articles.

iii. **Colors, Textures, and Patterns**: Where manufacturer's standard products are indicated for tile, grout, and other products requiring selection of colors, surface textures, patterns, and other appearance characteristics, provide specific products or materials complying with the following requirements: □

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Provide Consultant's selections from manufacturer's full range of colors, textures, and patterns for products of type indicated.

iv. **Factory Blending**: For tile exhibiting color variations within the ranges selected during Sample submittals, blend tile in the factory and package so tile units taken from one package show the same range in colors as those taken from other packages and match approved Samples.

v. **Mounting:** Where factory-mounted tile is required, provide back- or edge-mounted tile assemblies as standard with manufacturer, unless another mounting method is indicated.

vi. **Factory-Applied Temporary Protective Coating**: Where indicated under tile type, protect exposed surfaces of tile against adherence of mortar and grout by precoating them with a continuous film of petroleum paraffin wax, applied hot. Do not coat unexposed tile surfaces.

3.2.14 TILE PRODUCTS

i. **General Characteristics**: Tiles are to comply with the following general requirements:

Floor Tiles:

1) **Abrasive Hardness**: Minimum Index 253 to ASTM C 501 (unglazed tiles), unless otherwise specified.
2) **Bending Strength**: Minimum 35 Kg/cm2 to ASTM C 648.
3) Water Absorption: As specified.
4) Chemical Resistance: Unaffected with moderate acids.
5) **Tile Rating**: For heavy duty floor by a rating system acceptable to the Consultant.
6) **Background/Base**: 15mm thick 1:4 cement/sand render on concrete or concrete block works.
7) **Bedding:** Thin cement based adhesive to be approved
8) **Grouting material**: Epoxy grout Nitotile 489 as supplied by Fosroc or equal approved to be used in accordance with manufacturer recommendations. Colour to architects approval.
9) **Movement joints**: All internal corners; Width: 6mrn.
10) **Accessories**: all exposed edges and corners to have preformed rounded edges.

3.2.15 FLOOR TILING

Background/Base: screed 1 in-situ concrete
Screed: 1:3:6 cement/sand/aggregate semi-dry screed laid to falls and towards floor drain outlets, overall thickness of flooring to be 75mm Bedding: Waterproof adhesive on cement 1 sand bed Adhesive: to be approved
Waterproofing: 2 coats Fosroc Nitoproof 10, or equal, to B.S. Standard. laid to manufacturer's recommendations, with necessary accessories
Grouting material: Epoxy grout Nitotile 489 as supplied by Fosroc or equal approved to be used in accordance with manufacturer recommendations. Colour to architects approval.
Joint width: 2 mm
Movement joints:
Location: At all perimeters including door thresholds;
Width: 2 mm
Accessories: Skirting: Coved skirting tiles, 100mm high to match ceramic floor tiles, set flush with

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render, to be fixed on plastered walls, grouted with epoxy grout Nitotile 489 as supplied by Fosroc or equal approved, applied in accordance with manufacturer's recommendations.

3.2.16 GROUTING MATERIALS

i. Sand-Portland Cement Grout: ANSI A108.10, composed of white or gray cement and white or colored aggregate as required to produce color indicated.
ii. Chemical-Resistant Epoxy Grout: ANSI A 118.3, color as indicated.
□ Provide product capable of resisting continuous and intermittent exposure to temperatures of up to 60 deg C and 100 deg C, respectively, as certified by mortar manufacturer for intended use.
iii. Grout Colors: Provide colors as selected by the Consultant from manufacturer's full range of standard and custom colors. Finish shall be smooth, unless otherwise specified or directed by the Consultant

3.2.17 ELASTOMERIC SEALANTS

i. General: Provide manufacturer's standard chemically curing, elastomeric sealants of base polymer and characteristics indicated that comply with applicable requirements of Joint Sealants.
ii. Colors: Provide colours of exposed sealants to match colors of grout in tile adjoining sealed joints, unless otherwise indicated.

3.2.18 MISCELLANEOUS MATERIALS

i. Trowelable Underlayments and Patching Compounds: Latex-modified, Portland-cement-based formulation provided or approved by manufacturer of tile- setting materials for installations indicated.
ii. Temporary Protective Coating: Provide product indicated below that is formulated to protect exposed surfaces of tile against adherence of mortar and grout; is compatible with tile, mortar, and grout products; and is easily removable after grouting is completed without damaging grout or tile.
□ Petroleum paraffin wax, fully refined and odorless, containing at least 0.5 percent oil with a melting point of 49 to 60 deg C per ASTM D 87.
iii. Tile Cleaner: A neutral cleaner capable of removing soil and residue without harming tile and grout surfaces, specifically approved for materials and installations indicated by tile and grout manufacturers

3.2.19 MIXING MORTARS AND GROUT

i. Mix mortars and grouts to comply with referenced standards and mortar and grout manufacturers' written instructions.
ii. Add materials, water, and additives in accurate proportions.
iii. Obtain and use type of mixing equipment, mixer speeds, mixing containers, mixing time, and other procedures to produce mortars and grouts of uniform quality with optimum performance characteristics for installations indicated.

3.2.20 EXECUTION EXAMINATION

Examine substrates, areas, and conditions where tile will be installed for compliance with requirements for installation tolerances and other conditions affecting performance of installed tile.

- Verify that substrates for setting tile are firm; dry; clean; free from oil, waxy films, and curing compounds; and within flatness tolerances required by referenced ANSI A108 series of tile installation standards for installations indicated.

DOORS, WINDOWS AND CEILINGS

3.3 WOOD WORK FOR DOOR/ WINDOW FRAMES AND SHUTTERS

3.3.7 DESCRIPTION

Works covered under this item shall consist of furnishing, finishing and installing of wooden door/ window frames and shutters of the size and shape shown on the Drawings and/or as specified in the Bill of Quantities and/or as directed by the Engineer including supplying and fixing of all finished hardware and glazing.

3.3.8 GENERAL REQUIREMENTS

Design drawings

Design Drawings shall be thoroughly studied by the Contractor before the Work is commenced. Detail of joints as shown on the Drawings must be specifically checked. If any detail description or specification is found missing or in the opinion of the Contractor inadequate, inconsistent or otherwise, the Contractor shall draw the same to the attention of the Engineer who may make necessary arrangements as deemed fit. On no account, the Contractor shall use his own judgement when any discrepancy is noticed in the Drawings, details and descriptions.

Shop drawings

Detailed Shop Drawings of doors and windows and other wooden works including glazing and installation details, when required, shall be submitted to the Engineer for approval.

Shop Drawings shall include the submission of manufacturer's literature, brochures and delivery date for all finish hardware and manufacturer's literature or specification for glass.

Fabrication of wooden doors/windows shall not start until the Engineer approves the Shop Drawings.

Samples

Within 35 days (or as may be specified otherwise) following the Contract is awarded, the Contractor shall furnish the Engineer, for his approval, a complete list in 4 copies of all hardware proposed for use under the Contract, scheduling all hardware for every door/window.

The Contractor shall submit to the Engineer two pieces of wood specimens, each of size 150mm x 250mm x 25mm, for his approval. The Contractor shall submit to the Engineer one sample of each type of finished hardware for doors and windows for his approval. However, the hardware shall be of the quality equal to or better than the samples, if available in the Engineer's office.

The Contractor shall submit to the Engineer two pieces of glass sample, each of size 150mm x 200mm and of required thickness proposed for glazing for his approval. The samples shall bear the name of the manufacturer, thickness and the type of glass.

All approved samples may be kept at Site for comparing the materials supplied by the Contractor.

The works of this Sub-section shall not commence until the samples get approval of the Engineer.

3.3.9 OTHER REQUIREMENTS

Dimensions shown on the Drawings are finished dimensions. In sizing rough components, necessary allowance, therefore, must be kept for the working loss arising from planning, smoothening and finishing.

Requisite precautionary measures against fire, denting, breakage or loss must be ensured while the articles are in transit and till the supply is completed.

Polishing or painting, as the case may be, shall be done at Site on receiving approval of the woodwork, carpentry etc. by the Engineer. The working area shall be cleaned properly before the finishing works start and subsequently before each day's work to ensure reasonably dust-free surroundings.

Particulars of the workshop, working area and storage space must be furnished to the Engineer, which shall be checked by him. If required, modifications shall be made as instructed by the Engineer to ensure proper atmosphere and amenities.

The Contractor shall provide adequate locked-up storage space. The Contractor shall replenish all lost or damaged hardware at his own expenses.

In case of inflicting injury to any part of the building/other works while installing, the Contractor shall

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rectify the same employing proper workers of the trade and furnishing all requisite materials at his own expenses.
The Contractor shall keep the Employer indemnified against all charges, which may arise out of this Contract in case of procurement of timbers from local sources.

3.3.10 MATERIALS

Timber
General
Timber, only as specified on the Drawings and Bill of Quantities, shall be used. Timber used for woodwork shall be well seasoned, kiln dry containing not more than 8% to 12% moisture so as to ensure minimum tendency towards warping, shrinking and swellings. It shall be free from all defects, such as large or loose knots, saps, shakes, upsets, wane edge and twisted fibre. It shall also be free from all diseases such as decay, wet rot, dry rot, woodworms and white ant. Timber shall be finished to the exact dimensions shown on the Drawings or as directed by the Engineer. The pieces of wood shall be properly finished by planer and other tools before joining and the completed wood works shall be accepted by the Engineer before fixing those in position.
Wood for frame
High quality, well-seasoned Garjan, Jarul, Local Sal, Shilkarai/Chikrashi, Telsu and Teak Chambol or any other equivalent type of wood as approved by the Engineer, shall be used for frame work or any other related works required.
Wood veneered flash door shutter
Jack wood, Gamari and Chapalish wood, Teak Chambol wood and Chittagong Teak wood veneered flash door shall be used for door shutter or sash or any other related works required. Any other equivalent type of wood may be used when it is required by the Engineer.
Wood for solid door shutter
High quality Jack wood, Chittagong Teak wood, Gammari and Chapalish wood and Teak Chambol wood or any other equivalent type of wood, as approved by the Engineer, shall be used for solid door shutter or any other related works required.
Wood for panel door shutter
High quality Jack wood, Chittagong Teak wood Gammari and Chapalish wood and Teak Chambol wood or any other equivalent type of wood, as approved by the Engineer, shall be used for solid door shutter or any other related works required.

3.3.11 FINISH HARDWARE

3.3.12 MATERIALS AND FINISH

Two sets of complete list indicating the manufacturer's name, brand name, type, size and location of all hardware to be installed shall be submitted to the Engineer for his approval. No hardware shall be ordered until the Engineer has approved this list.
Unless otherwise specified on the Drawings and in the Bill of Quantities or directed by the Engineer, specifications of the finish hardware shall be as follows:
Door hinges
Hinges shall be locally available, best quality iron or brass hinge of 100mm size and attached with No. 8 steel screw 32mm long, as approved by the Engineer or as directed by him.
Door stopper
Door stopper shall be made of timber as specified previously in the relevant portion of this Sub-section and shall be 100mm long to act as a stopper to keep the door in open position. Cleat with 65mm steel hinge, "Lion" brand or approved equal shall be fixed with No. 6 steel screws 20mm long, "Diamond" or "Star" brand or equal standard approved by the Engineer or as directed by him. One cleat to be furnished for each leaf as approved by the Engineer.
PVC buffer block
PVC buffer block shall be locally available best quality PVC block 38mm diameter and attached to wall

with No.8 steel screw 50mm long, "Diamond" or "Star" brand or approved equal or as directed by the Engineer. One block to be furnished for each leaf as approved by the Engineer.

Door handle

Door handle shall be locally available best quality chromium or nickel plated 150mm long, attached with No.7 steel screw 25mm long or as directed by the Engineer. Two handles to be furnished for each door, one inside and one outside as approved by the Engineer.

Door tower bolts

Door tower bolts shall be locally available best quality 250mm and 200mm brass or iron bolts fitted on the interior side of the door leaf. 250mm long bolts shall be fitted at the top of the leaf vertically and the 200mm long bolts shall be fitted at the bottom of the door leaf horizontally. The 250mm and 200mm tower bolts shall be fitted with No. 6 brass screw 20mm long and as approved by the Engineer.

Hatch bolt

Hatch bolt shall be locally available best quality brass or iron bolt 300mm long fixed with approved bolts and nuts fitted on the outside of the door for locking arrangement as per direction of the Engineer.

Window hinge

Window hinge shall be locally available best quality 100mm iron hinge, "Lion" brand or approved equal, 75mm x 50mm in size and fixed with No. 7 steel screw 25mm long "Diamond" or "Star" brand or approved equal or as directed by the Engineer. Three hinges shall be furnished per window.

Window handles

Window handles shall be locally available best quality Chromium plated 100mm long, "Lion" brand or approved equal or as directed by the Engineer. One handle shall be furnished for each leaf at the centre on the inside.

Windows catch hook

Window catch hook shall be locally available best quality, "Diamond" brand or approved equal, galvanized iron 225mm long or as directed by the Engineer. One catch hook shall be furnished for each leaf.

Window tower bolt

Window tower bolt shall be locally available best quality iron, "Diamond" brand or approved equal. Tower bolts 150mm long be fitted on the interior side of the window leaf. Tower bolts shall be fixed with No. 5 steel screw 20mm long, "Diamond" or "Star" brand or approved equal or as directed by the Engineer and fixed vertically one each at the top and bottom on the interior side of the leaf to close the window from inside.

Glass

All glass shall be the approved best quality locally available sheet glass unless otherwise specified and shall be of the various sizes and thickness as shown on the Drawings and Bill of Quantities. All glass shall be free from bubbles, distortion and flaws of every kind with even surface and free from all other imperfections. Each piece of glass shall bear a label indicating the name of the manufacturer, the thickness and the type of glass. Label shall remain on the glass till they are cleaned finally on completion of work.

Lock sets

All Lock sets shall be of the best quality 'Yale' brand door lock or approved equal in perfect operating conditions or as directed by the Engineer, if not shown on the Drawings or mentioned elsewhere. Strikes shall be used where required to protect trim from being marred by hatch bolt. Three keys shall be furnished with proper identification for each lock set.

3.3.13 JOINERY

Joints shall be made according to the sizes and profiles as shown on the Drawings.

No extra nails or screws, other than those used in the approved samples, shall be used. Nails and screws to be used on finished surfaces shall be fitted slightly below the surface. Polyvinyl acetate adhesive of 'Aica Aibon' brand or other equivalent brand shall be used where use of adhesive is required or instructed.

Wooden pins, where required or instructed, shall be of the same specimen, perfectly round and pressure

fitted in the holes which shall be circular.
All joints shall be of such true-fit that they will not be discernible from a distance of one meter.
Layout of the joints shall be made by using accurate instruments. A knife can be used whenever a line is to be cut. A sharp pencil can be used for all layouts and specially when part of the area is to be cut away.
All measurements shall be made from a common starting point, edge or surface. All identical joints shall be laid out at the same time. Two members of each joint shall always be identified with a pencil mark for quick identification during assembling.
Right instrument or machine shall be used for each cut. The cut shall always be made just inside or outside the layout line. The joints shall be trimmed out with a router plane or chisel when necessary.
Proper type of clamping devices shall be used for assembling the joint. A trial assembly shall be made to make sure that each joint shall fit properly. A correct method of fastening shall have to be determined. The same shall be completely square and aligned when properly assembled.

3.3.14 GLUING UP

The stock shall be glued together where necessary. The glue shall be of 'Aica Aibon' brand Polyvinyl-acetate emulsion adhesive or its equivalent quality. The grain of all the pieces shall run in the same direction. The edge of gluing stock shall be of the same maturity and strength.
Good glue must develop the full strength of the wood under all condition stress. To obtain this result, it is necessary to control the gluing operation as well as the condition of the material. The moisture content before gluing shall not be too low or too high.
The average moisture content of wood is about twelve percent. High quality glue joints can not be made on wet wood. The moisture content of timber shall be checked through each step of manufacturing preferably with an electrical Moisture Meter. The following points must be checked in order to ensure proper gluing:

i. Parts of the assembly are at proper moisture content and temperature.
ii. Gluing surfaces have been made smooth, free from irregularities and even as much as possible.
iii. All joints have been placed under equal pressure.
iv. Excess glue has been removed before machining.

3.3.15 FABRICATION AND INSTALLATION

All materials and finish shall get the approval of the Engineer before they are installed. All hardware and accessories shall be purchased in the manufacturer's original packages complete with all required trimmings. They shall conform to the requirements of the specifications and no substitution shall be made for the samples submitted without prior approval of the Engineer. Required templates shall be submitted for proper installation.
All wood works shall be fabricated and installed in a way to conform to the details and dimensions indicated on the Drawings in the Bill of Quantities and as directed by the Engineer.
All hardware and accessories shall be of best stainless and non-corroding variety of screws, bolts, nuts and other fastenings and approved by the Engineer before attaching them. These shall be of the same finish as the material, which they attach and shall be of the type and standard of the manufacturer.
All items of finish hardware and accessories shall be carefully fitted and adjusted to ensure smooth operation. All items of finish hardware and accessories shall be in perfect operating condition and undamaged while installing.
Door/window frames shall be properly cut, housed together and jointed with 'mortice' and 'tenon' joints. The frames shall be rabbeted on one side by a cut measuring 13mm in one direction and the full thickness of the shutter in the other. Frames shall be plumbed and leveled with corners at right angles. All exposed surfaces shall be smoothened with sandpaper. Back faces of wood, remaining in contact with or against concrete or masonry, shall be treated with a minimum of two coats of wood preservation paint, such as creosote or solignum. Wood preservatives, to be used, shall be approved by the Engineer.

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The frame shall be fitted vertically in position true and plumb and fixed with clamps made with M.S. angle iron of size 375mm x 40mm x 6mm set in cement concrete within the masonry wall. There shall be six clamps for door frames and four clamps for window frames in general. However, the number and the size of the clamps shall conform to the requirements of the Drawings and as specified in the Bill of Quantities. The clamps shall be fitted by filling the recess properly so as to fit the frame nicely with the wall.

Door sash shall be of panel design and made as shown on the Drawings. Panel-sash frame shall be housed and jointed with mortise and 'tenon' joints. Panels for doors shall be solid wood, placed properly in retaining grooves with 4mm gap between adjacent panels on all sides or as indicated/shown on the Drawings.

Door/window frames and door sash shall be approved by the Engineer on assembling and before installing in position.

All hardware shall be installed and all door/window assemblies shall be fitted properly with minimum clearances. Hinges shall be recessed flush with surrounding wood surfaces. All sash shall be tested for proper and smooth operation without hinge bind.

On completion of door/window installation, all wood surfaces shall be French polished or painted.

3.3.16 GLAZING

General requirements

All glazing work shall be performed in accordance with the typical glazing details shown on the Drawings. Joints and spaces, to be sealed, shall be thoroughly dried and made free from dust and other foreign materials before glazing. All glass shall be set with proper clearance as recommended by the manufacturer at all edges. Glass with nipped or damaged edges shall not be installed. Adjacent materials, which are solid, shall be cleaned immediately before the sealant and compound harden or stain the adjoining surfaces.

Glazing process

Glass to be cut to provide a clearance of 1.7mm to 3mm on all sides. A thin layer of sealant made of chalk, double boiled linseed oil and resin is to be applied to the frame surfaces coming in contact with the glass. The glass panes shall be fitted in to the rabbet not less than 20mm wide taking care to centre with equal clearance of jambs between glass and frame. The glass is next to be pressed firmly in to the place against the sealant. A bead of sealant is then to be laid in to the spaces between the glass and the frame. Sufficient sealant shall be applied so that when the stop is put in place, the sealant will be forced in to the gap between the glass and the stop and completely fill the space between the frame, glass and stop. The removal stop is then to be installed. The remaining space between the face of glass and stop shall be completely filled with sealant.

Cleaning

No glazing shall be considered complete until and unless paints and other stains have been removed from the surface of the glass. Glass must be cleaned and polished with pads of damp cloth and then with clean dry soft cloths. It will have to be finally finished with appropriate glass cleaning fluid and made absolutely free of foreign particles.

Defects and breakage

The Contractor shall replace any glass not conforming these specifications or having defects not admissible under the manufacturer's grading rules. The Contractor shall replace all glass, broken, cracked or chipped by his workers or by faulty installation or from any other cause. All glasses shall remain in perfect condition at the time of handing over of the building to the Employer.

3.3.17 MEASUREMENT

All wood door/window frames and assemblies completed, including all hardware installed in place, shall be measured in cubic meter for the specified section of the installed frame and accepted by the Engineer.

All wood door/window leaf and assemblies completed, including glass panes and all hardware installed in place shall be measured in square meter of the installed area and accepted by the Engineer.

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3.3.18 PAYMENT

For all wood door/window frames, the amount of completed and accepted work measured as provided above shall be paid at the Contract unit price per linear meter, which payment shall constitute the full compensation for furnishing all materials and assemblies, fitting and fixing the frames, filling the recess, painting, all tools and appliances and labour including storage, transport, providing scaffolding and other works as well as all incidentals necessary for completion of all works as per specifications and requirements described under this Sub-section the Bill of Quantities, as shown on the Drawings and as directed by the Engineer.

For all wood door/window shutters including window glass panes, the amount of completed and accepted work measured as provided above shall be paid at the Contract unit price per square meter, which payment shall constitute the full compensation for furnishing all materials, hardware and assemblies, fitting and fixing the shutters/panes, all tools and appliances and labour including storage, transport, and providing scaffolding and all other works as well as all incidentals necessary for satisfactory completion of all works as per specifications and requirements described under this Subsection the Bill of Quantities, as shown on the Drawings and as directed by the Engineer.

Item of Payment	Unit
Wood door/window frame	Cubic meter / Cubic feet
Wood door/window shutters/panes	Square meter / Square feet

3.4 VENEERED PARTEX FIXED PANEL DOOR/WINDOW

3.4.7 DESCRIPTION

Works covered by this item shall consist of supplying and fitting fixing Gammari Veneered Partex Panel of the size and shape as shown on the Drawing or as directed by the Engineer including supplying and fixing of all necessary hardware and meeting all requirements as described under the Sub-section on the 'Wood Work for Door/Window Frames and Shutters'.

3.4.8 GENERAL REQUIREMENTS

Same as stated under the Sub-section on 'Wood Work for Door/Window Frames and Shutters'.

3.4.9 OTHER REQUIREMENTS

Same as stated under the Sub-section on 'Wood Work for Door/Window Frames and Shutters'.

3.4.10 MATERIALS

Gammari Veneered Partex door/window panel.

3.4.11 JOINERY

Same as stated under the Sub-section on 'Wood Work for Door/Window Frames and Shutters'.

3.4.12 GLUING UP

Same as stated under the Sub-section on 'Wood Work for Door/Window Frames and Shutters'.

3.4.13 FINISH HARDWARE

Same as stated under the Sub-section on 'Wood Work for Door/Window Frames and Shutters'.

3.4.14 FABRICATION AND INSTALLATION

Same as stated under the Sub-section on 'Wood Work for Door/Window Frames and Shutters'.

3.4.15 MEASUREMENT

All Veneered Partex panel door/window and assemblies completed and all hardware installed in place shall be measured in square meter of the installed area. Only the works completed in accordance with the provisions of the BOQ, and/or as shown on the Drawings and/or as directed by the Engineer and accepted by the Engineer will be eligible for payment.

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3.4.16 PAYMENT

For all Veneered Partex panel door/window and assemblies, the amount of completed and accepted work measured as provided above shall be paid at the Contract unit price per square meter, which payment shall constitute the full compensation for furnishing all materials, hardware and assemblies, fitting and fixing the panel, all tools and appliances and labour including storage, transport, and providing scaffolding and all other works as well as all incidentals necessary for satisfactory completion of all works as per specifications and requirements described under this Sub-section the Bill of Quantities, as shown on the Drawings and as directed by the Engineer.

Item of Payment	Unit
Veneered Partex fixed panel door/window	Square meter / Square fee

3.5 ALUMINIUM DOORS, WINDOWS AND CURTAIN WALLS

3.5.7 DESCRIPTION

Works covered under this item shall consist of supplying and fixing aluminum products of various types and uses such as doors, windows, curtain wall, curtain rail, cladding/flushing of sills, window grills, etc. fitted with necessary hardware, glass (where required) and finished in accordance with applicable Drawings and specifications.

3.5.8 MATERIALS AND PRODUCTS

Doors, windows and curtain walls

Doors, windows, curtain walls etc. shall be of approved standard conforming to the U.S. Architectural Aluminium Manufacturing Association (AAMA) or approved equivalent specifications. The frames and such members shall be of extruded shape made of 6063-T5 high quality aluminum alloy having a minimum section thickness of 1.8mm unless otherwise shown on the Drawings or indicated in the Bill of Quantities and shall conform to the U.S. Architectural Aluminum Manufacturing Association or approved equivalent standard.

Fasteners, hardware and anchors

Fasteners, hardware and anchors shall be of aluminum or non-magnetic, non-corrosive material compatible with aluminum. All windows shall be provided with non-jamming latches of rocker type designed to be locked from inside. Window locks shall be 'flush type' as manufactured by the Adams Rite Manufacturing Company of Glendale, California or any approved equivalent. The doors shall be provided with cylinder lock and suitable built-in-non-jamming latches and bolts.

Security locks shall be pin type 'Mortice' lock, 6 or 7 pins and adaptable to Master, Grand Master and Great Grand Master keys. Sliding windows and doors shall be fitted with adjustable sealed bearing sheaves of durable hydrated nylons or approved equivalent. Closer, push/pull and kick plates shall have to match with the frames. Any other necessary hardware to be incorporated in the works shall also match with the frame. Assembly and installation screws shall be of stainless steel. Doors, windows, curtain walls etc., to be installed with 'Teflon' injected expanding bolts and sills, shall contain adequate provisions for drainage. Head, sills and jamb members shall be comprised as single unit. Aluminum to aluminum contact between hardware parts or moving members shall not be permitted. Such contacts shall be properly insulated.

Glazing beads

Glazing beads shall be aluminum shape-in-interchangeable type.

Weather stripping

Weather stripping shall be of neoprene or silicon treated woven wood or any approved equivalent.

Joints

All joints shall be mechanically done square (telescopic) joints. No 'Mitral' joints and forced fitting shall be accepted. All units shall be fabricated at the factory with high dimensional accuracy. It shall be rigid and designed to permit complete weather stripping. In principle, the parts should be put together by self-tapping screws.

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Surface finish
All exposed surfaces of aluminum members shall be factory finish and of substantially uniform appearance maintaining the "Architectural" standard.
All exposed surfaces shall be given a natural Anodic Oxide Hardcore coating of 15 micron in thickness and a density of 4 mg per square centimeter and a uniform colour tone conforming to the U.S. Architectural Aluminum Manufacturing Association or any other approved equivalent standard. The colour spectrum shall be an-lock. Finish of hardware shall match closely with the door/window/curtain wall finish.
Accessories
All accessories necessary for proper fixing and operation such as anchors, clips, fins, sub-frames, metal sills, mullion, covers, other trim, cleaning anchors, glazing beads, weathering and glazing strips, hardware and mechanical operators, etc. shall be supplied ready to set in place with the door, window, curtain wall units.
Steel or wood sub-frames shall be painted with Zinc Chromatic primer incase of steel and with wood preservative in case wood. Steel anchor shall be properly insulated from aluminum frame.
Sealant
Sealant shall be one part elastic compound of "Architectural" grade caulk and shall be in matching colour.

3.5.9 SHOP DRAWINGS

The Contractor shall prepare detailed design of all works involved in line with the Employers design and prepare Shop Drawings for the total works and submit to the Engineer for approval before factory fabrication starts. All exterior doors, windows and curtain walls shall be designed to withstand a wind pressure of 180 kg/cm2.

3.5.10 INSTALLATION

All units shall be assembled at Site under proper conditions, erected, fixed and glazed in place in strict conformity with the manufacturer's instruction. All cut-out operations for hardware preparation shall be made accurately and reinforced as required.
All doors, windows, curtain walls, etc. shall be set plumb, square, level and in exact alignment with surrounding works and shall be securely anchored ready for operation. All joints between the masonry opening and frames shall be caulked and sealed after installation of the frames. All installation works shall be done and finished in such a way as to ensure a free and smooth operation.
Abrasion or other injuries to the finished surfaces shall be carefully avoided. Cleaning should be accomplished with plain water or a petroleum type cleaning agent or with the manufacturer's recommended cleaning reagent. No corrosive reagent shall be used

3.5.11 MEASUREMENT

All aluminium door and window frame shutter with glass assemblies complex including all hardware, installed in place shall be measured in square meter of the installed frame. Only the works completed in accordance with the provisions of the BOQ, and/or as shown on the Drawings and/or as directed by the Engineer and accepted by the Engineer will be eligible for payment.

3.5.12 PAYMENT

For all aluminium door and window frame shutter with glass, the amount of completed and accepted work measured as provided above shall be paid at the Contract unit price per square meter, which payment shall constitute the full compensation for furnishing all materials and assemblies and hardware, fitting and fixing, all tools, accessories and appliances and labour including storage, transport, and providing scaffolding and all other works as well as all incidentals necessary for satisfactory completion of all works as per specifications and requirements described under this Subsection the Bill of Quantities, as shown on the Drawings and as directed by the Engineer.

Item of Payment	Unit
Aluminium door, windows and curtain walls	Square meter / Square feet

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3.6 LIME

Lime shall be stone lime of good quality high calcium lime containing calcium oxide from 95% upwards. The impurities, insoluble in acids, should not exceed 3% for the quick lime and 1% for the hydrated lime. Limes shall conform to the requirements of ASTM C 5 for quick lime and ASTM C 207 for hydrated lime.

3.6.7 STORAGE AND HANDLING OF LIME

Quicklime shall be slaked as soon as possible. If not possible, it may be stored in compact heaps having only the minimum of exposed area. The heaps shall be stored on a suitable platform under a roof protected from rain and wind. A minimum space of 300mm shall be provided all round the heaps to avoid bulging of walls.
Un-slaked lime shall be stored in a watertight place and shall be separated from combustible materials.
Hydrated lime shall be supplied either in containers or sacks, such as jute bags lined with polyethylene or high density polyethylene woven bags lined with polyethylene or craft paper bags. It shall be stored in a dry room to protect the lime from dampness and to minimize warehouse deterioration.
When dry slaked lime is to be used within a few days, it shall be stored on a covered platform and protected from rain and wind. It shall be kept in a dry airtight god own when immediate use is not required. However, it shall never be stored for more than two months.
Workmen, handling bulk lime, shall wear protective clothing, respirators and goggles. They shall be instructed for cleanliness as a preventive measure against dermatitis and shall be provided with hand cream, petroleum jelly or similar protectors.

3.6.8 WATER

Water shall be clean, fresh and free from organic or inorganic matter in solution or suspension in such amount that may impair the strength or durability of the concrete. Water shall be obtained from a supply, where possible. However, it may be taken from any other sources, only if approved. No water from excavation shall be used. Only water of approved quality shall be used for washing shuttering, curing of concrete and similar other purposes.
Water to be used in construction shall be stored in tanks, bottom and the sides of which shall be constructed with brick or concrete. Contact with any organic impurities shall be prevented.
The tank shall be so located as to facilitate easy storage and filling in, and supply for construction works and other purposes.

3.6.9 FILL

Materials for filling shall be uniform in character throughout and free from substances that by decay or otherwise may cause the formation of hollows or cavities or otherwise affect the stability of the filling. Earth filling shall be of selected materials obtained from the excavation or carted fine sand as approved by the Engineer. No soft chalk or clay or earth with a predominating clay content shall be used. Hard core shall be selected hard clean gravel, broken brick, broken concrete, broken or crushed stone, quarry waste or similar approved materials. Concrete for filling shall be to the proportions specified.

3.7 TIMBER

3.7.7 GENERAL

All timbers for temporary or permanent works shall be of best quality, sound, straight and wellseasoned. They shall be free from sap, defects, radial cracks, cup-shakes, large/loose/dead knots, or other imperfections and shall show a clean surface with cut.
Timber shall be stored in stacks on well treated and even surfaced beams, sleepers or brick pillars so as to be at least 200mm above the ground level. Members shall be stored separately in layers according to the lengths.
A space of 25mm shall be kept between the members. The longer pieces shall be placed in the bottom layers and the shorter pieces in the top layers. At least one end of the stack shall be in true vertical

alignment.
The recommended width and height of a stack are 1.5m and 2.0m respectively. Minimum distance between two stacks shall be 800mm.
The stacks of the timbers shall be protected from hot dry wind, direct sun and rain. Weights may be placed on top of the stacks to prevent wrapping of timber. Nails, metal straps, etc. attached to used timber shall be removed before stacking.

3.7.8 INSPECTION

All timbers shall be subject to inspection at Site piece by piece and shall be to the approval of the Engineer who may reject such timber as is considered by him to be under-specified. In the case of timber specified to be creosoted, the Engineer may reject such timber before or after creosoting, if specifications are not correctly followed. The Contractor shall provide all necessary labour for handling the timber during inspection free of charge.

3.7.9 WROUGHT FACES AND ALLOWANCES ON JOINER'S WORK

All joiner's works shall be wrought and finished with a clean, even and smooth face. Thickness shall be given to include 2mm for each wrought face in soft- wood and 1.5mm for hard wood.

3.8 MARBLE

3.8.7 MARBLE STONE

Marble shall be of Italian origin or equivalent and size as per Drawing having approved color and texture.

3.8.8 MARBLE CHIPS

Marble chips shall be white in approved color and shall be of size # 2-3 (retained on screens 6mm and 19mm mesh). The chips shall be of uniform color and texture and shall be made from white marble stone, a calcareous metamorphic rock, which is capable of being polished and have following properties:

compressive strength	562 - 844 kg/cm2
Specific gravity	2.72
Unit-weight	2563-2724 kg/m3

3.8.9 MARBLE DUST

Marble dust shall consist of finely grounded white marble stone and 90% shall pass sieve # 100.

3.10 FALSE WORK AND FORMS

SCAFFOLDING (FALSE WORK)
Scaffolding is defined to be any temporary structure required to support structural elements of concrete, steel, masonry, or other materials at the time of their construction or erection.
Plans, Drawings and structural calculations in details shall be submitted to the Engineer for approval, but in no case shall the Contractor be relieved of his responsibilities for results obtained by using this Document.
All scaffolding shall be designed and constructed to provide the necessary rigidity and strength to safely support all loads imposed and produced in the finished structure, the lines and grades indicated on the Drawings. The supports shall be designed to withstand the worst combination of self-weight, formwork weight, formwork forces, reinforcement weight, wet concrete weight, construction and wind loads, together with all incidental dynamic effects caused by placing, vibrating and compacting the concrete. No harmful cracking should occur in the placed concrete. The Engineer may require the Contractor to employ screw jacks or hardwood wedges to take up any settlement in the formwork either before or during the placing of concrete.
All scaffolding, exceeding 20m or six storeys in height, shall be constructed of noncombustible or fire-retardant materials.
Scaffolding shall be founded on a solid base, which is safe against undermining, protected from softening and capable of supporting the loads imposed on it. Scaffolding which cannot be founded on a satisfactory

footing shall be supported on piling, which shall be spaced, driven and removed in a manner approved by the Engineer.

Horizontal and inclined bracings shall be provided for posts higher than 3m. Spans of beam bottoms shall be supported by posts with maximum 1m apart when steel is used and instructions from the manufacturer/supplier shall be strictly followed. Spacing of the props under beams shall consider the increased load and shall be posted closer than those under the floor slab.

Scaffolding can, in certain cases, be supported on structures already constructed. In that case, the Contractor shall submit in due time to the Engineer in writing all information on the loading from the scaffolding as requested. The Engineer shall consider the loading and submit his approval in writing.

Scaffolding shall be set to give the finished structure the camber shown on the Drawings or specified by the Engineer. If any weakness develops or the scaffolding shows undue settlement or distortion during construction, the work shall be stopped and any structure affected thereby shall be removed and the scaffolding shall be further strengthened before work is resumed. Suitable screw jacks, pairs of wages or other devices shall be used at each post to adjust scaffolding to grade.

All materials used in the construction of the scaffolding shall conform to the corresponding ASTM or BS Standards or any other equivalent International Standards. Material tests and certificates may be required by the Engineer. Examinations of welding may also be requested. Test loading of the scaffoldings may be requested for the determination of the flexibility and the strength. All expenses of the tests and examinations of scaffoldings shall be borne by the Contractor on non-reimbursable basis.

Scaffolds shall be made from strong bamboo poles, wooden posts, steel pipes or any other suitable materials. They shall be adequately tied to vertical members resting on firm floor. Strong ropes shall be used to tie up bamboo poles. In addition, cross-bracing with bamboo or wooden posts shall be provided along with ties or guys of steel wire or rod not less than 6mm in diameter.

Good, sound and uniform bamboo shall be collected in sufficient quantities for providing scaffolding, propping, temporary staging, ramp etc. The bamboos shall be free from any defects, firmly ties to each other and joints made smooth. Joining members only with nails shall be prohibited. Bamboos for vertical support shall not be less than 75mm in diameter and shall be straight as far as possible. Bamboos may be used as vertical support for up to a height of 4m, if horizontal bracings are provided at the centre. Splicing shall be prohibited.

After stripping the formwork, the bamboo posts shall be cleaned and stacked vertically in shade protected from rain and sun. Defective or damaged bamboo posts shall be removed from the Site.

Timber posts shall be used in supporting formwork upto a height of 6m. The posts shall not be less than 80mm in diameter at any place and shall spread to at least 150mm in diameter at the top. The timber posts shall be supported on timber planks at the bottom. Either the bottom or the top of the posts shall be wedged with a piece of triangular wood peg for easy removal. Adequate horizontal and inclined braces shall be used for all timber centering. All timber posts shall be carefully inspected before use and members with cracks and excessive knots and crookedness shall be discarded. The joints shall normally be made with bolts and nuts. No rusted or spoilt threaded bolts and nuts shall be used.

When steel scaffoldings are used, it shall be painted in a manner that no mark of corrosion shall appear on the permanent concrete structures.

The Engineer shall only select the type of scaffolding. Bamboo scaffolding will only be used, if agreed and allowed by the Engineer. All scaffoldings shall remain in place for a period, which shall be determined by the Engineer.

Scaffold shall be dismantled after use piece by piece. Holes in the wall shall be filled up with the same materials as that of the wall. Filled up holes shall have uniformity in texture and colour with the surrounding surface. Crash striking shall not be allowed.

Triangular wooden wedges shall be put under the posts for easy dismantling of the members. Timber planks or steel sheets shall be placed at a time below the vertical or inclined posts covering several posts.

Materials and joints in scaffolding shall be inspected from time to time both before and after erection for the soundness, strength, damage due to weathering etc. Inspections shall be made for spillage of material or liquids, loose material lying on the gangways and proper access to the platform.

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The scaffold shall be secured to the building at enough places; no ties shall be removed. Warning sign, prohibiting the use of any defective or incomplete scaffold and working in bad weather and high wind, shall be posted in a prominent place. Inspections shall be made for the observance of these requirements.

3.11 DAMP PROOF COURSE

3.11.1 DESCRIPTION

Works covered under this item shall consist of constructing a layer of cement concrete with specified proportion and in required thickness with top surface painted with Asphalt/Coal tar.

3.11.2 MATERIALS

Cement

Cement used in the works shall be ordinary Portland cement complying with the requirements of ASTM C150 Type 1 or BS 12 or equivalent standard and those stated under the Section on 'Construction Materials' of this Specification.

Coarse aggregate

Coarse aggregate shall conform to the requirements of ASTM C 330.

Coarse aggregate shall be hard, durable, clean, free from dust and other deleterious material to be obtained by crushing 1st class/picked jhama bricks. The grading of the coarse aggregate shall be such that when combined with the approved fine aggregate and cement, it shall produce a workable concrete of maximum density which has been considered to be 10mm down graded in this case.

Materials shall also conform to the requirements specified in the relevant Sub-section of the Section titled 'Construction Materials' of this Specification.

Fine aggregate

Fine aggregates shall be non-saline clean natural sand and have a specific gravity not less than 2.6, a Fineness Modulus not less than what will be specified for a particular type of DPC and conform to the requirement of ASTM C 33 and those stated under the relevant Sub-section(s) of the Section on 'Construction Materials' of this Specification. Sand, to be used for Damp Proof Course, will be of FM normally not below 1.8 or as directed by the Engineer.

Water

Water shall be clean, free from injurious quantities of oil, alkali, salts and organic materials or other substances that may be deleterious to concrete or reinforcement and shall not contain any visibly solid material. If requested by the Engineer, water shall be tested by comparing with water of known satisfactory quality. All other requirements shall be similar to what have been stated under the relevant Sub-sections of the Sections on 'Concrete Work' and 'Construction Materials' of this Specification.

Asphalt

Asphalt shall conform to the requirements of ASTM D 312. Type-1 shall be used below ground and Type- 2 shall be used above ground.

3.11.3 CONSTRUCTION METHODS

25mm to below 40mm thick cement concrete mixture prepared with 1 part cement, 2 parts sand and 4 parts brick chips is to be installed following the procedures stated under the Section on 'Concrete Work' of this Specification. In case of DPC designed with a 40mm thickness, the cement concrete mixture may be prepared with 1 part cement, 1½ parts sand and 3 parts brick chips. Two coats of hot asphalt should be applied over the cement concrete when the concrete has been fully cured and dried. The surface to be damp-proofed shall be primed and thoroughly mopped with asphalt. When the first mopping of asphalt has set sufficiently, the entire surface shall be mopped with second coating of hot asphalt. Special care shall be taken to see that there are no skips in the coatings and that all surfaces are thoroughly covered. The asphalt used should not melt or soften in the hottest days and should not get squeezed due to pressure of the masonry over it.

All concrete surfaces, which are to be damp-proofed shall be reasonably smooth and free from foreign material that would prevent bond. The surface shall be dry and immediately before the application of the

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primer, the surface shall be thoroughly cleaned of dust and loose materials.
The damp-proof course should be laid flush with the floor surface and should not be carried across doorways or other openings. The upper layer of cement concrete floors should be continued over such openings and should be laid at the same time as the floors. The asphalt or tar layer should be laid under the concrete at the openings. Where concrete is laid on bitumen or tar, the surface of the bitumen or tar must be sprinkled with dry sand.
The position of the damp proof course is also an important factor and it should be laid at such a height that it is above the normal level to which water splashes from the ground when it is raining. A damp proof course should not be less than 15cm above the highest level of the ground.

3.11.4 MEASUREMENT

Damp proofing shall be measured in square meter of the works completed in place, in accordance with the Specifications stated herein and/or with the provisions of the Bill of Quantities and/or as shown on the Drawings and/or as directed by the Engineer. Only the completed works as accepted by the Engineer will be eligible for payment.

3.11.5 PAYMENT

The amount of completed and accepted work as measured above shall be paid for at the Contract unit price per square meter. The payment shall constitute the full compensation for the cost of furnishing all equipment, materials, labour for preparation of concrete mixture and its casting, compacting, curing, including, asphalt painting including all storage, handling and transport and all incidentals necessary for the satisfactory completion of the damp-proofing as per specifications and requirements described under this Sub-section the Bill of Quantities, as shown on the Drawings and as directed by the Engineer.

Item of Payment	Unit
Damp-proofing	Square meter / Square feet

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3.12 SYNTHETIC ENAMEL PAINT

Works covered under this item shall consist of painting metallic surface or wooden surface where water proofing is required or the places as directed by the Engineer. Synthetic enamel paint of any approved brand and colour shall be used in minimum 3 coats in accordance with these specifications, as per the provisions in the BOQ and/or as directed by the Engineer or as specified by the manufacturers. Painting shall be done in a manner to obtain an even, smooth finish of confirm shade and without any mark of brush and joint.

3.12.1 MATERIALS

Paint shall consist of ready-mixed synthetic enamel of approved type supplied in original sealed containers bearing the name of the manufacturer of the paint.
All painting materials shall be of the best quality and be delivered at the Site in sealed original containers bearing manufacturer's labels and seals.
Materials to be used in the work shall conform to the reputed manufacturer's specifications and to the satisfaction of the Engineer.

3.12.2 STORAGE OF MATERIALS

Materials and tools shall be stored in a single place at the Site as designated by the Engineer.
Storage area shall be maintained in a neat and clean condition with surroundings protected from damage.
Inflammable materials shall be stored in sealed containers. Waste shall be removed from the premises at the end of each day's work. Every precaution shall be taken to prevent fire.
Storage area shall be all time accessible to the Engineer.

3.12.3 CONSTRUCTION METHODS

General
Before purchasing materials, the Contractor shall submit to the Engineer a list showing the brand and type of paints proposed for this item of work. Manufacturer's catalogue or specification sheets, in triplicate, for materials selected shall be submitted to the Engineer with the list of brands and types. No material shall be used without the approval of the Engineer.
Colours And Samples
Colour scheme shall conform the Finish Schedule and as directed by the Engineer. All tinting and matching shall be to the satisfaction of the Engineer.
For all painted finishes, samples shall be prepared as per direction of the Engineer on pieces of the same kind of material surface at least on an area of 150mm by 300mm. The finished sample shall be approved by the Engineer.
Protection
Drop cloths or other approved protection materials shall be furnished and laid on all areas where painting and finishing is being done so as to adequately protect floor and other places from all damages caused during the execution of the painting work.
SURFACE PREPARATION
For Metallic Surface
All metallic surfaces shall be prepared before application of paint.
For ferrous metal, the surfaces shall be cleaned by brushing with wire brush or sand paper to remove all rust, weld spatter an other foreign particles. Any grease and oil film shall be removed with a solvent, using a fine steel wood pad or a coarse cloth. All damages to shop coat caused by erection, repairing and cleaning shall be spot primed with the same materials used for the shop coat.
In case of galvanized metal, the surfaces shall be cleaned and dried. Any grease and oil film shall also be removed with a solvent, using a fine steel wood pad or a coarse cloth. It is considered that paint will adhere to galvanized iron if the surface is washed with vinegar or slaked lime and washing soda before painting.
In all cases manufacturer's instructions are to be strictly followed in preparing the surfaces to be painted.

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For Wooden Surface

Wood, the surfaces, which are to be painted, shall be well seasoned and the surface to be painted shall be perfectly dry. The surfaces of woodwork to be painted or polished should be rubbed down perfectly smooth with medium and fine grade sandpaper. All rubbing to be done with the grain. Worked timber should be primed as soon as possible particularly on the cut end grain. New woodwork shall be knotted, primed and stopped before given coats of paint.

APPLICATION OF PAINT

Wooden And Ferrous Metallic Surfaces

The workmanship for painting shall be of high quality and experienced and skilled painters shall be engaged for the work.

No work shall be done under conditions, which are not suitable for the production of good results. All spaces shall be broom cleaned before painting or finishing is started.

All paint shall be applied with brushes under adequate illumination, evenly spread, smoothly flowed on without runs or sags. Paint shall be worked into all corners and crevices. Materials shall be applied in strict accordance with the manufacturer's directions. In particular, no prepared paint shall be thinned by any methods except as directed by the manufacturer. All paint shall be thoroughly mixed before being applied.

Each coat applied must be inspected and approved by the Engineer before the application of the succeeding coat. Otherwise no credit for the coat applied will be given and the Contractor may require to repeat the work at his own expenses. The Contractor shall notify the Engineer when each coat is ready for inspection.

No exterior painting shall be done in rainy and damp weather until the surface is thoroughly dry. No interior painting shall be done on damp surfaces.

Drying time for every coat shall not be less than 72 hours and 48 hours for exterior paints and interior paints respectively. Each coat shall be thoroughly dry before application of subsequent coat.

All natural finished woodwork, painted woodwork and painted metal shall be slightly sanded between coats using No.'00' sandpaper. The finished surface must be smooth, evenly leveled and free from brush marks.

Natural finished woodwork only shall be rubbed with fine sandpaper after the last coat has received the desired finish as per approved sample.

All woodwork for natural finish shall be sealed on the back and all surfaces, which will be concealed after erection with two coats of an approved transparent sealer prior to installation.

After being fitted by the Carpenter, all edges of the doors and windows shall be finished in the same way as the faces.

All exposed piping (except PVC), if specified shall be painted to match the adjoining wall surfaces where such wall surfaces are either glazed tile or painted.

Painting around finish hardware of other removable items already in place shall not be allowed.

Wherever scaffolding is necessary, it shall be free standing so as not to damage or scratch the painted surface.

The Contractor shall rectify at his own expenses any damage that may be caused to the adjacent works during painting.

Galvanized Iron Surfaces

Galvanized iron should not be painted until it has been exposed to the weather for a year as paint adheres badly to new galvanized iron. If necessary to paint sooner, a coat composed of about 200 grams of copper acetate added to 5 litres of water, or 60 grams of muriatic acid added to a mixture of 60 grams each of copper chloride, copper nitrate and sal-ammoniac, dissolved in 5 litres of soft water, to which a small quantity of hydrochloric acid has been added, should be given. This will be sufficient for about a surface area of 250 square meter.

Completion

At completion of painting work, the Contractor shall remove any paint spot and stain caused during the whole process of works as stated under this Sub-section from floors, walls, glass, hardware, equipment

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and other surfaces leaving these surfaces in perfect condition.
The Engineer shall conduct a final inspection of all works completed in accordance with this Subsection and the Contractor shall repaint or retouch, as directed by the Engineer, any surface which do not comply with the requirements of these specifications or which have been damaged during performing works. All surfaces finished under this Sub-section shall be left in perfect condition, free from defects and blemishes. All rubbish and accumulated painting materials shall be removed from the premises.

3.12.4 MEASUREMENT

Measurement shall be taken for payment in square meter of the surface area actually painted with required quality in accordance with the provisions of the BOQ and/or as directed by the Engineer. Only the completed works as accepted by the Engineer will be eligible for payment.

3.12.5 PAYMENT

The amount of completed and accepted work measured as provided above shall be paid at the Contract unit price per square meter which payment shall constitute the full compensation for furnishing all materials, equipment, appliances and labour including storage, transport, preparing, mixing and applying putty, primer and paint and providing scaffolding as well as all incidentals necessary to complete the work as per specifications and requirements described under this Subsection the Bill of Quantities, as shown on the Drawings and as directed by the Engineer.

Item of Payment	Unit
Synthetic enamel painting	Square meter / Square feet

3.13 PAINTS AND PROTECTIVE MATERIALS

3.13.1 KNOTTING

Knotting shall be uniform dispersion of lac or suitable resin (natural or synthetic) in a suitable solvent. White lead paint shall be made from pure white lead in accordance with BS 239, mixed with fine boiled linseed oil, turpentine, dryers and pigments and strained free from skins and all extraneous matter before being pigments. If so used, the quantity shall not exceed 8% of the paint mixed ready for the brush. No other ingredient except the coloring matter will be allowed and the color shall be produced by using the least required amount of coloring matter. The proportions of the ingredients for the various coats shall be subject to the approval of the Engineer.

3.13.2 RED LEAD PAINT

Red lead paint shall be made from non-setting red lead in accordance with BS 217, thoroughly ground and well and freely mixed with approximately 15% of boiled linseed oil to give a paint with good covering power, bobby and adhesion. It shall be determined by tests to be made by the Contractor to the satisfaction of the Engineer. The Engineer may select samples of the paint for analysis after a sufficient quantity of the work about to be painted has been mixed.

3.13.3 LINSEED OIL PUTTY

Putty for stopping and glazing shall consist of whiting/chalk powder thoroughly ground with linseed oil to form a smooth paste, and shall conform BS 544.

3.13.4 VARNISHES/WOOD POLISH

The material is required to be clear and transparent and when applied shall on drying, give a glossy coating free from fun and specks. The composition of the varnish shall conform to the requirements of BS 274.

3.13.5 WHITE WASH

White wash shall be made from pure flat lime brought to the work in an un slaked condition. Water shall be added to this lime in a tub until the mixture is of the consistency of cream and shall be allowed to rest for a period of 48 hours. The mixture shall then be strained through an approved cloth strainer and 4 kg of

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gum boiled with 12 kg of rice and a suitable quantity of blue shall be added per cubic meter of the mixture.

3.13.6 COLOUR WASH

Colour wash, where not of an approved proprietary brand, shall be made from pure selected fat lime as described above for white wash, to which shall be added and intimately mixed the necessary pigment to produce the tint specified. The pigment shall be to the approval of the Engineer.

3.13.7 OIL BOUND DISTEMPER

Oil bound distemper shall comply with BS 1053 Type-1 and shall be obtained from an approved manufacturer.

3.13.8 EMULSION PAINTS

Berger/ICI Emulsion Paints shall preferably be used but the Engineer may allow any other brands of equivalent standard subject to the production of appropriate test certificates and guarantees.

3.13.9 CREOSOTE

The Creosote is a paint used for preservation of timber. It shall be pure tar distillate of the best quality as obtained and sold under the trade name "SOLIGNUM'. The 'SOLIGNUM' shall be clear so as not to mar the timber. Other brands equivalent to 'SOLIGNUM' may also be used, if only approved by the Engineer.

3.13.10 STORAGE AND HANDLING OF PAINT, VARNISHES, ETC

Paints, varnishes, lacquers and thinners shall be kept in properly sealed or closed containers. The containers shall be kept in a well-ventilated location, free from excessive heat, smoke, sparks or flames. The floor of the paint store shall have at least 100 mm thick loose sand on it.
Temporary electrical wiring and fittings shall not be installed in a paint store. When electrical lights, switches or electrical equipment are necessary to be stored or used in the same room, the room shall be designed in a way to reduce explosion risks.
Buckets containing sand shall be kept ready for use. A five-kilogram dry powder fire extinguisher conforming to accepted standards shall be kept at an easily accessible position close to the paint store.

3.14 PLASTIC PAINTING

Works covered under this item shall consist of painting plastered wall or ceiling surfaces or the places as directed by the Engineer. Synthetic resin emulsion paint of any approved brand and colour shall be used in minimum 3 coats in accordance with these specifications, as per the provisions in the BOQ and/or as directed by the Engineer or as specified by the manufacturers. Painting shall be done in a manner to obtain an even, smooth finish of confirm shade and without any mark of brush and joint.

3.14.1 MATERIALS

Paint shall consist of ready-mixed synthetic emulsion resin base water-thinned approved products supplied in original sealed containers bearing the manufacturer's trade mark.
All painting materials shall be of the best quality and be delivered at the Site in sealed original containers bearing manufacturer's labels and seals.
Materials to be used in the work shall conform to the reputed manufacturer's specifications and to the satisfaction of the Engineer.

Storage Of Materials

Materials and tools shall be stored in a single place at the Site as designated by the Engineer.
Storage area shall be maintained in a neat and clean condition with surroundings protected from damage.
Inflammable materials shall be stored in sealed containers. Waste shall be removed from the premises at the end of each day's work. Every precaution shall be taken to prevent fire.
Storage area shall be all time accessible to the Engineer.

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3.14.2 CONSTRUCTION METHODS

General

Before purchasing materials, the Contractor shall submit to the Engineer a list showing the brand and type of paints proposed for this item of work. Manufacturer's catalogue or specification sheets, in triplicate, for materials selected shall be submitted to the Engineer with the list of brands and types. No material shall be used without the approval of the Engineer.

Colours And Samples

Colour scheme shall conform the Finish Schedule and as directed by the Engineer. All tinting and matching shall be to the satisfaction of the Engineer.

For all finished painting on plastered masonry and concrete surfaces, samples shall be prepared as per direction of the Engineer on the surfaces to be painted. The finished samples shall be approved by the Engineer.

Protection

Drop cloths or other approved protection materials shall be furnished and laid on all areas where painting and finishing is being done so as to adequately protect floor and other places from all damages caused during the execution of the painting work.

Surface Preparation

All surfaces to be painted shall be thoroughly cleaned of all grit, grease, dirt, loose materials, mortar drippings and the like. It is better that some soap is added in the wash.

The surface shall be given a thorough rub down to remove all loose materials and all cracks and surface irregularities shall be prepared with patching plaster and filler to obtain a smooth and even surface to the satisfaction of the Engineer. The filler shall always be spread from the same face of the filling knife, the other face shall be kept clean and free. Brush shall always be cleaned after use. Filler shall be applied before priming and the surface shall be rubbed before the application to ensure clean work and again after application on allowing 12 hours to dry.

The plastered surfaces shall be made smooth by sand papering and made free from marks before applying the first coat.

Voids and holes shall be filled after first the coat becomes dry by using filler compatible with the finishing specified and tinted, if required to camouflage repairs.

In the case of new cement plaster walls, a solution of 2 kg of zinc sulphate in 4 litres of water should be applied to the surface and when dry should be given a coat of pure raw linseed oil; or the surface can be treated with dilute sulphuric or hydrochloric acid (1 part acid to 50 parts water) and then washed down with water. Cares shall be taken to ensure that acids are added to the water and not water to the acids.

Application Of Paint

The workmanship for painting shall be of high quality and experienced and skilled painters shall be engaged for the work.

No work shall be done under conditions, which are not suitable for the production of good results. All spaces shall be broom cleaned before painting or finishing is started.

All paints shall be applied with brushes under adequate illumination, evenly spread, smoothly flowed on without runs or sags. Paint shall be worked into all corners and crevices.

Materials shall be applied in strict accordance with the manufacturer's directions. In particular, no prepared paint shall be thinned by any method except as directed by the manufacturer. All paint shall be thoroughly mixed before being applied.

Each coat shall be thoroughly dry before application of subsequent coat.

Drying time for every coat shall not be less than 72 hours and 48 hours for exterior and interior painting respectively.

Each coat applied must be inspected and approved by the Engineer before the application of the succeeding coat. Otherwise, no credit for the coat applied will be given and the Contractor may require to repeat the work at his own expenses. The Contractor shall notify the Engineer when each coat is ready for inspection.

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No exterior painting shall be done in rainy and damp weather until the surface is thoroughly dry. No interior painting shall be done on damp surfaces.
Wherever scaffolding is necessary, it shall be free standing so as not to damage or scratch the painted surface.
The Contractor shall rectify at his own expenses any damage that may be caused to the adjacent works during painting.

Completion

At completion of painting work, the Contractor shall remove any paint spot and stain caused during the whole process of works as stated under this Sub-section from floors, walls, glass, hardware, equipment and other surfaces leaving these surfaces in perfect condition.
The Engineer shall conduct a final inspection of all works completed in accordance with this Subsection and the Contractor shall repaint or retouch, as directed by the Engineer, any surface which do not comply with the requirements of these specifications or which have been damaged during performing works. All surfaces finished under this Sub-section shall be left in perfect condition, free from defects and blemishes. All rubbish and accumulated painting materials shall be removed from the premises.

3.14.3 MEASUREMENT

Measurement shall be taken for payment in square meter of the surface area actually painted with required quality in accordance with the provisions of the BOQ and/or as directed by the Engineer. Only the completed works as accepted by the Engineer will be eligible for payment.

3.14.4 PAYMENT

The amount of completed and accepted work measured as provided above shall be paid at the Contract unit price per square meter which payment shall constitute the full compensation for furnishing all materials, equipment, appliances and labour including storage, transport, preparing, mixing and applying putty, primer and paint and providing scaffolding as well as all incidentals necessary to complete the work as per specifications and requirements described under this Subsection, the Bill of Quantities, as shown on the Drawings and as directed by the Engineer.

Item of Payment	Unit
Plastic painting on plastered surface	Square meter / Square feet

3.15 DISTEMPERING

Works covered under this item shall consist of distempering plastered wall or ceiling surfaces or the places as directed by the Engineer. Distemper of any approved brand and colour shall be used in minimum 3 coats in accordance with these specifications, as per the provisions in the BOQ and/or as directed by the Engineer or as specified by the manufacturers.
Distempering shall be done in a manner to obtain an even, smooth finish of confirm shade and without any mark of brush and joint.

3.15.1 MATERIALS

Paint shall consist of approved ready-mixed distemper supplied in original sealed containers bearing the manufacturer's trademark.
All distempering materials shall be of the best quality and be delivered at the Site in sealed original containers bearing manufacturer's labels and seals.
Materials to be used in the work shall conform to the reputed manufacturer's specifications and to the satisfaction of the Engineer.

Storage Of Materials

Materials and tools shall be stored in a single place at the Site as designated by the Engineer.
Storage area shall be maintained in a neat and clean condition with surroundings protected from damage. Inflammable materials shall be stored in sealed containers. Waste shall be removed from the premises at the end of each day's work. Every precaution shall be taken to prevent fire.
Storage area shall be all time accessible to the Engineer.

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3.15.2 CONSTRUCTION METHODS

General

Before purchasing materials, the Contractor shall submit to the Engineer a list showing the brand and type of distemper proposed for this item of work. Manufacturer's catalogue or specification sheets, in triplicate, for materials selected shall be submitted to the Engineer with the list of brands and types. No material shall be used without the approval of the Engineer.

Colours And Samples

Colour scheme shall conform the Finish Schedule and as directed by the Engineer. All tinting and matching shall be to the satisfaction of the Engineer.

For all finished distempering on plastered masonry and concrete surfaces, samples shall be prepared as per direction of the Engineer on the surfaces to be painted. The finished samples shall be approved by the Engineer.

Protection

Drop cloths or other approved protection materials shall be furnished and laid on all areas where distempering and finishing is being done so as to adequately protect floor and other places from all damages caused during the execution of the distempering work.

Surface Preparation

All surfaces to be distempered shall be thoroughly cleaned of all grit, grease, dirt, loose materials, mortar drippings and the like.

The surface shall be given a thorough rub down to remove all loose materials and all cracks and surface irregularities shall be prepared with patching plaster and filler to obtain a smooth and even surface to the satisfaction of the Engineer. The filler shall always be spread from the same face of the filling knife, the other face shall be kept clean and free. Brush shall always be cleaned after use. Filler shall be applied before priming and the surface shall be rubbed before the application to ensure clean work and again after application on allowing 12 hours to dry.

The plastered surfaces shall be made smooth by sand papering and made free from of marks before applying the first coat.

Voids and holes shall be filled after first the coat becomes dry by using filler compatible with the finishing specified and tinted, if required to camouflage repairs.

In the case of new cement plaster walls, a solution of 2 kg of zinc sulphate in 4 litres of water should be applied to the plastered surface and when dry should be given a coat of pure raw linseed oil; or the surface may be treated with dilute sulphuric or hydrochloric acid (1 part acid to 50 parts water) and then washed down with water. Cares shall be taken to ensure that acids are added to the water and not water to the acids.

Application Of Distemper

The workmanship for painting shall be of high quality and experienced and skilled painters shall be engaged for the work.

No work shall be done under conditions, which are not suitable for the production of good results. All spaces shall be broom cleaned before distempering or finishing is started.

All distemper shall be applied with brushes under adequate illumination, evenly spread, smoothly flowed on without runs or sags. Distemper shall be worked into all corners and crevices.

Materials shall be applied in strict accordance with the manufacturer's directions. In particular, no prepared distemper shall be thinned by any method except as directed by the manufacturer. All distemper shall be thoroughly mixed before being applied.

Each coat shall be thoroughly dry before application of subsequent coat.

Drying time for every coat shall not be less than 72 hours and 48 hours for exterior and interior painting respectively.

Each coat applied, must be inspected and approved by the Engineer before the application of the succeeding coat. Otherwise, no credit for the coat applied will be given and the Contractor may require to repeat the work at his own expenses. The Contractor shall notify the Engineer when each coat is ready for

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inspection.
No exterior distempering shall be done in rainy and damp weather until the surface is thoroughly dry. No interior painting shall be done on damp surfaces.
Wherever scaffolding is necessary, it shall be free standing so as not to damage or scratch the painted surface.
The Contractor shall rectify at his own expenses any damage that may be caused to the adjacent works during distempering.

Completion

At completion of distempering work, the Contractor shall remove any distemper spot and stain caused during the whole process of works as stated under this Sub-section from floors, walls, glass, hardware, equipment and other surfaces leaving these surfaces in perfect condition.
The Engineer shall conduct a final inspection of all works completed in accordance with this Subsection and the Contractor shall repaint with distemper or retouch, as directed by the Engineer, any surface which does not comply with the requirements of these specifications or which has been damaged during performing works. All surfaces finished under this Sub-section shall be left in perfect condition, free from defects and blemishes.
All rubbish and accumulated painting materials shall be removed from the premises.

3.15.3 MEASUREMENT

Measurement shall be taken for payment in square meter of the surface area actually distempered with required quality in accordance with the provisions of the BOQ and/or as directed by the Engineer. Only the completed works as accepted by the Engineer will be eligible for payment.

3.15.4 PAYMENT

The amount of completed and accepted work measured as provided above shall be paid at the Contract unit price per square meter which payment shall constitute the full compensation for furnishing all materials, equipment, appliances and labour including storage, transport, preparing, mixing and applying putty, primer and distemper and providing scaffolding as well as all incidentals necessary to complete the work as per specifications and requirements described under this Subsection, the Bill of Quantities, as shown on the Drawings and as directed by the Engineer.

Item of Payment	Unit
Distempering plastered surface	Square meter / Square feet

3.16 WHITE WASHING

Works covered under this item shall consist of white washing on the plastered wall or ceiling surfaces or at locations as directed by the Engineer in minimum 3 coats in accordance with these specifications, as per the provisions in the BOQ and/or as directed by the Engineer. White washing shall be done in a manner to obtain an even, smooth finish without any mark of brush and joint.

3.16.1 MATERIALS

Limestone

Limestone is high calcium lime with about 6% material insoluble in acid, obtained by burning pure limestone or chalk in a kiln. Limestone shall be slaked as early as possible after it is burnt in a kiln. Stone lime should be stored in an enclosed space in large heaps and air excluded as far as possible. Un-slaked lime weighs 640 kilogram per cubic meter when fresh, increasing to about 800 kilogram per cubic meter after 10 days.

Shell lime

Shell lime is also high calcium lime with about 6% material insoluble in acid, obtained by burning seashells in a kiln.

Gum Arabic

This is a kind of glue used as a binding agent between the white wash and the plaster surfaces.

Robin Blue

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Robin blue is a kind of manufactured ready-made blue available in packets from reputed manufacturer. This is required for maintaining the whiteness of the wash.

Water

Water shall be clean, free from injurious quantities of oil, alkali, salts and organic materials or other substances that may be deleterious to concrete or reinforcement and shall not contain any visibly solid material. If requested by the Engineer, water shall be tested by comparing with water of known satisfactory quality. All other requirements shall be similar to what have been stated under the relevant Sub-sections of the Sections on 'Concrete Work' and 'Construction Materials' of this Specification.

3.16.2 CONSTRUCTION METHODS

Samples

White washing scheme shall conform the Finish Schedule and as directed by the Engineer. All matching shall be to the satisfaction of the Engineer.

For all finished white washing on plastered masonry and concrete surfaces, samples shall be prepared as per direction of the Engineer on the surfaces to be washed. The finished samples shall be approved by the Engineer.

Protection

Drop cloths or other approved protection materials shall be furnished and laid on all areas where white washing is being done so as to adequately protect floor and other places from all damage caused during the execution of the distempering work.

Preparation Of White Wash

The lime shall be brought to the Site in an un-slaked condition and thoroughly slaked on the spot, mixed and stirred with sufficient water and requisite amount of blue and gum to make a thin cream and allowed to stand for 24 hours. If 4 grams of gum (or shellac) and 50 grams of common salt dissolved in hot water are added to 1 kilogram of limestone for the last coat, the white wash will not easily rub off. Indigo (blue) upto 3 grams per kilogram of lime dissolved in water is added and the wash stirred well.

The lime is placed 30cm deep in a drum or a tub with about 90cm of water and allowed to stand for about 24 hours or such longer period as may be necessary to slake the lime completely. It is better to add lime to the water and not water to the lime. The mixture should be well stirred.

Lime is considered to be completely slaked when the temperature of the lime and the water ceases to rise and any further addition of water also produces no further chemical action or heat. As a precaution, water should be allowed to stand on for 12 hours or more. A vigorous slaking with heat and noise indicates a high calcium content. After slaking, the lime should be screened through a 3.35mm sieve or kept in excess of water to meet the requirements. Limes must be thoroughly slaked which is also ground very fine. Any un-slaked particles left will produce "blisters".

Application Of White Wash

The workmanship for white washing shall be of high quality. Experienced and skilled painters shall be engaged for the work.

No work shall be done under conditions, which are not suitable for the production of good results. All spaces shall be broom cleaned before washing or finishing is started.

The lime wash should be strained through a course cloth or sieved through a fine wire gauge before applying.

All white washing shall be applied with brushes under adequate illumination, evenly spread, smoothly flowed on without runs or sags. White washing shall be worked in to all corners and crevices.

The coats shall be applied alternatively vertically and horizontally. One stroke is given from the top down- wards and the other from the bottom up-wards over the first stroke and similarly, one stroke from the right and another from the left over the first brush before it dries. Each coat shall be let to dry before applying the next coat.

White wash shall be applied on surfaces in two coats over a priming coat. The final coat shall be applied vertically and finished surface shall be free of dust, dirt and must be free from brush marks. The finished dry surface shall not readily come off on the hand when rubbed.

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Brush shall always be cleaned after use.
Wherever scaffolding is necessary, it shall be free standing so as not to damage or scratch the painted surface.
Adequate precautionary measures shall be taken so as not to damage or stain floors, walls or any other works while applying white wash. Any damage, stains or spots caused by white washing shall be rectified and removed at the expenses of the Contractor.
Each coat applied must be inspected and approved by the Engineer before the application of the succeeding coat. Otherwise, no credit for the coat applied will be given and the Contractor may require to repeat the work at his own expenses. The Contractor shall notify the Engineer when each coat is ready for inspection.
No exterior washing shall be done in rainy and damp weather until the surfaces are thoroughly dry. No interior washing shall be done on damp surfaces.
Each coat shall be thoroughly dry before application of the subsequent coat.
Drying time for every coat shall not be less than 72 hours and 48 hours for exterior and interior washing respectively.
The Contractor shall rectify at his own expenses any damage that may be caused to the adjacent works during white washing.

Completion

At completion of white washing, the Contractor shall remove any wash spot and stain caused during the whole process of works as stated under this Sub-section from floors, walls, glass, hardware, equipment and other surfaces leaving these surfaces in perfect condition.
The Engineer shall conduct a final inspection of all works completed in accordance with this Subsection and the Contractor shall rewash or retouch any surface, which do not comply with the requirements of these specifications or which have been damaged during performing works. All surfaces finished under this Sub-section shall be left in perfect condition, free from defects and blemishes.
All rubbish and accumulated painting materials shall be removed from the premises.

3.16.3 MEASUREMENT

Measurement shall be taken for payment in square meter of the surface area actually white washed with required quality in accordance with the provisions of the BOQ and/or as shown on the Drawings and/or as directed by the Engineer. Only the completed works as accepted by the Engineer will be eligible for payment.

3.16.4 PAYMENT

The amount of completed and accepted work measured as provided above shall be paid at the Contract unit price per square meter which payment shall constitute the full compensation for furnishing all materials, equipment, appliances and labour including storage, transport, preparing, mixing and applying putty, primer and all white washing materials and providing scaffolding as well as all incidentals necessary to complete the work as per specifications and requirements described under this Sub- section, the Bill of Quantities, as shown on the Drawings and as directed by the Engineer.

Item of Payment	Unit
White washing	Square meter / Square feet

3.17 CEMENT PLASTER & POINTING

3.17.1 12MM THICK CEMENT-SAND PLASTER ON BRICK MASONRY WALL

3.17.1.1 DESCRIPTION

This item of work shall consist of making 12mm or 19 mm thick cement plaster on Block masonry wall surfaces and at any other appropriate locations in cement mortar with specified proportion. The Work shall consist of furnishing all materials, its transportation and storage, supply of all labors, tools and equipment and the performance of all other allied works that would be required to complete the Work in

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all respect. All works shall be carried out in accordance with these specifications and conforming to the levels, dimensions and designs as shown on the Drawings, provisions of the BOQ and/or to carry out the Work following the directions of the Engineer.

3.17.1.2 MATERIALS

Cement
Cement used in the works shall be ordinary Portland cement complying with the requirements of ASTM C 150 Type 1 or equivalent standard and those stated under the Section on 'Construction Materials' of this Specification.
Fine aggregate
Fine aggregates shall be non-saline clean natural sand and have a specific gravity not less than 2.6, a Fineness Modulus not less than what will be specified for a particular type of plastering and conform to the requirements of ASTM C 33 and those stated under the relevant Sub-section of the Section on 'Construction Materials' of this Specification. Sand, to be used for plastering work, will be normally of F.M. 1.2 or as directed by the Engineer.
Water
Water shall be clean, free from injurious quantities of oil, alkali, salts and organic materials or other deleterious substances and shall not contain any visibly solid materials. All requirements shall be similar to what have been stated under the relevant Sub-section of the Sections on 'Concrete Work' and 'Construction Materials' of this Specification. The Contractor shall get the water tested by comparing with water of known satisfactory quality, if requested by the Engineer.

3.20.1.3 CONSTRUCTION METHODS

Preparation of mortar
Unless otherwise specified on the Drawings or in the BOQ or instructed by the Engineer, cement mortar for plaster works on block masonry walls shall consist by volume of one part Ordinary Portland cement and six parts screened sand of specified F.M. In each mortar, requisite quantity of water shall be added and the components mixed and thoroughly incorporated together to give a workability, appropriate to its use.
Mortar shall be used whilst freshly mixed and no softening or re-tampering will be allowed. Mortar shall be mixed in an approved mechanical mixer unless hand-mixing is specifically permitted by the Engineer and in a manner as to accurately determine and control the quantity of each ingredient in the mortar. The cement and sand shall be first mixed dry until thoroughly mixed before adding mixing water. If hand mixing is permitted, the operation shall be carried out on a clean watertight platform. Cement and sand shall be first mixed dry in the required proportion to obtain a uniform color of the mixture. Water shall then be added sparingly, only to the minimum as would be necessary to produce a workable mixture of normal consistency. The water cement ratio in no case shall exceed 0.50 by weight, or as directed by the Engineer.
Only a sufficient quantity of sand and cement shall be mixed with water that can be used within 30 minutes after water is added. The adding of additional water to and re-tempering (cement mortar that stiffened because of evaporation of water), shall be permitted only within 30 minutes from the time of adding water at the time of initial mixing.
Mortar that has taken initial set shall not be used in the work with or without addition of fresh materials.
Preparation of surface
Before application of plaster, all joints in brick masonry walls shall be adequately raked out with a hooked tool made for the purpose whilst the mortar is still green and not later than 48 hours of the time of lying and smooth concrete surfaces shall be roughened to provide key. Joints should not be raked out with a trowel or a hammer to avoid the edges of the bricks getting chipped. The brickwork should be brushed down with stiff wire brush so as to remove all loose dust from the joints. Surfaces to be rendered shall also be scrubbed clean of all loose materials and be made free from all dust, grease, etc. and be well wetted with water and kept dampen for 24 hours before applying plaster (the walls should not be soaked

but only damped evenly). On old walls it would be required to ensure a good key for the new rendering, to destroy the smooth surface of the brick masonry work with appropriate tools.
Application of plaster
Plaster shall consist of two coats when applied over brick masonry i.e. under and finish.
The under and finish coats shall be applied without an interval. The undercoat shall have a minimum thickness of 6mm and shall be leveled with straight edge and scratched for key. The finish coat shall be troweled over with care and leveled with a straight edge to obtain a flat smooth surface. All edges and corners, unless otherwise shown on the Drawings, shall be rounded or chamfered as directed by the Engineer. All moulds shall be neat, clean and true to template.
Plaster shall be floated and troweled to a true and plumbed surface and tested frequently during the progress of the work with a straight edge sufficiently long. There shall be no overlaps or construction joints in single unbroken surface unless the area is over 28 square meter or prior permission is taken from the Engineer for a deviation. Plaster shall be stopped only at corners, construction or expansion joints.
If any crack appears in the plaster or any part sound hollow when tapped, or found to be soft or otherwise defective after the plaster has dried, the defects shall be mended by cutting out and re- plastering at the Contractor's own costs. Such woks should not leave any visible impression on the places mended.
The methods and equipment used for transporting and placing mortar shall be such, as not to damage or delay the use of mixed mortar. All equipment and tools used for mixing or vehicles used for transporting mortar shall be kept clean and free from set mortar, dirt or other deleterious foreign substances.
All plastering works shall be placed only after all brick masonry surfaces have been prepared satisfactorily in accordance with the specifications and the Engineer's instructions.
The plaster shall not be applied during rain sufficiently heavy or prolonged to wash the mortar. Mortar already applied, but becomes diluted by rain, shall be removed and replaced at the expenses of the Contractor before continuing any further works.

3.20.1.4 SCAFFOLDING

The scaffolding shall be sound and strong enough to withstand all loads likely to be imposed upon it and subject to the Engineer's approval. Pole, going into the masonry should be at a place, which can be filled with a header brick. The holes, which provide resting space for horizontal members shall not be left in masonry under 1m in width or immediately near the skewbacks of arches. The holes left in the masonry work for supporting the scaffolding shall be filled, made good and to be properly finished with plaster.

3.20.1.5 PROTECTION AND CURING

All plasters shall be kept moist throughout the progress of work and protected for a minimum 10 days immediately following completion against harmful effects of weather by suitable covering. During hot weather, all finished or partly completed works shall be covered or wetted in such a manner as will prevent rapid drying of the plaster.
On completion of works, all visible surfaces shall be free from damage or debris and shall look clean. All cares shall be taken so that the plaster surfaces are not stained or coated as the work proceeds. No rubbing of the faces to remove coating shall be allowed,

3.20.1.6 MEASUREMENT

Measurement shall be taken for payment in square meter of the surface of the finished plaster works completed in accordance with the Specifications stated herein and/or as per the provisions of the BOQ and/or as shown on the Drawings and/or as directed by the Engineer. Only the completed works as accepted by the Engineer will be eligible for payment.

3.20.1.7 PAYMENT

The amount of completed and accepted work measured as provided above shall be paid at the Contract unit price per square meter of plaster which price shall constitute full compensation for furnishing all materials including their transportation and storage, mixing of mortar, plastering surfaces and corners, rounding and/or chamfering preparing, cleaning and watering the surfaces to be plastered, watering and

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protecting the plaster after completion, providing scaffolding and its erection and removal, all other works and all incidentals necessary to complete the Work as per requirements described under this item of work, the BOQ, as shown on the Drawings and/or as directed by the Engineer.

Item of Payment	Unit
12mm thick cement-sand plaster	Square meter / Square feet

3.20.2 12MM THICK CEMENT-SAND PLASTER ON R.C.C SURFACES

3.20.2.1 DESCRIPTION

This item of work shall consist of making 12 mm thick cement plaster on R.C.C surfaces and at any other appropriate locations in cement mortar with specified proportion. The Work shall consist of supply of all materials, labor, tools and equipment, carriage and the performance of all other allied works. All works shall be carried out in accordance with these specifications and conforming to the levels, dimensions and designs as shown on the Drawings, provisions of the BOQ and/or to carry out the Work following the directions of the Engineer.

3.20.2.2 MATERIALS

Cement

Cement used in the works shall be ordinary Portland cement complying with the requirements of ASTM C 150 Type 1 or equivalent standard and those stated under the Section on 'Construction Materials' of this Specification.

Fine aggregate

Fine aggregates shall be non-saline clean natural sand and have a specific gravity not less than 2.6, a Fineness Modulus not less than what will be specified for a particular type of plastering and conform to the requirements of ASTM C 33 and those stated under the relevant Sub-section of the Section on 'Construction Materials' of this Specification. Sand, to be used for plastering work, will be normally of F.M. 1.2 or as directed by the Engineer.

Water

Water shall be clean, free from injurious quantities of oil, alkali, salts and organic materials or other deleterious substances and shall not contain any visibly solid materials. All requirements shall be similar to what have been stated under the relevant Sub-section of the Sections on 'Concrete Work' and 'Construction Materials' of this Specification. The Contractor shall get the water tested by comparing with water of known satisfactory quality, if requested by the Engineer.

3.20.2.3 CONSTRUCTION METHODS

Preparation of mortar

Unless otherwise specified on the Drawings, or in the BOQ or instructed by the Engineer, cement mortar for plaster works on R.C.C surfaces shall consist of one part Ordinary Portland cement and four parts screened sand of specified F.M. by volume. In each mortar, right quantity of water shall be added and the components mixed and thoroughly incorporated together to give a workability, appropriate to its use. Mortar shall be used whilst freshly mixed and no softening or re-tampering will be allowed.

Mortar shall be mixed in an approved mechanical mixer unless hand-mixing is specifically permitted by the Engineer and in a manner as to accurately determine and control the quantity of each ingredient in the mortar. The cement and sand shall be first mixed dry until thoroughly mixed before adding mixing water. If hand mixing is permitted, the operation shall be carried out on a clean watertight platform, Cement and sand shall be first mixed dry in the required proportion to obtain a uniform color of the mixture. Water shall then be added sparingly, only the minimum necessary to produce a workable mixture of normal consistency. The water cement ratio in no case shall exceed 0.50 by weight, or as directed by the Engineer.

Only a sufficient quantity of sand and cement shall be mixed with water that can be used within 30 minutes after water is added. The adding of additional water to and re-tempering (cement mortar that stiffened because of evaporation of water), shall be permitted only within 30 minutes from the time of

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adding water at the time of initial mixing.
Mortar that has taken initial set shall not be used in the work with or without addition of fresh materials.
Preparation of surface
Before application of plaster, smooth concrete surfaces shall be roughened to provide key. The surfaces shall be scrubbed clean of all loose materials and soaked with water and kept dampen for 2 hours before plastering. A neat cement coat shall be applied on all concrete surfaces before application of plaster.
Application of plaster
Plaster shall consist of a grout application and a finish coat, when applied direct to concrete surface. The under and finish coats shall be applied without an interval.
All edges and corners, unless otherwise shown on the Plans, shall be rounded or chamfered as directed by the Engineer. All molds shall be neat, clean and true to template.
Plaster shall be floated and troweled to a true surface and tested frequently during the progress of the work with a straight edge sufficiently long. There shall be no overlaps or construction joints in single unbroken surface unless the area is over 28 square meter or prior permission is taken from the Engineer for a deviation. Plaster shall be stopped only at corners, construction or expansion joints.
If any crack appears in the plaster or any part sound hollow when tapped or found to be soft or otherwise defective after the plaster has dried, the defect shall be mended by cutting out and replastering at the Contractor's own costs.
The methods and equipment used for transporting and placing mortar shall be such, as not to damage or delay the use of mixed mortar. All equipment and tools used for mixing or transporting mortar shall be kept clean and free from set mortar, dirt or other deleterious foreign substances.
All plastering works shall be placed only after all R.C.C surfaces have been prepared satisfactorily in accordance with the specifications and the Engineer's instructions.
The plaster shall not be applied during rain sufficiently heavy or prolonged to wash the mortar when the works are carried out under open sky. Mortar already applied, but becomes diluted by rain, shall be removed and replaced before continuing the work at the expenses of the Contractor.

3.20.2.4 SCAFFOLDING

The scaffolding shall be sound and strong enough to withstand all loads likely to be imposed upon it and subject to the Engineer's approval. If any place is left out or the plaster gets damaged by resting of poles, the places shall be made plastered or repaired before/on removal of the scaffolding at the expenses of the Contractor.

3.20.2.5 PROTECTION AND CURING

All plaster shall be kept moist throughout the progress of work and protected for a minimum 10 days immediately following completion against harmful effects of weather by suitable covering when the location is exposed under the open sky. During hot weather, all finished or partly completed works shall be covered or wetted in such a manner as will prevent rapid drying of the plaster.
On completion of works, all visible surfaces shall be free from damage or debris and shall look clean. All cares shall be taken that the plaster surfaces are not stained or coated as the work proceeds. No rubbing of the faces to remove coating shall be allowed.

3.20.2.6 MEASUREMENT

Measurement shall be taken for payment in square meter of the surface of the finished plaster works completed in accordance with the Specifications stated herein and/or as per the provisions of the BOQ and/or as shown on the Drawings and/or as directed by the Engineer. Only the completed works as accepted by the Engineer will be eligible for payment.

3.20.2.7 PAYMENT

The amount of completed and accepted work measured as provided above shall be paid at the Contract unit price per square meter of plaster which price shall constitute full compensation for furnishing all materials including their transportation and storage, mixing of mortar, plastering surfaces and corners,

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rounding or chamfering preparing, cleaning and watering the surface to be plastered, watering and protecting the plaster after completion, providing scaffolding and its erection and removal, all other works and all incidentals necessary to complete the Work as per requirements described under this item of work, the Bill of Quantities, as shown on the Drawings and/or as directed by the Engineer.

Item of Payment	Unit
6mm thick cement-sand plaster	Square meter / Square feet

3.20.3 12MM THICK CEMENT - SAND SKIRTING/DADO

3.20.3.1 DESCRIPTION

This item of work shall consist of providing 12mm thick cement-sand plaster with neat cement finishing in skirting/dado on brick masonry wall surfaces and at any other locations where necessary in cement mortar with specified proportion. The Work shall include supply of all labour, materials, tools and equipment, carriage and the performance of all necessary works. All works shall be carried out in accordance with these specifications and conforming to the levels, dimensions and designs as shown on the Drawings, provisions of the BOQ and/or to carry out the Work following the directions of the Engineer.

3.20.3.2 MATERIALS

Cement

Cement used in the works shall be ordinary Portland cement complying with the requirements of ASTM C 150 Type 1 or BS 12 or equivalent standard and those stated under the Section on 'Construction Materials' of this Specification.

Fine aggregate

Fine aggregates shall be non-saline clean natural sand and have a specific gravity not less than 2.6, a Fineness Modulus not less than what will be specified for a particular type of plastering and conform to the requirements of ASTM C 33 and those stated under the relevant Sub-section(s) of the Section on 'Construction Materials' of this Specification. Sand, to be used for plastering work, will be normally of F.M. 1.2 or as directed by the Engineer.

Water

Water shall be clean, free from injurious quantities of oil, alkali, salts and organic materials or other substances that may be deleterious and shall not contain any visibly solid material. If requested by the Engineer, water shall be tested by comparing with water of known satisfactory quality. All other requirements shall be similar to what have been stated under the relevant Sub-sections of the Sections on 'Concrete Work' and 'Construction Materials' of this Specification.

3.20.3.3 CONSTRUCTION METHODS

Preparation of mortar

Unless otherwise specified on the Drawings or in the BOQ or instructed by the Engineer, cement mortar for skirting/dado works on brick masonry walls shall consists by volume of one part Ordinary Portland cement and four parts screened sand of specified F.M. In each mortar, requisite quantity of water shall be added and the components mixed and thoroughly incorporated together to give a workability, appropriate to its use. Mortar shall be used whilst freshly mixed and no softening or retampering will be allowed. Mortar shall be mixed in an approved mechanical mixer unless hand-mixing is specifically permitted by the Engineer and in a manner as to accurately determine and control the quantity of each ingredient in the mortar. The cement and sand shall be first mixed dry until thoroughly mixed before adding mixing water. If hand mixing is permitted, the operation shall be carried out on a clean watertight platform, Cement and sand shall be first mixed dry in the required proportion to obtain a uniform colour of the mixture. Water shall then be added sparingly, only the minimum necessary to produce a workable mixture of normal consistency. The water cement ratio in no case shall exceed 0.50 by weight, or as directed by the Engineer.

Only a sufficient quantity of sand and cement shall be mixed with water that can be used within 30

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minutes after addition of water. The adding of additional water to and re-tempering (cement mortar that stiffened because of evaporation of water), shall be permitted only within 30 minutes from the time of addition of water at the time of initial mixing.
Mortar that has taken initial set shall not be used in the work with or without addition of fresh materials.
Preparation of surface
Before application of skirting/dado, wall plaster, if there be any, shall be removed along the floor to the required height and the joints in brick-walls shall be adequately raked out to provide key. The surfaces shall be scrubbed clean of all loose materials and soaked with water and kept damped for 24 hours before skirting/dado works start.
Application of skirting/dado
Skirting/dado shall consist of two coats i.e under and finish. The under and finish coats shall be applied without an interval to permit the undercoat to set.
The undercoat shall have a minimum thickness of 6mm and the total built-up thickness will be same as that of the plaster on the wall. A 3mm groove shall be formed where skirting/dado meets wall plaster.
The skirting/dado shall be installed flushed with the finished wall surface. The intersection with the floor shall be right-angled and the top of the skirting/dado shall be straight and sharp.
The under-bed shall be laid as uniformly as possible and allowed to become firm before scratching for key and subsequently allowed to become thoroughly dry before applying the second under-coat. A neat cement paste of 3mm thickness shall be spread evenly over the second coat and shall be steel troweled under firm pressure to produce a dense uniform smooth surface free from trowel marks.
The finish coat shall be troweled over with care and leveled with a straight-edge to obtain a flat smooth surface including neat cement finishing. All edges and corners unless otherwise shown on the Drawings shall be rounded or chamfered as directed by the Engineer. All moulds shall be neat clean and true to template.
Skirting/dado shall be floated and troweled to a true and plumbed surface and tested frequently during the progress of the work with a straight edge sufficiently long. There shall be no overlaps or construction joints in single unbroken surface unless the area is over 28 square meter or prior permission is taken from the Engineer. Skirting/dado shall be stopped only at corners, sieves, construction or expansion joints.
If any crack appears in the skirting/dado, or any part sound hollow when tapped or found to be soft or otherwise defective after the skirting/dado has dried, the defect shall be made good by cutting out and re-plastering at the Contractor's own costs.
When the skirting/dado is applied on the plinth wall, it shall be plastered up to 150mm below the ground level.
The methods and equipment used for transporting and placing mortar shall be such, as not to damage or delay the use of mixed mortar. All equipment and tools used for mixing or transporting mortar shall be kept clean and free from set mortar, dirt or other deleterious foreign substances.
All skirting/dado works shall be placed only after all brick-wall surfaces have been prepared satisfactorily in accordance with the specifications and the Engineer's instructions.
The skirting/dado shall not be applied during rain sufficiently heavy or prolonged to wash the mortar. Mortar already applied, but becomes diluted by rain shall be removed and replaced before continuing the work at the expenses of the Contractor.

3.20.3.4 PROTECTION AND CURING

All skirting/dado shall be kept moist throughout the progress of work and protected for a minimum 10 days immediately following completion against harmful effects of weather by suitable covering. During hot weather, all finished or partly completed works shall be covered or wetted in such a manner as will prevent rapid drying of the skirting/dado.
On completion of works, all visible surfaces shall be free from damage or debris and shall look clean. All cares shall be taken that the skirting/dado surfaces are not stained or coated as the work proceeds. No rubbing of the faces to remove coating shall be allowed.

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3.20.3.5 MEASUREMENT

Measurement shall be taken for payment in square meter of the surface of the finished skirttng/dado works completed in accordance with the Specifications stated herein and/or as per the provisions of the BOQ and/or as shown on the Drawings and/or as directed by the Engineer. Only the completed works as accepted by the Engineer will be eligible for payment.

3.20.3.6 PAYMENT

The amount of completed and accepted work measured as provided above shall be paid at the Contract unit price per square meter of skirting/dado which price shall constitute full compensation for furnishing all materials, mixing of mortar, plastering surfaces and corners, rounding and/or chamfering, preparing, cleaning and watering the surface to be skirted, watering and protecting the skirting/dado after completion, all other works and all incidentals necessary to complete the Work as per requirements described under this item of Work, the BOQ, as shown on the Drawings and/or as directed by the Engineer.

Item of Payment	Unit
12mm thick skirting/dado	Square meter / Square feet

3.21 RULE POINTING ON BLOCK MASONRY WALL JOINTS

3.21.1 DESCRIPTION

This item of work shall consist of making v-grooved pointing in the joints of the block masonry wall surfaces and at any other locations where necessary in cement mortar with specified proportion. The Work shall include supply of all labor, materials, tools and equipment, carriage and the performance of all necessary works. All works shall be carried out in accordance with these specifications and conforming to the levels, dimensions and designs as shown on the Drawings, provisions of the BOQ and/or to carry out the Work following the directions of the Engineer.

3.21.2 MATERIALS

Cement

Cement used in the works shall be ordinary Portland cement complying with the requirements of ASTM C 150 Type 1 or BS 12 or equivalent standard and those stated under the Section on 'Construction Materials' of this Specification.

Fine aggregate

Fine aggregates shall be non-saline clean natural sand and have a specific gravity not less than 2.6, a Fineness Modulus not less than what will be specified for a particular type of rule pointing and conform to the requirements of ASTM C 33 and those stated under the relevant Sub-section(s) of the Section on 'Construction Materials' of this Specification. Sand, to be used for plastering work, will be normally of F.M. 1.2 or as directed by the Engineer.

Water

Water shall be clean, free from injurious quantities of oil, alkali, salts and organic materials or other substances that may be deleterious and shall not contain any visibly solid material. If requested by the Engineer, water shall be tested by comparing with water of known satisfactory quality. All other requirements shall be similar to what have been stated under the relevant Sub-sections of the Sections on 'Concrete Work' and 'Construction Materials' of this Specification.

3.21.3 CONSTRUCTION METHODS

- **Preparation Of Mortar**

Unless otherwise specified on the Drawings or in the BOQ or instructed by the Engineer, cement mortar for rule pointing works on brick masonry wall joints shall consist by volume of one part Ordinary Portland cement and two parts screened sand unless otherwise required by the Drawings or instructed by the Engineer. In each mortar, requisite quantity of water shall be added and the components mixed and

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thoroughly incorporated together to give a workability, appropriate to its use. Mortar shall be used whilst freshly mixed and no softening or re-tampering will be allowed.
Mortar shall be mixed in an approved mechanical mixer unless hand-mixing is specifically permitted by the Engineer and in a manner as to accurately determine and control the quantity of each ingredient in the mortar. The cement and sand shall be first mixed dry until thoroughly mixed before adding mixing water. If hand mixing is permitted, the operation shall be carried out on a clean watertight platform. Cement and sand shall be first mixed dry in the required proportion to obtain a uniform color of the mixture. Water shall then be added sparingly, only the minimum necessary to produce a workable mixture of normal consistency. The water cement ratio in no case shall exceed 0.50 by weight, or as directed by the Engineer.
Only a sufficient quantity of sand and cement shall be mixed with water that can be used within 30 minutes after addition of water. The adding of additional water to and re-tempering (cement mortar that stiffened because of evaporation of water), shall be permitted only within 30 minutes from the time of addition of water at the time of initial mixing.
Mortar that has taken initial set shall not be used in the work with or without addition of fresh materials.

- **Preparation Of Surface**

Before rule pointing, the joints in brick-walls shall be adequately roughened. The surfaces shall be scrubbed clean of all loose materials and soaked with water and kept damped for 24 hours.
Making rule points
Unless otherwise specified, mortar for rule pointing shall be prepared with one part of Portland cement and two parts of sand generally of F.M. 1.2. Lime in powder form passing 100 mesh in the proportion of 2% by weight of cement shall also constitute an ingredient of the mortar.
The methods and equipment used for transporting and placing mortar shall be such, as not to damage or delay the use of mixed mortar. All equipment and tools used for mixing or transporting mortar shall be kept clean and free from set mortar, dirt or other deleterious foreign substances.
When all brick walls surfaces including the joints are well prepared as described earlier, mortar of specified proportion shall be applied at the joints and finished in rule or concave pointing as mentioned in the 'BOQ' or indicated on the Drawings or directed by the Engineer. The concave pointing shall be done with the help of rebar's wooden template to prepare semi-circular pointing intruding inside the brick wall joints. The Contractor shall remain very careful in maintaining the type of pointing as asked for in the Contract.
All rule-pointing works shall only start when all brick-wall surfaces have been prepared satisfactorily in accordance with the specifications and the Engineer's instructions.
The rule pointing works shall not be undertaken during rain sufficiently heavy or prolonged to wash the mortar. Mortar already applied, which becomes diluted by rain shall be removed and replaced before continuing the work at the expenses of the Contractor.

3.21.3 SCAFFOLDING

The scaffolding shall be sound and strong enough to withstand all loads likely to be imposed upon it and subject to the Engineer's approval. Pole, going into the masonry should be at a place, which can be filled with a header brick. The holes, which provide resting, space for horizontal members shall not be left in masonry under 1m in width or immediately near the skewbacks of arches. The holes left in the masonry work for supporting the scaffolding shall be filled and made good.

3.21.4 PROTECTION AND CURING

All works shall be kept moist throughout the progress of work and protected for minimum 10 days immediately following completion against harmful effects of weather by suitable covering. During hot weather, all finished or partly completed works shall be covered or wetted in such a manner as will prevent rapid drying of the plaster.
On completion of works, all visible surfaces shall be free from damage or debris and shall look clean. All

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cares shall be taken that the plaster surfaces are not stained or coated as the work proceeds. No rubbing of the faces to remove coating shall be allowed.

3.21.5 RE-POINTING OF EXISTING BRICK MASONRY WORK JOINTS

The extent of re-pointing of existing brick masonry works shall be jointly surveyed by the Contractor and the Engineer at the start of the work and the location of all repairs needed shall be recorded and permanently marked in paint, The defective mortar shall be carefully removed from the joints and the joints shall be cleaned immediately prior to re-pointing. The re-pointing shall be done with cement mortar of specified proportion to full depth, penetration and trimmed flush with the face of the brick masonry works.

Cracks in the existing brick masonry works shall be treated in the same way. Defective materials shall be carefully removed and the cracks shall be filled with cement mortar of specified proportion.

3.21.6 MEASUREMENT

Measurement shall be taken for payment in square meter of the surface of the brick masonry works with all joints have been finished by rule pointing in accordance with the Specifications stated herein and/or as per the provisions of the BOQ and/or as shown on the Drawings and/or as directed by the Engineer. Only the completed works as accepted by the Engineer will be eligible for payment.

3.21.7 PAYMENT

The amount of completed and accepted work measured as provided above shall be paid at the Contract unit price per square meter of brick masonry wall which price shall constitute full compensation for furnishing all materials, mixing of mortar, rule pointing of joints, cleaning and watering the surface to be rule pointed, watering and protecting the work after completion, providing scaffolding and its erection and removal, all other works and all incidentals necessary to complete the Work as per specifications and requirements described under this Sub-section the Bill of Quantities, as shown on the Drawings and/or as directed by the Engineer.

Item of Payment	Unit
Rules pointing of joints of brick masonry wall	Square meter / Square ~~feet~~

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3.22 COLOUR WASHING

Works covered under this item shall consist of colour washing on the plastered wall or ceiling surfaces or at locations as directed by the Engineer in minimum 3 coats in accordance with these specifications, as per the provisions in the BOQ and/or as directed by the Engineer. Colour washing shall be done in a manner to obtain an even, smooth finish without any mark of brush and joint.

3.22.1 MATERIALS

Lime stone
Limestone is high calcium lime with about 6% material insoluble in acid, obtained by burning pure limestone or chalk in a kiln. Limestone shall be slaked as early as possible after it is burnt in a kiln. Stone lime should be stored in an enclosed space in large heaps and air excluded as far as possible. Un-slaked lime weighs 640 kilogram per cubic meter when fresh, increasing to about 800 kilogram per cubic meter after 10 days.

Shell Lime
Shell lime is also high calcium lime with about 6% material insoluble in acid, obtained by burning seashells in a kiln.

Gum Arabic
This is a kind of glue used as a binding agent between the white wash and the plaster surfaces.

Colour
Mineral colours, not affected by lime, shall be added to white wash instead of indigo (blue).

Water
Water shall be clean, free from injurious quantities of oil, alkali, salts and organic materials or other substances that may be deleterious to concrete or reinforcement and shall not contain any visibly solid material. If requested by the Engineer, water shall be tested by comparing with water of known satisfactory quality. All other requirements shall be similar to what have been stated under the relevant Sub-sections of the Sections on 'Concrete Work' and 'Construction Materials' of this Specification.

3.22.2 CONSTRUCTION METHODS

Samples
Color washing scheme shall conform the Finish Schedule and as directed by the Engineer. All tinting and matching shall be to the satisfaction of the Engineer.
For all finished color washing on plastered masonry and concrete surfaces, samples shall be prepared as per direction of the Engineer on the surfaces to be washed. The finished samples shall be approved by the Engineer.

Protection
Drop cloths or other approved protection materials shall be furnished and laid on all areas where color washing is being done so as to adequately protect floor and other places from all damage caused during the execution of the distempering work.

Surface Preparation
All surfaces to be colour washed shall essentially be thoroughly cleaned through removing all grit, grease, dirt, loose materials, mortar drippings and the like. It is better that some soap is added in the wash.
The surfaces shall be given a thorough rub down with a brush or by rubbing with an old gunny bag to remove all loose materials. All holes, cracks, surface irregularities and minor repairs shall be made good with patching plaster and lime putty to obtain a smooth and even surface to the satisfaction of the Engineer. Lime putty is obtained by slaking lime with water and sifting it. The filler shall be let dry for 24 hours before colour washing. The filler shall always be spread from the same face of the filling knife, the other face shall be kept clean and free. Filler shall be applied before priming and the surface shall be rubbed before the application to ensure clean work and again after application on allowing 12 hours to dry.
The plastered surfaces shall be made smooth by sand papering and made free from marks before applying the prime coat.

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In the case of new cement plaster walls, a solution of 2 kg of zinc sulphate in 4 litres of water should be applied to the plastered surface and when dry given a coat of pure raw linseed oil; or the surface may be treated with dilute sulphuric or hydrochloric acid (1 part acid to 50 parts water) and then washed down with water. Cares shall be taken to ensure that acids are added to the water and not water to the acids.

Preparation Of Colour Wash

The lime shall be brought to the Site in an un-slaked condition and thoroughly slaked on the spot, mixed and stirred with sufficient water and requisite amount of colour and gum to make a thin cream and allowed to stand for 24 hours. If 4 grams of gum (or shellac) and 50 grams of common salt dissolved in hot water are added to 1 kilogram of limestone for the last coat, the colour wash will not easily rub off. Mineral colour in requisite quantity per kilogram of lime dissolved in water is added and the wash stirred well.

The lime is placed 30cm deep in a drum or a tub with about 90cm of water and allowed to stand for about 24 hours or such longer period as may be necessary to slake the lime completely. It is better to add lime to the water and not water to the lime. The mixture should be well stirred.

Lime is considered to be completely slaked when the temperature of the lime and the water ceases to rise and any further addition of water also produces no further chemical action or heat. As a precaution, water should be allowed to stand on for 12 hours or more. A vigorous slaking with heat and noise indicates high calcium content. After slaking, the lime should be screened through a 3.35mm sieve or kept in excess of water to meet the requirements. Limes must be thoroughly slaked which is also ground very fine. Any un-slaked particles left will produce "blisters".

Application Of Colour Wash

The workmanship for colour washing shall be of high quality. Experienced and skilled painters shall be engaged for the work.

No work shall be done under conditions, which are not suitable for the production of good results. All spaces shall be broom cleaned before washing or finishing is started.

The colour wash should be strained through a course cloth or sieved through a fine wire gauge before applying.

All colour washing shall be applied with brushes under adequate illumination, evenly spread, smoothly flowed on without runs or sags. Colour washing shall be worked in to all corners and crevices.

The coats shall be applied alternatively vertically and horizontally. One stroke is given from the top down- wards and the other from the bottom up-wards over the first stroke and similarly, one stroke from the right and another from the left over the first brush before it dries. Each coat shall be let to dry before applying the next coat.

Colour wash shall be applied on the surfaces in two coats over a prime coat. The prime coat for the colour wash shall be of white wash with lime or with whiting. The final coat shall be applied vertically and finished surface shall be free of dust, dirt and must be free from brush marks. The finished dry surface shall not readily come off on the hand when rubbed.

In replacing one colour with another, a coat of white wash shall be given or the old paint scraped off, before the new colour is given. Gum or rice water shall be added as for white washing.

Brush shall always be cleaned after use.

Wherever scaffolding is necessary, it shall be free standing so as not to damage or scratch the painted surface.

Adequate precautionary measures shall be taken so as not to damage or stain floors, walls or any other work while applying white wash. Any damage, stains or spots caused by colour washing shall be rectified and removed at the expenses of the Contractor.

Each coat applied must be inspected and approved by the Engineer before the application of the succeeding coat. Otherwise, no credit for the coat applied will be given and the Contractor may require to repeat the work at his own expenses. The Contractor shall notify the Engineer when each coat is ready for inspection.

No exterior washing shall be done in rainy and damp weather until the surfaces are thoroughly dry.

No interior washing shall be done on damp surfaces.

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Each coat shall be thoroughly dry before application of subsequent coat.
Drying time for every coat shall not be less than 72 hours and 48 hours for exterior and interior washing respectively.
The Contractor shall rectify at his own expenses any damage that may be caused to the adjacent works during application of colour wash.

Completion

At completion of colour washing, the Contractor shall remove any wash spot and stain caused during the whole process of works as stated under this Sub-section from floors, walls, glass, hardware, equipment and other surfaces leaving these surfaces in perfect condition.
The Engineer shall conduct a final inspection of all works completed in accordance with this Subsection and the Contractor shall rewash or retouch any surface, which do not comply with the requirements of these specifications or which have been damaged during performing works. All surfaces finished under this Sub-section shall be left in perfect condition, free from defects and blemishes.
All rubbish and accumulated painting materials shall be removed from the premises.

3.22.3 MEASUREMENT

Measurement shall be taken for payment in square meter of the surface area actually colour washed with required quality in accordance with the provisions of the BOQ and/or shown on the Drawings and/or as directed by the Engineer. Only the completed works as accepted by the Engineer will be eligible for payment.

3.22.4 PAYMENT

The amount of completed and accepted work measured as provided above shall be paid at the Contract unit price per square meter which payment shall constitute the full compensation for furnishing all materials, equipment, appliances and labour including storage, transport, preparing, mixing and applying putty, primer and all colour washing materials and providing scaffolding as well as all incidentals necessary to complete the work as per specifications and requirements described under this Sub- section, the Bill of Quantities, as shown on the Drawings and as directed by the Engineer.

Item of Payment	Unit
Colour washing	Square meter / Square feet

3.23 COLOURED CEMENT PAINTING

Works covered under this item shall consist of applying coloured cement paint on the wall or ceiling plaster or at any other locations as directed by the Engineer. Cement paint of any approved brand and colour shall be used in minimum 2 coats over a coat of priming in accordance with these specifications as per the provisions in the BOQ and/or as directed by the Engineer or as specified by the manufacturers. Painting shall be done in a manner to obtain an even, smooth finish of confirm shade and without any mark of brush and joint.

3.23.1 MATERIALS

Cement Powder

Cement powder shall be manufactured of the best quality and of approved colour supplied in original sealed containers bearing the manufacturers labels and seals and be delivered at the Site.
Materials to be used in the work shall conform to the reputed manufacturer's specifications and to the satisfaction of the Engineer.

Water

Water shall be clean, free from injurious quantities of oil, alkali, salts and organic materials or other substances that may be deleterious to concrete or reinforcement and shall not contain any visibly solid material. If requested by the Engineer, water shall be tested by comparing with water of known satisfactory quality. All other requirements shall be similar to what have been stated under the relevant Sub-sections of the Sections on 'Concrete Work' and 'Construction Materials' of this Specification.

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3.23.2 CONSTRUCTION METHODS

General

Before purchasing materials, the Contractor shall submit to the Engineer a list showing the brand and type of cement powder proposed for this item of work. Manufacturer's catalogue or specification sheets, in triplicate, for materials selected shall be submitted to the Engineer with the list of brands and types. No material shall be used without the approval of the Engineer.

Samples

Coloured cement painting scheme shall conform the Finish Schedule and as directed by the Engineer. All tinting and matching shall be to the satisfaction of the Engineer. For all finished coloured cement painting on plastered masonry and concrete surfaces, samples shall be prepared as per direction of the Engineer on the surfaces to be painted. The finished samples shall be approved by the Engineer.

Protection

Drop cloths or other approved protection materials shall be furnished and laid on all areas where painting is being done so as to adequately protect floor and other places from all damages caused during the execution of the coloured cement painting.

Surface preparation

All surfaces to be painted shall essentially be thoroughly cleaned through removing all grit, grease, dirt, loose materials, mortar drippings and the like. It is better that some soap is added in the wash.

The surfaces shall be given a thorough rub down with a brush or by rubbing with an old gunny bag to remove all loose materials. All holes, cracks, surface irregularities and minor repairs shall be made good with patching plaster and lime putty to obtain a smooth and even surface to the satisfaction of the Engineer. Lime putty is obtained by slaking lime with water and sifting it. The filler shall be let dry for 24 hours before colour painting. The filler shall always be spread from the same face of the filling knife, the other face shall be kept clean and free. Filler shall be applied before priming and the surface shall be rubbed before the application to ensure clean work and again after application on allowing 12 hours to dry.

The plastered surfaces shall be made smooth by sand papering and made free from marks before applying the prime coat.

In case of any inconsistency with the manufacturer's instructions, the manufacturer's instructions shall prevail.

Preparation Of Paint

The paint shall be prepared by mixing and stirring coloured cement powder, sand/lime as per manufacturer's specifications and water in such quantities as will produce a mixture of the consistency of thin cream. When sufficiently mixed, the mixture shall be strained through a clean coarse cloth.

Application Of Paint

The workmanship for coloured cement painting shall be of high quality and experienced and skilled painters shall be engaged for the work.

No work shall be done under conditions, which are not suitable for the production of good results. All spaces shall be broom cleaned before washing or finishing is started.

All painting shall be applied with brushes under adequate illumination, evenly spread, smoothly flowed on without runs or sags. Painting shall be worked into all corners and crevices.

Painting shall be applied on the surfaces in two coats over a prime coat. The prime coat shall be of white wash with lime or with whiting. The coats shall be applied alternately vertically and horizontally. The final coat shall be applied vertically and finished surface shall be free from dust, dirt and must be free of brush marks. The finished dry surface shall not readily come off on the hand when rubbed.

In replacing one colour with another, a coat of white wash shall be given or the old paint scraped off, before the new colour is given. Gum or rice water shall be added as for white washing.

Brush shall always be cleaned after use.

Wherever scaffolding is necessary, it shall be free standing so as not to damage or scratch the painted surface.

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Adequate precautionary measures shall be taken so as not to damage or stain floors, walls or any other work while applying paint. Any damage, stains or spots caused by coloured cement painting shall be rectified and removed at the expenses of the Contractor.
Each coat applied must be inspected and approved by the Engineer before the application of the succeeding coat. Otherwise, no credit for the coat applied will be given and the Contractor may require to repeat the work at his own expenses. The Contractor shall notify the Engineer when each coat is ready for inspection.
No exterior painting shall be done in rainy and damp weather until the surface is thoroughly dry. No interior painting shall be done on damp surfaces.
Each coat shall be thoroughly dry before application of subsequent coat.
The washing shall be done with good hairbrush and not with brush made of jute.
Proper curing shall be done at least for 7 days on application of the final coat and/or as per instructions of the manufacturer. The Contractor shall rectify at his own expenses any damage that may be caused to the adjacent works during application of paint.
In case of any inconsistency with the manufacturer's instructions, the manufacturer's instructions shall prevail.

Completion

At completion of coloured cement painting, the Contractor shall remove any paint spot and stain caused during the whole process of works as stated under this Sub-section from floors, walls, glass, hardware, equipment and other surfaces leaving these surfaces in perfect condition.
The Engineer shall conduct a final inspection of all works completed in accordance with this Subsection and the Contractor shall repaint or retouch, as directed by the Engineer, any surface which do not comply with the requirements of these specifications or which have been damaged during performing works. All surfaces finished under this Sub-section shall be left in perfect condition, free from defects and blemishes. All rubbish and accumulated painting materials shall be removed from the premises.

3.23.3 MEASUREMENT

Measurement shall be taken for payment in square meter of the surface area actually painted with required quality in accordance with the provisions of the BOQ and/or as shown on the Drawings and/or as directed by the Engineer. Only the completed works as accepted by the Engineer will be eligible for payment.

3.23.4 PAYMENT

The amount of completed and accepted work measured as provided above shall be paid at the Contract unit price per square meter which payment shall constitute the full compensation for furnishing all materials, equipment, appliances and labour including storage, transport, preparing, mixing and applying putty, primer and all painting materials and providing scaffolding as well as all incidentals necessary to complete the work as per specifications and requirements described under this Sub-section, the Bill of Quantities and/or as directed by the Engineer.

Item of Payment	Unit
Coloured cement painting	Square meter / Square feet

3.24 WATER REPELLENT PAINTING

Works covered under this item shall consist of applying two coats of clean silicon water repellent on exposed brick or concrete surfaces and cement rendered on wall, ceiling and at any other locations in accordance with these specifications, as per the provisions in the BOQ and/or as directed by the Engineer or as specified by the manufacturers.

3.24.1 MATERIALS

Silicon water repellent shall consist of sodium silicate or other alkaline silicates based clear approved product supplied in original sealed containers bearing the manufacturer's trade mark.
All silicon water repellent painting materials shall be of the best quality and be delivered at the Site in sealed original containers bearing manufacturer's labels and seals. Materials to be used in the work shall

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conform to the reputed manufacturer's specifications and to the satisfaction of the Engineer.

3.24.2 CONSTRUCTION METHODS

General

Before purchasing materials, the Contractor shall submit to the Engineer a list showing the brand and type of silicon water repellent proposed for this item of work. Manufacturer's catalogue or specification sheets, in triplicate, for materials selected shall be submitted to the Engineer with the list of brands and types. No material shall be used without the approval of the Engineer.

Samples

For all finished silicon water repellent painting on masonry and concrete surfaces, samples shall be prepared as per direction of the Engineer on the surfaces to be painted. The finished samples shall be approved by the Engineer.

Protection

Drop cloths or other approved protection materials shall be furnished and laid on all areas where colour washing is being done so as to adequately protect floor and other places from all damages during the execution of the painting.

Surface Preparation

All surfaces to be silicon water repellent painted shall essentially be thoroughly cleaned by removing all grit, grease, dirt, loose materials, mortar drippings and the like.

The surfaces shall be given a thorough rub down with a brush or by rubbing with an old gunny bag to remove all loose materials. All holes, cracks, surface irregularities and minor repairs shall be prepared in such a manner so as to provide a smooth and even surface to the satisfaction of the Engineer.

Application Of Silicon Water Repellent Paint

The workmanship for silicon water repellent paint shall be of high quality and experienced and skilled painters shall be engaged for the work.

No work shall be done under conditions, which are not suitable for the production of good results. All spaces shall be neatly cleaned before painting or finishing starts.

All silicon water repellent paints shall be applied with brushes under adequate illumination, evenly spread and smoothly flowed on. Silicon water repellent paint shall be worked into all corners and crevices.

The application of water repellent coat shall strictly comply with the manufacturer's instruction. The application shall preferably be carried out after a period of dry weather and before application, the surface shall be thoroughly cleaned and dried. A heavy coat shall be applied evenly direct from the container by flooding the surface with a wide brush so that at least 6mm penetration is achieved. A second coat shall be applied in the similar manner, which shall follow after 24 hours.

Brush shall always be cleaned after use. Wherever scaffolding is necessary, it shall be free standing so as not to damage or scratch the painted surface.

Adequate precautionary measures shall be taken so as not to damage or stain floors, walls or any other work while applying the paint. Any damage, stains or spots caused by painting shall be rectified and removed at the expenses of the Contractor.

Each coat applied must be inspected and approved by the Engineer before the application of the succeeding coat. Otherwise, no credit for the coat applied will be given and the Contractor may require to repeat the work at his own expenses. The Contractor shall notify the Engineer when each coat is ready for inspection.

No exterior painting shall be done in rainy and damp weather until the surface is thoroughly dry. No interior painting shall be done on damp surfaces.

The Contractor shall rectify at his own expenses any damage that may be caused to the adjacent works during painting.

Completion

At completion of silicon water repellent paint the Contractor shall remove any wash spot and stain caused during the whole process of works as stated under this Sub-section from floors, walls, glass, hardware, equipment and other surfaces leaving these surfaces in perfect condition.

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The Engineer shall conduct a final inspection of all works completed in accordance with this Subsection, and/or as per provision of the BOQ and the Contractor shall re-paint or retouch, as directed by the Engineer, any surface which do not comply with the requirements of these specifications and/or the provisions of the BOQ or which have been damaged during performing works. All surfaces finished under this Sub-section shall be left in perfect condition, free from all defects and blemishes.
All rubbish and accumulated painting materials shall be removed from the premises.

3.24.3 MEASUREMENT

Measurement shall be taken for payment in square meter of the surface area actually painted with silicon water repellent of required quality in accordance with the provisions of the BOQ and/or as shown on the Drawings and/or as directed by the Engineer. Only the completed works as accepted by the Engineer will be eligible for payment.

3.24.4 PAYMENT

The amount of completed and accepted work measured as provided above shall be paid at the Contract unit price per square meter which payment shall constitute the full compensation for furnishing all materials, equipment, appliances and labour including storage, transport all silicon water repellent materials and providing scaffolding as well as all incidentals necessary to complete the work as per specifications and requirements described under this Sub-section, the Bill of Quantities, as shown on the Drawings and as directed by the Engineer.

Item of Payment	Unit
Water repellent paint	Square meter / Square feet

3.25 VARNISHING

Works covered under this item shall consist of varnishing to the surfaces of wood works in three coats in accordance with these specifications, as per the provisions of the BOQ and/or as directed by the Engineer.

3.25.1 MATERIALS

Oil Varnish
This is a kind of varnish belonging to the class 'Oil Varnish'. The essential constituent is 'resin' or rosin which is dissolved in oils, turpentine, or alcohol. Shellac, Gum Arabic, Rosin and Amber. Resins are most commonly used for preparation of varnishes. Various types of varnishes are obtainable in the market, each suited to a specific work. Preparation of varnishes is a difficult matter and it is best to purchase ready-made.

Storage Of Materials
Materials and tools shall be stored in a single place at the Site as designated by the Engineer.
Storage area shall be maintained in a neat and clean condition with surroundings protected from damage.
Inflammable materials shall be stored in sealed containers. Waste shall be removed from the premises at the end of each day's work. Every precaution shall be taken to prevent fire.
Storage area shall be all time accessible to the Engineer.

3.25.2 CONSTRUCTION METHODS

Samples
Before starting full scale finishing work, sample finishing shall be done on similar wooden surfaces on an area of 300mm x 300mm and shall receive the approval of the Engineer.
Modifications, if required, in the above specimen shall be done depending on the outcome of sample work.
No payment will be made unless samples are made beforehand and approval of the Engineer is received for the same.

Surface Preparation
Wood, surfaces that would be varnished, shall be well seasoned. The surfaces to be varnished shall be perfectly dry.

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Technical Specifications

The process of preparing the surfaces shall include removal of all machine and plain marks and defects that will make an imperfect surface. Unless the surface is perfectly smooth and free from defects, varnish shall not be applied. The following rules shall be maintained in preparing the wood surfaces.

ii. Before assembling the work, all marks shall be removed from the visible parts with a plane or cabinet scraper.

iii. All traces of glue from around the joints shall be removed.

iv. Defects, such as cracks and holes that can not be removed, shall be filled with stick shellac or its equivalent.

v. After the shellac or its equivalent hardens, it shall be placed down until it is nearly leveled with the adjoining surfaces.

The surfaces then shall be scraped and sanded thoroughly. Emery paper shall be used as abrasive. Four grades of abrasive paper shall be used successively in the order of No. 2, No. 1, No. 0 and No. 00. Sand papering shall be done with the grain. When thoroughly sand papered, the dust shall be brushed off with a stiff brush and inspected to see if the surfaces are free from all blemishes. It shall then be rubbed with a clean woolen rag.

Before application of varnish or painting, all articles shall receive inspection and approval of the Engineer.

Application

Type Of Finish

Unless otherwise specified wooden surfaces shall receive clear shellac varnish.

Finishing Materials

Fillers shall be White Zinc or natural paste fillers.

Sealers shall be of shellac wash coat. This is a mixture of seven parts alcohol to one part shellac, using Two-Pound-Cut shellac. Two-Pound-Cut shellac means that there are 1.8 kg of shellac mixed to 4.5 liters of alcohol.

Finish shall be done with a mixture of equal amount of alcohol and Four-Pound-Cut shellac.

Benzene shall be used as a cleaning fluid.

Application Method

Fillers made in the form of heavy paste by adding desired amount of turpentine shall be applied with a stiff brush, brushing first with the grain and then across it, covering only a small area at a time. It shall be allowed to dry for a few minutes until it loses its glossy appearance.

Excess fillers shall be wiped off across the grain with rough cloth. The surface shall then be rubbed down with the grain lightly with soft cloth to remove the excess. It should be pressed in such hardness so that the filler is not wiped off the pores.

Finishing shall be applied only after the filler has dried up.

Clean shellac varnish shall be applied with a good quality brush, 40mm to 75mm wide. Varnishing shall start near the center and top of a vertical surface or the middle of a horizontal surface, quickly brushing out in long sweeping strokes without going over the same area several times as shellac dries out vary rapidly.

Brushing should be done towards the edges and care should be taken not to allow the shellac to run over the edges and pile up. It shall then be allowed to dry for 3 to 4 hours. The surface shall be lightly rubbed down with No.00 dry abrasive paper along the grain.

Grit and dust shall be removed with soft cloth before applying the second coat with slightly reduced alcohol mixture. It shall then be allowed to dry and rubbed down lightly with No.00 dry abrasive paper along the grain.

Grit and dust shall be removed again before applying the third coat with 25 percent alcohol mixture.

After the last coat dries up, the surface shall be wiped out lightly with Benzene.

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The workmanship for varnishing shall be of high quality for this purpose, experienced and skilled painters shall be engaged for the work.
No work shall be done under conditions, which are not congenial for the production of good results. All spaces shall be broom cleaned before varnishing or finishing starts.
All varnish shall be applied under adequate illumination. Varnish shall be worked into all corners and crevices.
The Contractor shall rectify at his own expenses any damage that may be caused to the adjacent works during varnishing.

Completion

At completion of varnishing work, the Contractor shall remove any varnished spot and stain caused during the whole process of works as stated under this Sub-section leaving the surfaces in perfect condition.
The Engineer shall conduct a final inspection of all works completed in accordance with this Subsection and as per provisions of the BOQ. The Contractor shall re-varnish or retouch, as directed by the Engineer, any surface which does not comply with the requirements of these specifications, as per provisions of the BOQ or which have been damaged during performing works. All surfaces finished under this Sub-section shall be left in perfect condition, free from defects and blemishes.
All rubbish and accumulated varnishing materials shall be removed from the premises.

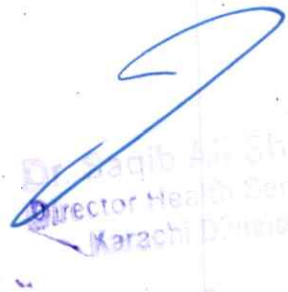
3.25.3 MEASUREMENT

Measurement shall be taken for payment in square meter of the surface area actually varnished with required quality in accordance with the provisions of the BOQ and/or as shown on the Drawings and/or as directed by the Engineer. Only the completed works as accepted by the Engineer will be eligible for payment.

3.25.4 PAYMENT

The amount of completed and accepted work measured as provided above shall be paid at the Contract unit price per square meter which payment shall constitute the full compensation for furnishing all materials, equipment, appliances and labour including storage, transport, preparing, mixing and applying putty, primer and varnish and providing scaffolding as well as all incidentals necessary to complete the work as per specifications and requirements described under this Subsection, the Bill of Quantities, as shown on the Drawings and as directed by the Engineer.

Item of Payment	Unit
Varnishing	Square meter / Square feet



3.26 ROUGH CARPENTRY

3.26.1 GENERAL

RELATED WORK

- Architectural Wood Work
- Gypsum Board System

THIS SECTION INCLUDES

This Section specifies incidental rough carpentry required for support or attachment of other construction and not specified in other sections and includes, but is not limited to, the following items:

- Wood grounds, blockings, and nailers.
- Temporary and permanent grounds, blockings and supports required by other trades.

RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions.

- Wood grounds, nailers, and blocking.
- Wood furring.
- Wood sub-frames.

PRESERVATIVE TREATMENT

- Application is to be carried out after cutting and machining, but before assembly, by processor licensed by the treatment solution manufacturer
- Solution strengths and treatment by pressure, vacuum or immersion process are to be selected to achieve service life and to suit wood treatability.
- Moisture content of wood at time of treatment is to be as specified for use in the work.
- After treatment, allow wood to dry before use.
- For each batch of wood, provide certificate of assurance that treatment has been carried out as specified.
- Re-treat all treated wood which is sawn along the length, ploughed, thicknesses, planed or otherwise extensively processed.
- Treat wood surfaces exposed by minor cutting and drilling with two flood coats of solution recommended for the purpose by the treatment solution manufacturer.

SUBMITTALS

- Samples of all materials used in the work of this Section.
- Shop drawings for furring including details, sizes of wood sections, panel, spacing's and method of attachment.

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Technical Specifications

MDF (Fire Resistance)

- Medium density fibreboard's for fabric panels, 8-10mm thick.
- Strips of MDF around fabric panels edging.
- All MDF components to be fire resistant.

PLYWOOD

- Plywood: BS EN 636: Part 1, face grade for general use. Bonding is to be to BS 1203, type WBP for external use and type MR or INT for internal use.
- Marine Quality Plywood: to BS 1088 and BS 4079, excluding plywood made from gaboon.

CORK BOARD

Are to be pre-formed sheets that have been formed from clean granulated cork particles securely bound together by a synthetic resin of an insoluble nature. Minimum thickness of sheets is to be 25 mm (1"), width and length are to be as indicated on Drawings.

FASTNERS

- Nails: to BS 1202, Part 1, 2 or 3 generally, but non-ferrous types to Parts 2 or 3 for external use.
- Wood Screws: to BS 1210 generally, but non-ferrous types for external use.
- Self-Tapping Screws: to BS 4174.
- Dowels: mild steel, 10 mm (1/2") diameter, 100 mm (4") long, galvanized to BS EN ISO 1461 after fabrication.
- Cramps: mild steel, 25 x 3 x 250 mm (1" x 2/16" x 10") girth, turned up at one end and twice drilled for 3 mm (2/16") screws, fish-tailed at other end for building in and galvanized to BS 729 after fabrication.
- Plugs: either traditional hardwood plugs, shaped to twist and grip when driven, or proprietary fibre or plastics plugs, or other approved type.

TREATMENTS, ADHESIVE AND FINISHES

- Preservative Treatment: shall be type listed in BS 1282 (except coal tar creosote), obtained from an approved manufacturer, to give suitable protection against termites and other wood destroying organisms.
- Adhesive for Joinery: shall be close contact type to BS EN 301 or BS EN 302 suitable for the purpose. Obtain manufacturer's confirmation that adhesive is compatible with preservative treatment.

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EXECUTION INSTALLATION

GENERAL

- Discard units of material with defects that impair quality of rough carpentry and that are too small to use with minimum number of joints or optimum joint arrangement.
- Set rough carpentry to required levels and lines, with members plumb, true to line, cut, and fitted.
- Fit rough carpentry to other construction; scribe and cope as required for accurate fit. Correlate location of furring, nailers, blocking, grounds, and similar supports to allow attachment of other construction.
- Apply field treatment to cut surfaces of preservative-treated lumber and plywood.
- Securely attach rough carpentry work to substrate by anchoring and fastening as indicated.
- Use common wire nails, unless otherwise indicated. Select fasteners of size that will not fully penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood; predrill as required.
- Use hot-dip galvanized nails.
- Countersink nail heads on exposed carpentry work and fill holes with wood filler.

WOOD GROUNDS, NAILERS, BLOCKING AND SLEEPERS

- Install wood grounds, nailers, blocking, and sleepers where shown and where required for scree ding or attaching other work. Form to shapes shown and cut as required for true line and level of attached work. Coordinate locations with other work involved.
- Attach to substrates to support applied loading. Recess bolts and nuts flush with surfaces, unless otherwise indicated. Build into masonry during installation of masonry work. Where possible, anchor to formwork before concrete placement.
- Install permanent grounds of dressed, preservative-treated, key-bevelled lumber not less than 1-38 mm wide and of thickness required to bring face of ground to exact thickness of finish material. Remove temporary grounds when no longer required.

WOOD FURRING

- Install plumb and level with closure strips at edges and openings. Shim with wood as required for tolerance of finish work.
- Firestop furred spaces of walls at each floor level and at ceiling with wood blocking or non-combustible materials, accurately fitted to close furred spaces.

Technical Specifications

- Furring to Receive Wood or Plastic Sheets or Boards: Install 19-by-63-mm actualsize furring at 600 mm o.c., horizontally and vertically. Select furring with no knots capable of producing bent-over nails and damage to paneling.
- Furring to Receive Gypsum Board: Install 19 (3/4")-by-38-mm (1½") actual-size furring at 400 mm (16") o.c., vertically.
- Furring to Receive Plaster Lath: Install 19 (3/4")-by-38-mm (1½") actual-size furring at 400 mm (16") o.c., vertically

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3.27 TERMITE CONTROL

3.27.1 SCOPE

The work covered by this section of Specification consists of furnishing all labour, materials, equipmnt, services, miscellaneous and necessary items required to complete Termite Control and, related works as indicated on drawings, and specified herein, in strict accordance with this section of specifications, as subject to the terms and conditions of the Contract.

3.27.2 MATERIALS

i. Pesticides shall be 0.4% Termidor and/or as directed by the manufacturer, or solution of 0.5% Dieldrin or a 0.5% Aldrin, mixed in clean water for application in earth, and mixed in pure turpentine for application to wood.

ii. Pesticides (Dieldrin & Aldrin) shall be obtainable from the Government of Pakistan, Department of Agriculture, or other sources approved by Engineer in sealed drums at rates in force at the time of their acquisition and only in the quantity necessary for work of this Project. All mixing shall be done at site and the amount of pesticides used shall be verified by the Engineer

3.27.3 METHOD OF APPLICATION

Pesticides solution shall be applied with approved pressure spraying equipment maintaining a pressure of 150, p.s.i. (10.5kg/cm 2) to all application to, on or in earth. Spraying to wood shall be done by hand compression with an approximate pressure of 20 p.s.i.

3.27.4 WORKMANSHIP

The treatment operation shall be carried out as follows:-

i. After the excavation for foundation trenches and pits is completed in each and every respect, and passed for concreting work, but before laying of concrete, Pesticide shall be penetrated to a depth of 1" (25 mm) ;minimum in porous earth at bottom and 2" (50mm) to 3" (75 mm) at sides of excavation.

ii. Stock piled excavated material to be used as back fill is to be treated as above. After backfilling to required grade the area is again to be sprayed.

iii. After grading, compaction and levelling of fill and before installation of any soling, all areas are to be sprayed with pesticide, penetrating a minimum of 1" (25mm) into soil.

iv. Pesticide solution shall be applied inside the building lines and for a distance of 10 feet (3 M) out side all building with specified pressure.

v. All rough wood work for the entire project is to be pesticide treated (before application of Soligum in the case of material to receive both treatments). Pesticide shall be sprayed on all surfaces of all the wooden work viz, door frames blocking, furring, planks,, boards etc, before installation. No spraying shall be necessary after field sawing, planning, joining or installation of such material. All spraying will be done within one week of working of the materials.

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3.27.5 LOCATION AND SCHEDULING

i. Saturation of earth is to be done by adequate personnel and in such a manner as to in no way disrupt the progress of the work.

ii. Such work is to be scheduled and done by sufficient skilled personnel manner as to in no way impede the progress of the work.

iii. Care shall be exercised to ensure that no mark or damage occurs to the finished building as a result of the work under this section, and Contractor shall verify and ensure that no material used herein will impede the growth of grass or plants at areas where spraying is done.

3.27.6 STANDARDS

All methods of termite protections used herein be in accordance with best standard practices of National Pest Control Association, U.S.A. and the British Wood Preserving Association.

3.27.7 GUARANTEE

The Contractor is to guarantee that the building shall be free from termites (white ants), wood bores and other pests or rodents which cause damage to wood or other organic material for 10 years from the date of acceptance of the building.
In the event of any damage caused within the guaranteed period, the Contractor shall replace at his own cost such damage material, finishes affected and suitably preserve and treat the entire premises with the best method known to the trade to prevent the spreading of termites.

3.27.8 TESTING

All materials and samples shall be subject to testing in accordance with the relevant standards specified herein, and shall be rejected if found below these standards. Rejected materials shall be removed from the site immediately; Contractor shall quote a lump sum rate for the termite control testing and treatment of the ground and excavation covered by this specifications including all ditches, pits, excavations, wood etc., complete.

3.27.9 MEASUREMENT & PAYMENT

i. Unless otherwise specifically stated in the Bill of Quantities or herein, all the work involved within the scope of this section of specification shall be deemed to be inclusive of but not limited to the following:-

- CONTRACTOR's establishment charges, overhead charges, profit, interest.
- All other expenses, charges, taxes specified in the Conditions of CONTRACT.
- Labour and all costs in connection therewith.
- Use of plant, equipment and machinery and all costs in connection therewith, e.g. mobilizations, demobilization, transporting, fuel, energy charges, grease, oil, installing, operating, storing, watching, returning, replacing, handling, maintaining, idle stand parking, removing, damaged, destroyed, salvaged.
- Material and goods, e.g. marketing, selecting, conveyance, loading, unloading, storing, watching, returning, handling, hoisting, lowering cutting, joining fixing, wastage, destroyed, damaged, salvaged.

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ii. The cost of all the works involved within the scope of this specification as per all the Drawings and Conditions of CONTRACT are covered only within the quoted lump sum rate of the item of the Bill of Quantities.

iii. No separate payment will be made for wood work etc. Covered under this section of the specifications, and all cost in connection therewith shall be included in the unit rates of the various items of the wood work affected by treatment

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SECTION 3: ELECTRICAL WORKS

4.1 CONDUIT & PIPES

4.1.1 GENERAL

The work under this section consists of supplying, in¬stalling, and commissioning of all material and services of the complete conduit & pipe system as specified herein and/or shown on Tender Drawings and stated in the Bill of Quantities.

The Contractor shall discuss the electrical layout with the Engineer and co-ordinate at site with other services for exact route, location and position of the electrical lines.

4.1.2 PVC CONDUITS

All wiring for light, power, control and other circuits shall be carried out in PVC pipe otherwise as stated in BOQ, minimum 25mm dia. The conduits and pipes shall be supplied complete with all accessories including bends, sockets, junction boxes of identical material as that of conduit and all cutting, repair, excavation backfilling, etc., required for complete installation. The conduits for internal wiring to lights, sockets and power circuit shall be of approved brand.

Manufactured smooth bends shall be used wherever conduit changes direction. The sharp 90 degree bends or tees shall not be allowed. All conduit accessories shall conform to same material specifications as given above for conduit.

The bends shall have enlarged ends to receive conduit without any reduction in the internal diameter at joints.

The round junction box for ceiling light points shall be of PVC having minimum dimensions of 63 mm diameter and 63mm deep. The outlet box at wall light points shall be general purpose type having minimum dimensions of 75mm x 75mm and 38 mm deep. Pull boxes and inspection boxes shall be installed in conduit runs where required to limit the pulling of the cables or for inspection purposes. The pull boxes shall be square having minimum dimension of 100mm and 50 mm deep. In all cases, the minimum length of inspection boxes shall be not less than four times the cable manufacturers recommended bending radius of the cable. These dimensions are minimum only and the Contrac¬tor shall determine the exact size keeping in view ease of maintenance and installation. In general the use of pull boxes and inspection boxes shall be avoided. The pull boxes and inspection boxes shall be of 16SWG. sheet steel provided with anti-rust paint and finished in gray enamel paint or orange powder coated paint. The face plate shall be secured to the box by means of flat head galvanized screw.

4.1.3 INSTALLATION

1. Conduits

The conduit shall be installed concealed in wall, column ceiling or under floor, on surface, above the false ceiling or as stated on the drawings. The drawings are diagrammatic and do not indicate the location of junction boxes, pull boxes or inspection boxes which shall be provided to suit site conditions. The concealed conduits shall have a minimum of 25 mm concrete cover, when concealed in R.C.C works. The conduits in R.C.C works shall be laid before pouring of concrete. Chisels shall not be made in R.C.C structure for conduits and accessories after pouring of concrete. In slab, conduits shall be laid over the bottom reinforcement steel and tied firmly to it. The conduit outlet boxes shall be held firmly to finish with the surface of the slab or beam. At expansions joints, flexible conduits or alternate arrangement shall be provided.

Where conduits have to be concealed in cement concrete work after concreting or in block masonry, chisels shall be made with appropriate tools and of required depth. The conduit shall then be firmly recessed and covered after plastering. All chisels for concealing conduits shall be carried out by the Contractor. The Contrac¬tor will be responsible for bringing back the general finish to the condition that it was before the cutting and chiselling by the Contractor.

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The work of conduit installation and cutting in cement concrete work or brick work shall be coordinated with civil construction so as not to cause any undue hindrances and delays in progress. The Contractor shall obtain approval of the Consultant for route, etc. to suit the site conditions before starting chiselling and cutting. All junction boxes, outlet boxes, pull boxes etc., shall be installed concealed so as to finish with the surface.

Conduits installed on surface shall be fixed by means of black enamelled steel saddles and clamps having thickness of 3 mm or as mentioned in BOQ. The clamps shall be installed at a distance of not more than 600 mm.

All conduit bends shall be made with an approved conduit bending machine or hickory.

The radius of curvature of the inner edge of any bend shall not be less than the following table :

Conduit size	Radius
25 mm(1")	Not less than 150 mm.
32 mm (1-1/4")	Not less than 200 mm.
38 mm (1-1/2")	Not less than 255 mm.
50 mm (2")	Not less than 305 mm
70 mm (2-1/2")	Not less than 380 mm
82 mm (3")	Not less than 460 mm.
100 mm (4")	Not less than 610 mm

After completion of conduit in¬stallation, the system shall be checked for any charred or twisted portion prior to the pulling of wire. At all joints, PVC jointing solution or cement must be used.

The termination of conduits is shown diagrammatically on the drawings. The exact final location of the termination shall be coordinated with the equipment to be installed. Conduit ends pointing upwards or downwards shall be properly plugged, in order to prevent the entry of foreign materials. All openings through which concrete may leak shall be carefully plugged and boxes shall be suitably protected against filling with concrete. At all termina¬tion of conduit, soft bushes shall be fixed to prevent sharp edges of conduit ends from cutting or damaging the wires or cables to be pulled through them. Brass glands of appropriate sizes (as per size of conduit) with proper chuck nuts shall be used for fixing of conduits in junction boxes.

The entire conduit system shall be installed and tested before wiring is carried out. Any obstruction found shall be cleared by use of a cutting or other approved device and the conduit be cleaned out before the installation of cable.

4.1.4 OTHER ACCESSORIES

Outlet boxes, pull boxes, inspection boxes, switch and socket outlet boxes, fan regulator boxes, shall be of 16 SWG sheet steel, de-rusted, degreased, rust-proof with two coats of zinc chromate primer and painted with enamel, complete with earthing terminal. All boxes shall have ample wiring space, and boxes used outdoors shall be weather-proof.

All the pull boxes are to be properly labeled according to the type of services for which it is installed.

4.2 LED SURFACE MOUNTED PANEL LIGHTS

4.2.1 General Description

The LED Surface Mounted Panel Light is a high-efficiency lighting fixture designed for ceiling or wall mounting. It provides uniform illumination with low power consumption, long lifespan, and minimal maintenance. This 24-watt LED panel operates at 220-240V and is available in both round and square shapes, ensuring compatibility with various architectural and interior design requirements.

4.2.2 Material

- Panel Frame: Aluminum alloy, powder-coated for corrosion resistance
- Light Source: High-quality LED chips with a lifespan of 30,000–50,000 hours
- Diffuser: Frosted polycarbonate (PC) for glare-free light distribution

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Technical Specifications

- Driver: Isolated LED driver with surge protection and efficient thermal management
- Mounting Bracket: Galvanized steel or aluminum for secure attachment

4.2.3 Job Conditions

- Ensure the electrical supply is within the specified range (220-240V, 50/60Hz).
- Confirm surface stability before installation (e.g., ceilings or walls should be structurally sound).
- Keep the installation area dry and free of dust or debris.
- Check for any obstructions in the ceiling or wall that may interfere with mounting.
- Adhere to safety protocols for electrical installations, including shutting off power before working..

4.2.4 Installation

- **Preparation**
  - Verify the LED panel specifications and ensure compatibility with the power supply.
  - Measure and mark the mounting positions for alignment.
- **Mounting**
  - Attach the provided bracket to the ceiling or wall using appropriate fasteners.
  - Ensure the bracket is level and securely fixed.
- **Electrical Connection**
  - Connect the LED driver to the main power supply (220-240V).
  - Ensure proper wiring using insulated connectors and confirm polarity.
  - Secure all electrical connections to prevent loose wiring.
- **Fixing the Panel Light**
  - Align the LED panel with the mounting bracket and snap it into place.
  - Check for a secure fit and ensure there is no movement.
- **Testing & Final Adjustments**
  - Turn on the power and verify the functionality of the LED panel.
  - Adjust positioning if necessary for uniform light distribution.
  - Ensure there is no flickering or loose wiring.

4.2.5 Adjusting & Final Alignment

- If the light intensity is uneven, adjust the panel alignment.
- In case of flickering, check and tighten electrical connections.

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- Secure all mounting screws to prevent misalignment over time.

4.3 LED FLOOD SECURITY LIGHTS

4.3.1 General Description

The LED Flood Security Light is a high-efficiency, durable, and weather-resistant lighting fixture designed for outdoor security applications. It provides bright, wide-angle illumination with low power consumption and a long lifespan. This 30-watt floodlight operates on a 220-240V power supply and is built for reliable performance in various environmental conditions.

4.3.2 Material

- Housing: Die-cast aluminum with a corrosion-resistant powder-coated finish
- Light Source: High-lumen output LED chips with a lifespan of 30,000–50,000 hours
- Lens/Cover: Tempered glass with high light transmittance
- Reflector: Aluminum reflector with high-efficiency light distribution
- Bracket: Adjustable stainless steel or galvanized steel mounting bracket
- Driver: Isolated LED driver with over-voltage and surge protection
- Sealing: IP65 or higher rating for dust and water resistance

4.3.3 Job Conditions

- Ensure a stable power supply of 220-240V, 50/60Hz.
- The mounting surface should be strong enough to support the weight of the fixture.
- Verify that the installation location is free from excessive vibration or moisture intrusion.
- Keep the work area dry and clear of debris before installation.
- Follow all local electrical safety codes and regulations.

4.3.4 Installation

- **Preparation**
  - Inspect the LED floodlight for any damage before installation.
  - Identify the appropriate mounting height and angle for optimal coverage.
  - Turn off the power supply before making any electrical connections.
- **Mounting**
  - Secure the adjustable bracket to a wall, pole, or ceiling using appropriate anchors and screws.
  - Ensure the bracket is firmly fixed to withstand wind loads and vibrations.
- **Electrical Connection**

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- Connect the LED floodlight wires to the main power supply (Live, Neutral, and Ground).
- Use waterproof connectors for outdoor installations.
- Ensure proper insulation and avoid loose wiring to prevent short circuits.

- **Adjusting the Light Angle**

  - Adjust the floodlight angle for optimal illumination using the adjustable bracket.
  - Tighten all screws to secure the desired position.

- **Testing & Final Adjustments**

  - Turn on the power and check the functionality of the LED floodlight.
  - Verify that the light covers the intended area effectively.
  - If needed, readjust the angle for better coverage.

4.3.5 Adjusting & Final Alignment

- If illumination is uneven, slightly adjust the mounting angle.
- Ensure all electrical connections are secure to prevent flickering or power loss.
- Periodically check the bracket and screws to prevent loosening due to environmental conditions.
- Clean the glass cover periodically for maximum light output.

4.4 CABLE TRAY & LADDERS

4.4.1 Scope of Works

1. Under this section of the specification cable tray shall be installed to support distribution cables, communication cables and all wiring cables not generally installed in conduit and or trunking.

2. The cable tray shall be installed in such a manner to enable easy access for cable installation.

3. The cable tray shall vary in type, i.e: where large cables are installed, ladder rack type cable tray shall be permitted. Where smaller type communication cables are installed, ventilated type cable tray shall be permitted.

4. Cable trays shall be Mild Steel Powder Coated finish or as specified in BOQ.

5. Cable ladders shall be installed in risers for the full length of the risers unless otherwise instructed by the Consultant.

4.4.2 QUALITY ASSURANCE

1. Acceptable Manufacturers

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2. Subject to compliance with the requirements of the Contract Documents, acceptable manufacturers are to be firms regularly engaged in manufacturer of all materials specified in this section of types and sizes required, whose products have been in satisfactory use under similar service conditions for not less than ten years.

4.4.3 SUBMITTALS

1. Submit the standards to which the cable tray is manufactured to.

2. Submit shop drawings and data in accordance with the general requirements of the contract.

3. Show actual cable tray installation details, size and suspension system.

4.4.4 PRODUCTS

GENERAL

1. The cable tray system shall be of one manufacturer and shall include factory made trays, tray fittings, connections, complete with accessories and supports to from a complete tray support system.

2. The cable tray system shall include the following factory-made tray elements. Straight trays and ladders, fittings and horizontal and vertical bends of various angles crosses, tees, wyes, reducers, vertical riser elements, connectors, joint plates and all necessary fixing accessories including supports. No local or site fabrication of any cable tray system including ceiling and wall supports are acceptable. Threaded rods for ceiling supports are not acceptable.

4.5 CABLE TRAY

1. The whole of the tray work, fittings and supports shall be of mild steel after manufacture. The thickness of the powder coating on any element shall not be less than 80 microns with anti-corrosive treatment.

2. Cable trays shall be constructed from G.I of minimum thickness 12 gauge. Height shall be 60mm or as specified. Flange height shall be 100mm or as indicated in drawings.

3. Insert elements, bolts, screws, pins etc., shall be cadmium plated/stainless steel.

4. Tray work shall have oval perforations. Ladder type trays shall be used as required and/or approved by the Engineer.

5. All trays (straight and fittings) to be heavy duty returned flanged type unless specified otherwise.

6. Tray components are to be accurately rolled or formed to close tolerance and all edges rounded. Flanges are to have full round smooth edges.

7. Ladder racks for widths up to and including 300mm shall be constructed from G.I sections of minimum thickness 12 gauge. Height shall be 60mm or as specified. Ladders in excess of 300mm width shall be C Section construction with a minimum thickness of 12 gauge. Height shall be 100mm or as indicated in drawings. The rungs shall be spaced at a maximum 300mm.

8. Unless indicated otherwise on drawings, cable trays shall be used in the range and 150mm to 750mm wide, in five preferred standard sizes: 150, 300, 450, 600 and 750mm.

9. Other sizes shall be used where specified or previously agreed with the Engineer.

10. Return flanges shall be a minimum of 10mm deep, unless otherwise specified.

11. Minimum radii at side rails, horizontal, and vertical tees and crosses shall be in accordance with the Manufacturer's standard.

4.5.1 EXECUTION

4.5.1.1 INSTALLATION

1. Install all cable trays and ladder racks strictly in accordance with IEE and local authorities' requirements.

2. Drilling, machining or cutting shall not be carried out after application of protective coat, unless previously agreed by the Engineer. If cutting or drilling is necessary, edges shall be cleaned up and painted with zinc-based paint before erection.

3. Provision shall be made when installing all cables and cable trays for the expansion and settlement of the building.

4. Cables shall be fixed to the trays/ladders by means of PVC cleats and flame-retardant cleats for flame/fireproof cables with galvanized bolts, nuts and washers. Use galvanized metal trefoil cleats with rubber pad for single core cables

5. Control cables run and clipped in groups shall not exceed twelve in number and shall be not more than double banked. Power cables shall be laid in a single layer except with the prior approval of the Engineer. Power cables should be spaced 2D between centres of cables throughout the run of cables. Submit calculations for voltage drop for cables and increase the size if necessary.

6. Vertical distances between trays mounted horizontally shall be minimum of 250mm. Local reduction of distances between trays will be allowed to a minimum of 150mm with approval from the Engineer.

7. Trays shall be adequately supported to prevent sagging by more than 3 Deg. between fixed points. All supporting steel work shall be fixed at not more than 1-meter centers unless otherwise specified.

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8. Where cable tray pass through floor arrange for 100mm concrete curb around opening and fire sealants shall be provided.

9. The Contractor shall submit calculations relating to tray / ladder work and tray / ladder supports demonstrating acceptable mechanical stresses and sag.

10. Where cable tray must pass below a beam a short length of tray shall be installed on the underside of the beam with 25mm spacers between the tray and the beam underside surface. Cables shall be strapped rigidly to the tray to prevent any possible sag in the cables.

11. Where cable tray is intended to cross a series of beams the tray shall be supported from each beam it crosses by metal supports suspended from below the underside of the beam - the space between the tray and the beam underside surface shall not exceed three times the diameter of the largest cable to be carried on the tray.

12. Cable tray covers are only required on roofs or outdoor where cables are installed exposed to weather conditions.

4.5.1.2 EARTHING

1. The entire cable tray and ladder system shall be bonded using 12mm x 1.5mm braided tin copper, which shall be bolted across each joint in the system by means of galvanized nuts and bolts, complete with flat and spring washers.

2. Tray systems shall be bonded to the main building earthing system as required or directed by the Engineer

4.5.1.3 FIRE BARRIERS

1. Arrange for opening in fire rated walls, and floor for width and depth of cable tray to run through in addition to the specified clearance of the above cable trays.

2. Arrange and make good fire rating of floors or walls after cables have been installed. For all floor openings of all risers (telephone, power) except vertical telecom cable risers where grating shall be provided.

3. All openings / sleeves within floor slabs and fire rated walls shall be sealed with proper fire rated material.

4.6 MAINS & SUB-CIRCUIT DISTRIBUTION

PART 1 – GENERAL

4.6.1 Work Description

A. Mains and sub-circuit distribution cablings of the LV System shall be as shown on the Drawings and as specified hereinafter.

B. All mains and sub-circuit cables shall be in conduits, trunking, cable trays and ladders as appropriate. Armoured cables shall be used for all circuits in open ground in trenches or on open trays and ladders. All the mains, sub-mains and final sub-circuits shall include insulated earthing conductor sized in accordance with BS7671.

C. The current carrying capacities and voltage drops of cables shall be in accordance with BS7671, with ratings adjusted to suit local conditions.

D. Cable joint is not acceptable for all cable installation.

4.6.2 Submissions

A. All technical submissions shall be approved by the Engineer prior to the respective stages of construction.

1. Detailed schedule of cables and manufacturer's data, Manufacturer's type test certificates and testing documents shall be submitted for inspection. Detail requirement of cable schedule as specified in Section 3, Wire and cables;
2. Calculations of voltage drop of cables;
3. Calculations of the prospective short circuit current;
4. Co-ordinated drawings showing all cable routings;
5. Builder's works requirement;
6. Detailed control wiring diagram.

PART 2 – CABLE INSTALLATION

4.6.3 GENERAL

A. Cables shall be delivered on robust cable drums with cable ends treated to form an effective seal. When a cable is cut from a drum, the cable and the end left on the drum shall be immediately sealed in approved manner to prevent the ingress of moisture.

B. Cables shall be installed along the routes as indicated on the Specification and Drawings and shall be agreed in detail with the Engineer before any work is commenced. There is no cost adjustment to any routing of the cables as required to suit the installation and subject to site co-ordination.

C. All necessary precautions shall be taken to prevent damage to cables during installation.

D. Where cables are installed in situations where works by M&E Services are still incomplete, all reasonable precautions shall be taken to protect the cables against damages arising from the execution of such other works.

E. Cable laying shall be carried out by means of normal hand running off the cable drum. Roller guides shall be used all through and be drawn through by hands. No cable winches shall be employed.

F. Cable entries into buildings shall be hermetically sealed with an appropriate fire, heat and water-resistant, non-ageing, flexible material.

G. Cables shall be adequately protected against all risk of mechanical damage to which they may be liable in normal conditions of services.

H. Cables shall be installed in accordance with BS7671. In particular, the internal radius of every bend in a cable shall be such that as not to cause damage to the cable and not less than the appropriate value stated in BS7671.

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I. Except for cables laid in ducts, all cables as specified herein shall run on cable trays/cable ladder, vertically and horizontally, and properly fixed in the prescribed manner. Where cables are laid on cable trays/cable ladder in the horizontal directions, nylon cable ties shall be used. Where cables are installed in the vertical direction, approved clips and saddles shall be used. The spacing of cable fixings shall be in accordance with BS7671.
J. Not more than one circuit of single core cables or one multi-core cable shall be grouped together. The spacing between groups of single core cables or multi-core cables shall not be less than twice the diameter of the largest cable in the adjacent group of cables.
K. Where cables pass through structural elements such as floors and walls, the opening made shall be sealed with approved fire-resistant material of not less than two (2) hours fire rating or not less than the fire rating of the slab/wall to prevent the spread of fire.
L. Where cables pass through expansion joints, the cables shall be formed into a loop which shall be of such size that any movement in the joint shall not stress the cables.

4.6.4 Final Sub-Circuit PVC Cable Installation

A. In general, cables are to be run in zinc coated trunking to BS 50085.
B. Unless otherwise in plant rooms, within false ceiling and boxed up riser, all final circuit wiring shall be in concealed conduit in concrete slab, wall, column, etc.
C. Cables in trunking shall be bunched in approved cable tie.
D. Trunking shall be properly sized to conform to IEE Regulations with minimum space factor of 45%.
E. BS Standard or relevant other Standards, name of the manufacturer, the voltage grade and the relevant BS number shall be printed on the outer sheathed insulation of the cables.
F. Cables for 3 phase, 4 wire system shall be colour coded – red, yellow, blue for phases, black for neutral and green/yellow for earth.
G. Minimum size of cable shall be 2.5mm^2 for lighting, 4mm^2 for power and 2.5mm^2 /4 mm^2 for earth continuity (depending on the phase cable) subject to a maximum volt drop of 2.5% of the nominal voltage.
H. The cable size shall be selected to ensure that it has adequate current carrying capacity and that the voltage drop at the apparatus supplied does not exceed the approved limit. Derating of cables shall also be taken into account for adverse conditions.
I. Connection of fixtures shall be by the "loop-in & loop-out" method.

4.6.5 Non-Armoured Mains & Sub-Mains Cable Installation

A. In general, the cables shall be installed on cable trays or ladders. They shall be installed to an acceptable way conforming to IEE Regulations to prevent losses in cables and performance of the current carrying capacity.
B. Proper labeling shall be installed at every 6 m interval.
C. Avoiding of overlapping of cable is necessary.
D. A three phase circuit cables shall be installed on the same tray.
E. The cables shall be terminated in suitably tinned copper compression connectors.
F. Cables shall be routed at high level on proprietary make horizontal cable trays or cable ladders (for large cables) and support systems similar to UNISTRUT or other approved equivalent system. All vertical runs including cabling to switchboards, etc. shall be secured on approved type cable ladder system. For horizontal runs, cables shall be secured neatly on the cable trays or ladders at close intervals by means of moulded polythene cleats similar to BICC "Telecleat" or other approved equal whereas claw cleats shall be used for securing

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vertical cables. Fixing shall be made with rawl bolts or other patented fixing devices of manufacturer details to the Engineer approval. Details of cable routes, terminations and support system shall be forwarded to the Engineer for review prior to installation.

4.6.6 Fire Resistant (FR) Cable Installation

A. Fire Resistant cables shall be installed on a separate cable tray without sharing with other sub-main/control cables.
B. Fire Resistant cables shall be installed in accordance with the maker's recommendations and instructions. Fire Resistant cables shall be run on proprietary make horizontal cable trays, vertical cable ladders, trunkings or conduits depending on the sizes. For horizontal runs, Fire Resistant cables of larger sizes shall be secured neatly on the cable trays or ladders at close intervals by means of moulded polythene cleats similar to BICC "Telecast' or other approved equal whereas fire resistant claw cleats shall be used for securing vertical runs.
C. All installation accessories shall be of manufacturer's standard products. Cable glands shall be of fire rating equal to the cable The bending radius of the cables measured from the inside of the bend shall be not less than eight times the diameter of the cable or to manufacturer's recommendation, whichever is more.
D. For emergency final circuit, the FR cables shall be installed in GI conduit in concealed slab, wall, etc. unless otherwise approved by the Engineer.

4.6.7 Earth Continuity Conductor Installation

A. Each circuit wire shall have its own protective conductor with adequately sized in accordance with BS7671 using stranded copper cable with green/yellow PVC insulation.

4.6.8 CABLE TERMINATION

A. Tee-off

1. Tee-off as required for tapping of power supply from the main riser cables to individual circuits shall be suitable for such purposes. Installation method must be submitted for approval prior to commencement of works. Under all circumstances, the conductors to be tee-off shall be secured by means of proprietary made compression type mechanical connectors, enclosed in plastic protective shell and filled with acrylic resin. No strand of a stranded conductor shall be cut away in making the tee-off.

B. Cable Termination

1. Cable shall be terminated using suitably chosen cable glands as specified.
2. A PVC shroud as specified shall be fitted to cover the gland body.
3. In the case of armoured cables, all armour and all faces of armour clamps of connectors making contact with them shall be thoroughly cleaned before termination and the clamps shall be adequately tightened to ensure good electrical contact.
4. Cable conductor terminations shall be by means of heavy duty solderless cable lugs. The lugs shall be of high conductivity copper electro-tinned and applied to the conductor by means of a hydraulic crimping tool unless otherwise specified. Heat shrinkable tapes shall be used for insulating the termination whenever possible.

C. Armour Earthing

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3.26 ROUGH CARPENTRY

3.26.1 GENERAL

RELATED WORK

- Architectural Wood Work
- Gypsum Board System

THIS SECTION INCLUDES

This Section specifies incidental rough carpentry required for support or attachment of other construction and not specified in other sections and includes, but is not limited to, the following items:

- Wood grounds, blockings, and nailers.
- Temporary and permanent grounds, blockings and supports required by other trades.

RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions.

- Wood grounds, nailers, and blocking.
- Wood furring.
- Wood sub-frames.

PRESERVATIVE TREATMENT

- Application is to be carried out after cutting and machining, but before assembly, by processor licensed by the treatment solution manufacturer
- Solution strengths and treatment by pressure, vacuum or immersion process are to be selected to achieve service life and to suit wood treatability.
- Moisture content of wood at time of treatment is to be as specified for use in the work.
- After treatment, allow wood to dry before use.
- For each batch of wood, provide certificate of assurance that treatment has been carried out as specified.
- Re-treat all treated wood which is sawn along the length, ploughed, thicknesses, planed or otherwise extensively processed.
- Treat wood surfaces exposed by minor cutting and drilling with two flood coats of solution recommended for the purpose by the treatment solution manufacturer.

SUBMITTALS

- Samples of all materials used in the work of this Section.
- Shop drawings for furring including details, sizes of wood sections, panel, spacing's and method of attachment.

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Technical Specifications

MDF (Fire Resistance)

- Medium density fibreboard's for fabric panels, 8-10mm thick.
- Strips of MDF around fabric panels edging.
- All MDF components to be fire resistant.

PLYWOOD

- Plywood: BS EN 636: Part 1, face grade for general use. Bonding is to be to BS 1203, type WBP for external use and type MR or INT for internal use.
- Marine Quality Plywood: to BS 1088 and BS 4079, excluding plywood made from gaboon.

CORK BOARD

Are to be pre-formed sheets that have been formed from clean granulated cork particles securely bound together by a synthetic resin of an insoluble nature. Minimum thickness of sheets is to be 25 mm (1"), width and length are to be as indicated on Drawings.

FASTNERS

- Nails: to BS 1202, Part 1, 2 or 3 generally, but non-ferrous types to Parts 2 or 3 for external use.
- Wood Screws: to BS 1210 generally, but non-ferrous types for external use.
- Self-Tapping Screws: to BS 4174.
- Dowels: mild steel, 10 mm (1/2") diameter, 100 mm (4") long, galvanized to BS EN ISO 1461 after fabrication.
- Cramps: mild steel, 25 x 3 x 250 mm (1" x 2/16" x 10") girth, turned up at one end and twice drilled for 3 mm (2/16") screws, fish-tailed at other end for building in and galvanized to BS 729 after fabrication.
- Plugs: either traditional hardwood plugs, shaped to twist and grip when driven, or proprietary fibre or plastics plugs, or other approved type.

TREATMENTS, ADHESIVE AND FINISHES

- Preservative Treatment: shall be type listed in BS 1282 (except coal tar creosote), obtained from an approved manufacturer, to give suitable protection against termites and other wood destroying organisms.
- Adhesive for Joinery: shall be close contact type to BS EN 301 or BS EN 302 suitable for the purpose. Obtain manufacturer's confirmation that adhesive is compatible with preservative treatment.

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EXECUTION INSTALLATION

GENERAL

- Discard units of material with defects that impair quality of rough carpentry and that are too small to use with minimum number of joints or optimum joint arrangement.
- Set rough carpentry to required levels and lines, with members plumb, true to line, cut, and fitted.
- Fit rough carpentry to other construction; scribe and cope as required for accurate fit. Correlate location of furring, nailers, blocking, grounds, and similar supports to allow attachment of other construction.
- Apply field treatment to cut surfaces of preservative-treated lumber and plywood.
- Securely attach rough carpentry work to substrate by anchoring and fastening as indicated.
- Use common wire nails, unless otherwise indicated. Select fasteners of size that will not fully penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood; predrill as required.
- Use hot-dip galvanized nails.
- Countersink nail heads on exposed carpentry work and fill holes with wood filler.

WOOD GROUNDS, NAILERS, BLOCKING AND SLEEPERS

- Install wood grounds, nailers, blocking, and sleepers where shown and where required for scree ding or attaching other work. Form to shapes shown and cut as required for true line and level of attached work. Coordinate locations with other work involved.
- Attach to substrates to support applied loading. Recess bolts and nuts flush with surfaces, unless otherwise indicated. Build into masonry during installation of masonry work. Where possible, anchor to formwork before concrete placement.
- Install permanent grounds of dressed, preservative-treated, key-bevelled lumber not less than 1-38 mm wide and of thickness required to bring face of ground to exact thickness of finish material. Remove temporary grounds when no longer required.

WOOD FURRING

- Install plumb and level with closure strips at edges and openings. Shim with wood as required for tolerance of finish work.
- Firestop furred spaces of walls at each floor level and at ceiling with wood blocking or non-combustible materials, accurately fitted to close furred spaces.

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Technical Specifications

- Furring to Receive Wood or Plastic Sheets or Boards: Install 19-by-63-mm actualsize furring at 600 mm o.c., horizontally and vertically. Select furring with no knots capable of producing bent-over nails and damage to paneling.
- Furring to Receive Gypsum Board: Install 19 (3/4")-by-38-mm (1½") actual-size furring at 400 mm (16") o.c., vertically.
- Furring to Receive Plaster Lath: Install 19 (3/4")-by-38-mm (1½") actual-size furring at 400 mm (16") o.c., vertically

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3.27 TERMITE CONTROL

3.27.1 SCOPE

The work covered by this section of Specification consists of furnishing all labour, materials, equipmnt, services, miscellaneous and necessary items required to complete Termite Control and, related works as indicated on drawings, and specified herein, in strict accordance with this section of specifications, as subject to the terms and conditions of the Contract.

3.27.2 MATERIALS

i. Pesticides shall be 0.4% Termidor and/or as directed by the manufacturer, or solution of 0.5% Dieldrin or a 0.5% Aldrin, mixed in clean water for application in earth, and mixed in pure turpentine for application to wood.

ii. Pesticides (Dieldrin & Aldrin) shall be obtainable from the Government of Pakistan, Department of Agriculture, or other sources approved by Engineer in sealed drums at rates in force at the time of their acquisition and only in the quantity necessary for work of this Project. All mixing shall be done at site and the amount of pesticides used shall be verified by the Engineer

3.27.3 METHOD OF APPLICATION

Pesticides solution shall be applied with approved pressure spraying equipment maintaining a pressure of 150, p.s.i. (10.5kg/cm 2) to all application to, on or in earth. Spraying to wood shall be done by hand compression with an approximate pressure of 20 p.s.i.

3.27.4 WORKMANSHIP

The treatment operation shall be carried out as follows:-

i. After the excavation for foundation trenches and pits is completed in each and every respect, and passed for concreting work, but before laying of concrete, Pesticide shall be penetrated to a depth of 1" (25 mm) ;minimum in porous earth at bottom and 2" (50mm) to 3" (75 mm) at sides of excavation.

ii. Stock piled excavated material to be used as back fill is to be treated as above. After backfilling to required grade the area is again to be sprayed.

iii. After grading, compaction and levelling of fill and before installation of any soling, all areas are to be sprayed with pesticide, penetrating a minimum of 1" (25mm) into soil.

iv. Pesticide solution shall be applied inside the building lines and for a distance of 10 feet (3 M) out side all building with specified pressure.

v. All rough wood work for the entire project is to be pesticide treated (before application of Soligum in the case of material to receive both treatments). Pesticide shall be sprayed on all surfaces of all the wooden work viz, door frames blocking, furring, planks,, boards etc, before installation. No spraying shall be necessary after field sawing, planning, joining or installation of such material. All spraying will be done within one week of working of the materials.

3.27.5 LOCATION AND SCHEDULING

i. Saturation of earth is to be done by adequate personnel and in such a manner as to in no way disrupt the progress of the work.

ii. Such work is to be scheduled and done by sufficient skilled personnel manner as to in no way impede the progress of the work.

iii. Care shall be exercised to ensure that no mark or damage occurs to the finished building as a result of the work under this section, and Contractor shall verify and ensure that no material used herein will impede the growth of grass or plants at areas where spraying is done.

3.27.6 STANDARDS

All methods of termite protections used herein be in accordance with best standard practices of National Pest Control Association, U.S.A. and the British Wood Preserving Association.

3.27.7 GUARANTEE

The Contractor is to guarantee that the building shall be free from termites (white ants), wood bores and other pests or rodents which cause damage to wood or other organic material for 10 years from the date of acceptance of the building.
In the event of any damage caused within the guaranteed period, the Contractor shall replace at his own cost such damage material, finishes affected and suitably preserve and treat the entire premises with the best method known to the trade to prevent the spreading of termites.

3.27.8 TESTING

All materials and samples shall be subject to testing in accordance with the relevant standards specified herein, and shall be rejected if found below these standards. Rejected materials shall be removed from the site immediately; Contractor shall quote a lump sum rate for the termite control testing and treatment of the ground and excavation covered by this specifications including all ditches, pits, excavations, wood etc., complete.

3.27.9 MEASUREMENT & PAYMENT

i. Unless otherwise specifically stated in the Bill of Quantities or herein, all the work involved within the scope of this section of specification shall be deemed to be inclusive of but not limited to the following:-

- CONTRACTOR's establishment charges, overhead charges, profit, interest.
- All other expenses, charges, taxes specified in the Conditions of CONTRACT.
- Labour and all costs in connection therewith.
- Use of plant, equipment and machinery and all costs in connection therewith, e.g. mobilizations, demobilization, transporting, fuel, energy charges, grease, oil, installing, operating, storing, watching, returning, replacing, handling, maintaining, idle stand parking, removing, damaged, destroyed, salvaged.
- Material and goods, e.g. marketing, selecting, conveyance, loading, unloading, storing, watching, returning, handling, hoisting, lowering cutting, joining fixing, wastage, destroyed, damaged, salvaged.

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ii. The cost of all the works involved within the scope of this specification as per all the Drawings and Conditions of CONTRACT are covered only within the quoted lump sum rate of the item of the Bill of Quantities.

iii. No separate payment will be made for wood work etc. Covered under this section of the specifications, and all cost in connection therewith shall be included in the unit rates of the various items of the wood work affected by treatment

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SECTION 3: ELECTRICAL WORKS

4.1 CONDUIT & PIPES

4.1.1 GENERAL

The work under this section consists of supplying, in¬stalling, and commissioning of all material and services of the complete conduit & pipe system as specified herein and/or shown on Tender Drawings and stated in the Bill of Quantities.

The Contractor shall discuss the electrical layout with the Engineer and co-ordinate at site with other services for exact route, location and position of the electrical lines.

4.1.2 PVC CONDUITS

All wiring for light, power, control and other circuits shall be carried out in PVC pipe otherwise as stated in BOQ, minimum 25mm dia. The conduits and pipes shall be supplied complete with all accessories including bends, sockets, junction boxes of identical material as that of conduit and all cutting, repair, excavation backfilling, etc., required for complete installation. The conduits for internal wiring to lights, sockets and power circuit shall be of approved brand.

Manufactured smooth bends shall be used wherever conduit changes direction. The sharp 90 degree bends or tees shall not be allowed. All conduit accessories shall conform to same material specifications as given above for conduit.

The bends shall have enlarged ends to receive conduit without any reduction in the internal diameter at joints.

The round junction box for ceiling light points shall be of PVC having minimum dimensions of 63 mm diameter and 63mm deep. The outlet box at wall light points shall be general purpose type having minimum dimensions of 75mm x 75mm and 38 mm deep. Pull boxes and inspection boxes shall be installed in conduit runs where required to limit the pulling of the cables or for inspection purposes. The pull boxes shall be square having minimum dimension of 100mm and 50 mm deep. In all cases, the minimum length of inspection boxes shall be not less than four times the cable manufacturers recommended bending radius of the cable. These dimensions are minimum only and the Contrac¬tor shall determine the exact size keeping in view ease of maintenance and installation. In general the use of pull boxes and inspection boxes shall be avoided. The pull boxes and inspection boxes shall be of 16SWG. sheet steel provided with anti-rust paint and finished in gray enamel paint or orange powder coated paint. The face plate shall be secured to the box by means of flat head galvanized screw.

4.1.3 INSTALLATION

1. Conduits

The conduit shall be installed concealed in wall, column ceiling or under floor, on surface, above the false ceiling or as stated on the drawings. The drawings are diagrammatic and do not indicate the location of junction boxes, pull boxes or inspection boxes which shall be provided to suit site conditions. The concealed conduits shall have a minimum of 25 mm concrete cover, when concealed in R.C.C works. The conduits in R.C.C works shall be laid before pouring of concrete. Chisels shall not be made in R.C.C structure for conduits and accessories after pouring of concrete. In slab, conduits shall be laid over the bottom reinforcement steel and tied firmly to it. The conduit outlet boxes shall be held firmly to finish with the surface of the slab or beam. At expansions joints, flexible conduits or alternate arrangement shall be provided.

Where conduits have to be concealed in cement concrete work after concreting or in block masonry, chisels shall be made with appropriate tools and of required depth. The conduit shall then be firmly recessed and covered after plastering. All chisels for concealing conduits shall be carried out by the Contractor. The Contrac¬tor will be responsible for bringing back the general finish to the condition that it was before the cutting and chiselling by the Contractor.

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The work of conduit installation and cutting in cement concrete work or brick work shall be coordinated with civil construction so as not to cause any undue hindrances and delays in progress. The Contractor shall obtain approval of the Consultant for route, etc. to suit the site conditions before starting chiselling and cutting. All junction boxes, outlet boxes, pull boxes etc., shall be installed concealed so as to finish with the surface.

Conduits installed on surface shall be fixed by means of black enamelled steel saddles and clamps having thickness of 3 mm or as mentioned in BOQ. The clamps shall be installed at a distance of not more than 600 mm.

All conduit bends shall be made with an approved conduit bending machine or hickory.

The radius of curvature of the inner edge of any bend shall not be less than the following table :

Conduit size	Radius
25 mm(1")	Not less than 150 mm.
32 mm (1-1/4")	Not less than 200 mm.
38 mm (1-1/2")	Not less than 255 mm.
50 mm (2")	Not less than 305 mm
70 mm (2-1/2")	Not less than 380 mm
82 mm (3")	Not less than 460 mm.
100 mm (4")	Not less than 610 mm

After completion of conduit in¬stallation, the system shall be checked for any charred or twisted portion prior to the pulling of wire. At all joints, PVC jointing solution or cement must be used.

The termination of conduits is shown diagrammatically on the drawings. The exact final location of the termination shall be coordinated with the equipment to be installed. Conduit ends pointing upwards or downwards shall be properly plugged, in order to prevent the entry of foreign materials. All openings through which concrete may leak shall be carefully plugged and boxes shall be suitably protected against filling with concrete. At all termina¬tion of conduit, soft bushes shall be fixed to prevent sharp edges of conduit ends from cutting or damaging the wires or cables to be pulled through them. Brass glands of appropriate sizes (as per size of conduit) with proper chuck nuts shall be used for fixing of conduits in junction boxes.

The entire conduit system shall be installed and tested before wiring is carried out. Any obstruction found shall be cleared by use of a cutting or other approved device and the conduit be cleaned out before the installation of cable.

4.1.4 OTHER ACCESSORIES

Outlet boxes, pull boxes, inspection boxes, switch and socket outlet boxes, fan regulator boxes, shall be of 16 SWG sheet steel, de-rusted, degreased, rust-proof with two coats of zinc chromate primer and painted with enamel, complete with earthing terminal. All boxes shall have ample wiring space, and boxes used outdoors shall be weather-proof.

All the pull boxes are to be properly labeled according to the type of services for which it is installed.

4.2 LED SURFACE MOUNTED PANEL LIGHTS

4.2.1 General Description

The LED Surface Mounted Panel Light is a high-efficiency lighting fixture designed for ceiling or wall mounting. It provides uniform illumination with low power consumption, long lifespan, and minimal maintenance. This 24-watt LED panel operates at 220-240V and is available in both round and square shapes, ensuring compatibility with various architectural and interior design requirements.

4.2.2 Material

- Panel Frame: Aluminum alloy, powder-coated for corrosion resistance
- Light Source: High-quality LED chips with a lifespan of 30,000–50,000 hours
- Diffuser: Frosted polycarbonate (PC) for glare-free light distribution

Technical Specifications

- Driver: Isolated LED driver with surge protection and efficient thermal management
- Mounting Bracket: Galvanized steel or aluminum for secure attachment

4.2.3 Job Conditions

- Ensure the electrical supply is within the specified range (220-240V, 50/60Hz).
- Confirm surface stability before installation (e.g., ceilings or walls should be structurally sound).
- Keep the installation area dry and free of dust or debris.
- Check for any obstructions in the ceiling or wall that may interfere with mounting.
- Adhere to safety protocols for electrical installations, including shutting off power before working..

4.2.4 Installation

- **Preparation**
  - Verify the LED panel specifications and ensure compatibility with the power supply.
  - Measure and mark the mounting positions for alignment.
- **Mounting**
  - Attach the provided bracket to the ceiling or wall using appropriate fasteners.
  - Ensure the bracket is level and securely fixed.
- **Electrical Connection**
  - Connect the LED driver to the main power supply (220-240V).
  - Ensure proper wiring using insulated connectors and confirm polarity.
  - Secure all electrical connections to prevent loose wiring.
- **Fixing the Panel Light**
  - Align the LED panel with the mounting bracket and snap it into place.
  - Check for a secure fit and ensure there is no movement.
- **Testing & Final Adjustments**
  - Turn on the power and verify the functionality of the LED panel.
  - Adjust positioning if necessary for uniform light distribution.
  - Ensure there is no flickering or loose wiring.

4.2.5 Adjusting & Final Alignment

- If the light intensity is uneven, adjust the panel alignment.
- In case of flickering, check and tighten electrical connections.

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- Secure all mounting screws to prevent misalignment over time.

4.3 LED FLOOD SECURITY LIGHTS

4.3.1 General Description

The LED Flood Security Light is a high-efficiency, durable, and weather-resistant lighting fixture designed for outdoor security applications. It provides bright, wide-angle illumination with low power consumption and a long lifespan. This 30-watt floodlight operates on a 220-240V power supply and is built for reliable performance in various environmental conditions.

4.3.2 Material

- Housing: Die-cast aluminum with a corrosion-resistant powder-coated finish
- Light Source: High-lumen output LED chips with a lifespan of 30,000–50,000 hours
- Lens/Cover: Tempered glass with high light transmittance
- Reflector: Aluminum reflector with high-efficiency light distribution
- Bracket: Adjustable stainless steel or galvanized steel mounting bracket
- Driver: Isolated LED driver with over-voltage and surge protection
- Sealing: IP65 or higher rating for dust and water resistance

4.3.3 Job Conditions

- Ensure a stable power supply of 220-240V, 50/60Hz.
- The mounting surface should be strong enough to support the weight of the fixture.
- Verify that the installation location is free from excessive vibration or moisture intrusion.
- Keep the work area dry and clear of debris before installation.
- Follow all local electrical safety codes and regulations.

4.3.4 Installation

- **Preparation**
  - Inspect the LED floodlight for any damage before installation.
  - Identify the appropriate mounting height and angle for optimal coverage.
  - Turn off the power supply before making any electrical connections.
- **Mounting**
  - Secure the adjustable bracket to a wall, pole, or ceiling using appropriate anchors and screws.
  - Ensure the bracket is firmly fixed to withstand wind loads and vibrations.
- **Electrical Connection**

- Connect the LED floodlight wires to the main power supply (Live, Neutral, and Ground).
- Use waterproof connectors for outdoor installations.
- Ensure proper insulation and avoid loose wiring to prevent short circuits.

- **Adjusting the Light Angle**

  - Adjust the floodlight angle for optimal illumination using the adjustable bracket.
  - Tighten all screws to secure the desired position.

- **Testing & Final Adjustments**

  - Turn on the power and check the functionality of the LED floodlight.
  - Verify that the light covers the intended area effectively.
  - If needed, readjust the angle for better coverage.

4.3.5 Adjusting & Final Alignment

- If illumination is uneven, slightly adjust the mounting angle.
- Ensure all electrical connections are secure to prevent flickering or power loss.
- Periodically check the bracket and screws to prevent loosening due to environmental conditions.
- Clean the glass cover periodically for maximum light output.

4.4 CABLE TRAY & LADDERS

4.4.1 Scope of Works

1. Under this section of the specification cable tray shall be installed to support distribution cables, communication cables and all wiring cables not generally installed in conduit and or trunking.

2. The cable tray shall be installed in such a manner to enable easy access for cable installation.

3. The cable tray shall vary in type, i.e: where large cables are installed, ladder rack type cable tray shall be permitted. Where smaller type communication cables are installed, ventilated type cable tray shall be permitted.

4. Cable trays shall be Mild Steel Powder Coated finish or as specified in BOQ.

5. Cable ladders shall be installed in risers for the full length of the risers unless otherwise instructed by the Consultant.

4.4.2 QUALITY ASSURANCE

1. Acceptable Manufacturers

2. Subject to compliance with the requirements of the Contract Documents, acceptable manufacturers are to be firms regularly engaged in manufacturer of all materials specified in this section of types and sizes required, whose products have been in satisfactory use under similar service conditions for not less than ten years.

4.4.3 SUBMITTALS

1. Submit the standards to which the cable tray is manufactured to.

2. Submit shop drawings and data in accordance with the general requirements of the contract.

3. Show actual cable tray installation details, size and suspension system.

4.4.4 PRODUCTS

GENERAL

1. The cable tray system shall be of one manufacturer and shall include factory made trays, tray fittings, connections, complete with accessories and supports to from a complete tray support system.

2. The cable tray system shall include the following factory-made tray elements. Straight trays and ladders, fittings and horizontal and vertical bends of various angles crosses, tees, wyes, reducers, vertical riser elements, connectors, joint plates and all necessary fixing accessories including supports. No local or site fabrication of any cable tray system including ceiling and wall supports are acceptable. Threaded rods for ceiling supports are not acceptable.

4.5 CABLE TRAY

1. The whole of the tray work, fittings and supports shall be of mild steel after manufacture. The thickness of the powder coating on any element shall not be less than 80 microns with anti-corrosive treatment.

2. Cable trays shall be constructed from G.I of minimum thickness 12 gauge. Height shall be 60mm or as specified. Flange height shall be 100mm or as indicated in drawings.

3. Insert elements, bolts, screws, pins etc., shall be cadmium plated/stainless steel.

4. Tray work shall have oval perforations. Ladder type trays shall be used as required and/or approved by the Engineer.

5. All trays (straight and fittings) to be heavy duty returned flanged type unless specified otherwise.

6. Tray components are to be accurately rolled or formed to close tolerance and all edges rounded. Flanges are to have full round smooth edges.

7. Ladder racks for widths up to and including 300mm shall be constructed from G.I sections of minimum thickness 12 gauge. Height shall be 60mm or as specified. Ladders in excess of 300mm width shall be C Section construction with a minimum thickness of 12 gauge. Height shall be 100mm or as indicated in drawings. The rungs shall be spaced at a maximum 300mm.

8. Unless indicated otherwise on drawings, cable trays shall be used in the range and 150mm to 750mm wide, in five preferred standard sizes: 150, 300, 450, 600 and 750mm.

9. Other sizes shall be used where specified or previously agreed with the Engineer.

10. Return flanges shall be a minimum of 10mm deep, unless otherwise specified.

11. Minimum radii at side rails, horizontal, and vertical tees and crosses shall be in accordance with the Manufacturer's standard.

4.5.1 EXECUTION

4.5.1.1 INSTALLATION

1. Install all cable trays and ladder racks strictly in accordance with IEE and local authorities' requirements.

2. Drilling, machining or cutting shall not be carried out after application of protective coat, unless previously agreed by the Engineer. If cutting or drilling is necessary, edges shall be cleaned up and painted with zinc-based paint before erection.

3. Provision shall be made when installing all cables and cable trays for the expansion and settlement of the building.

4. Cables shall be fixed to the trays/ladders by means of PVC cleats and flame-retardant cleats for flame/fireproof cables with galvanized bolts, nuts and washers. Use galvanized metal trefoil cleats with rubber pad for single core cables

5. Control cables run and clipped in groups shall not exceed twelve in number and shall be not more than double banked. Power cables shall be laid in a single layer except with the prior approval of the Engineer. Power cables should be spaced 2D between centres of cables throughout the run of cables. Submit calculations for voltage drop for cables and increase the size if necessary.

6. Vertical distances between trays mounted horizontally shall be minimum of 250mm. Local reduction of distances between trays will be allowed to a minimum of 150mm with approval from the Engineer.

7. Trays shall be adequately supported to prevent sagging by more than 3 Deg. between fixed points. All supporting steel work shall be fixed at not more than 1-meter centers unless otherwise specified.

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8. Where cable tray pass through floor arrange for 100mm concrete curb around opening and fire sealants shall be provided.

9. The Contractor shall submit calculations relating to tray / ladder work and tray / ladder supports demonstrating acceptable mechanical stresses and sag.

10. Where cable tray must pass below a beam a short length of tray shall be installed on the underside of the beam with 25mm spacers between the tray and the beam underside surface. Cables shall be strapped rigidly to the tray to prevent any possible sag in the cables.

11. Where cable tray is intended to cross a series of beams the tray shall be supported from each beam it crosses by metal supports suspended from below the underside of the beam - the space between the tray and the beam underside surface shall not exceed three times the diameter of the largest cable to be carried on the tray.

12. Cable tray covers are only required on roofs or outdoor where cables are installed exposed to weather conditions.

4.5.1.2 EARTHING

1. The entire cable tray and ladder system shall be bonded using 12mm x 1.5mm braided tin copper, which shall be bolted across each joint in the system by means of galvanized nuts and bolts, complete with flat and spring washers.

2. Tray systems shall be bonded to the main building earthing system as required or directed by the Engineer

4.5.1.3 FIRE BARRIERS

1. Arrange for opening in fire rated walls, and floor for width and depth of cable tray to run through in addition to the specified clearance of the above cable trays.

2. Arrange and make good fire rating of floors or walls after cables have been installed. For all floor openings of all risers (telephone, power) except vertical telecom cable risers where grating shall be provided.

3. All openings / sleeves within floor slabs and fire rated walls shall be sealed with proper fire rated material.

4.6 MAINS & SUB-CIRCUIT DISTRIBUTION

PART 1 – GENERAL

4.6.1 Work Description

A. Mains and sub-circuit distribution cablings of the LV System shall be as shown on the Drawings and as specified hereinafter.

B. All mains and sub-circuit cables shall be in conduits, trunking, cable trays and ladders as appropriate. Armoured cables shall be used for all circuits in open ground in trenches or on open trays and ladders. All the mains, sub-mains and final sub-circuits shall include insulated earthing conductor sized in accordance with BS7671.

C. The current carrying capacities and voltage drops of cables shall be in accordance with BS7671, with ratings adjusted to suit local conditions.

D. Cable joint is not acceptable for all cable installation.

4.6.2 Submissions

A. All technical submissions shall be approved by the Engineer prior to the respective stages of construction.
   1. Detailed schedule of cables and manufacturer's data, Manufacturer's type test certificates and testing documents shall be submitted for inspection. Detail requirement of cable schedule as specified in Section 3, Wire and cables;
   2. Calculations of voltage drop of cables;
   3. Calculations of the prospective short circuit current;
   4. Co-ordinated drawings showing all cable routings;
   5. Builder's works requirement;
   6. Detailed control wiring diagram.

PART 2 – CABLE INSTALLATION

4.6.3 GENERAL

A. Cables shall be delivered on robust cable drums with cable ends treated to form an effective seal. When a cable is cut from a drum, the cable and the end left on the drum shall be immediately sealed in approved manner to prevent the ingress of moisture.

B. Cables shall be installed along the routes as indicated on the Specification and Drawings and shall be agreed in detail with the Engineer before any work is commenced. There is no cost adjustment to any routing of the cables as required to suit the installation and subject to site co-ordination.

C. All necessary precautions shall be taken to prevent damage to cables during installation.

D. Where cables are installed in situations where works by M&E Services are still incomplete, all reasonable precautions shall be taken to protect the cables against damages arising from the execution of such other works.

E. Cable laying shall be carried out by means of normal hand running off the cable drum. Roller guides shall be used all through and be drawn through by hands. No cable winches shall be employed.

F. Cable entries into buildings shall be hermetically sealed with an appropriate fire, heat and water-resistant, non-ageing, flexible material.

G. Cables shall be adequately protected against all risk of mechanical damage to which they may be liable in normal conditions of services.

H. Cables shall be installed in accordance with BS7671. In particular, the internal radius of every bend in a cable shall be such that as not to cause damage to the cable and not less than the appropriate value stated in BS7671.

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I. Except for cables laid in ducts, all cables as specified herein shall run on cable trays/cable ladder, vertically and horizontally, and properly fixed in the prescribed manner. Where cables are laid on cable trays/cable ladder in the horizontal directions, nylon cable ties shall be used. Where cables are installed in the vertical direction, approved clips and saddles shall be used. The spacing of cable fixings shall be in accordance with BS7671.
J. Not more than one circuit of single core cables or one multi-core cable shall be grouped together. The spacing between groups of single core cables or multi-core cables shall not be less than twice the diameter of the largest cable in the adjacent group of cables.
K. Where cables pass through structural elements such as floors and walls, the opening made shall be sealed with approved fire-resistant material of not less than two (2) hours fire rating or not less than the fire rating of the slab/wall to prevent the spread of fire.
L. Where cables pass through expansion joints, the cables shall be formed into a loop which shall be of such size that any movement in the joint shall not stress the cables.

4.6.4 Final Sub-Circuit PVC Cable Installation

A. In general, cables are to be run in zinc coated trunking to BS 50085.
B. Unless otherwise in plant rooms, within false ceiling and boxed up riser, all final circuit wiring shall be in concealed conduit in concrete slab, wall, column, etc.
C. Cables in trunking shall be bunched in approved cable tie.
D. Trunking shall be properly sized to conform to IEE Regulations with minimum space factor of 45%.
E. BS Standard or relevant other Standards, name of the manufacturer, the voltage grade and the relevant BS number shall be printed on the outer sheathed insulation of the cables.
F. Cables for 3 phase, 4 wire system shall be colour coded – red, yellow, blue for phases, black for neutral and green/yellow for earth.
G. Minimum size of cable shall be $2.5mm^2$ for lighting, $4mm^2$ for power and $2.5mm^2$ /4 mm^2 for earth continuity (depending on the phase cable) subject to a maximum volt drop of 2.5% of the nominal voltage.
H. The cable size shall be selected to ensure that it has adequate current carrying capacity and that the voltage drop at the apparatus supplied does not exceed the approved limit. Derating of cables shall also be taken into account for adverse conditions.
I. Connection of fixtures shall be by the "loop-in & loop-out" method.

4.6.5 Non-Armoured Mains & Sub-Mains Cable Installation

A. In general, the cables shall be installed on cable trays or ladders. They shall be installed to an acceptable way conforming to IEE Regulations to prevent losses in cables and performance of the current carrying capacity.
B. Proper labeling shall be installed at every 6 m interval.
C. Avoiding of overlapping of cable is necessary.
D. A three phase circuit cables shall be installed on the same tray.
E. The cables shall be terminated in suitably tinned copper compression connectors.
F. Cables shall be routed at high level on proprietary make horizontal cable trays or cable ladders (for large cables) and support systems similar to UNISTRUT or other approved equivalent system. All vertical runs including cabling to switchboards, etc. shall be secured on approved type cable ladder system. For horizontal runs, cables shall be secured neatly on the cable trays or ladders at close intervals by means of moulded polythene cleats similar to BICC "Telecleat" or other approved equal whereas claw cleats shall be used for securing

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vertical cables. Fixing shall be made with rawl bolts or other patented fixing devices of manufacturer details to the Engineer approval. Details of cable routes, terminations and support system shall be forwarded to the Engineer for review prior to installation.

4.6.6 Fire Resistant (FR) Cable Installation

A. Fire Resistant cables shall be installed on a separate cable tray without sharing with other sub-main/control cables.
B. Fire Resistant cables shall be installed in accordance with the maker's recommendations and instructions. Fire Resistant cables shall be run on proprietary make horizontal cable trays, vertical cable ladders, trunkings or conduits depending on the sizes. For horizontal runs, Fire Resistant cables of larger sizes shall be secured neatly on the cable trays or ladders at close intervals by means of moulded polythene cleats similar to BICC "Telecast' or other approved equal whereas fire resistant claw cleats shall be used for securing vertical runs.
C. All installation accessories shall be of manufacturer's standard products. Cable glands shall be of fire rating equal to the cable The bending radius of the cables measured from the inside of the bend shall be not less than eight times the diameter of the cable or to manufacturer's recommendation, whichever is more.
D. For emergency final circuit, the FR cables shall be installed in GI conduit in concealed slab, wall, etc. unless otherwise approved by the Engineer.

4.6.7 Earth Continuity Conductor Installation

A. Each circuit wire shall have its own protective conductor with adequately sized in accordance with BS7671 using stranded copper cable with green/yellow PVC insulation.

4.6.8 CABLE TERMINATION

A. Tee-off

1. Tee-off as required for tapping of power supply from the main riser cables to individual circuits shall be suitable for such purposes. Installation method must be submitted for approval prior to commencement of works. Under all circumstances, the conductors to be tee-off shall be secured by means of proprietary made compression type mechanical connectors, enclosed in plastic protective shell and filled with acrylic resin. No strand of a stranded conductor shall be cut away in making the tee-off.

B. Cable Termination

1. Cable shall be terminated using suitably chosen cable glands as specified.
2. A PVC shroud as specified shall be fitted to cover the gland body.
3. In the case of armoured cables, all armour and all faces of armour clamps of connectors making contact with them shall be thoroughly cleaned before termination and the clamps shall be adequately tightened to ensure good electrical contact.
4. Cable conductor terminations shall be by means of heavy duty solderless cable lugs. The lugs shall be of high conductivity copper electro-tinned and applied to the conductor by means of a hydraulic crimping tool unless otherwise specified. Heat shrinkable tapes shall be used for insulating the termination whenever possible.

C. Armour Earthing

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1. Metallic sheaths and/or armour of all cables in the same circuit shall be solidly bonded together at both ends of their runs. The bonding shall extend from the earth lug or earth lug attached to the cable glands to the main earth system.
2. The cross-sectional area of the bonding conductor shall be selected in accordance to BS7671.
3. The bonding conductor shall be as short and straight as possible.

4.6.8 CABLE IDENTIFICATION

A. Cables shall be provided with identification markers, at each end of the cable, at entry and exit points of buried ducts, and in such other positions as are necessary to identify and trace the route at any cable. Where cables are not enclosed in ducts and are of multiple runs, markers shall be provided at 15 meter intervals

B. Cable identification shall be assembled from elliptical profiled plasticised PVC markers, carrier strip and nylon ties, the complete assembly shall be suitable for a maximum service temperature of 70°C.

C. Every core of a multicore cable shall be provided with identification at its termination in the form of tapes, sleeves or discs of appropriate colours.

4.7 LOW VOLTAGE SWITCHBOARDS

PART 1 – GENERAL

4.7.1 WORK DESCRIPTION

A. The switchboards, distribution boards and control panels shall be built in accordance with IEC 61439 "Factory Built Assemblies for Low Voltage" or BS 5486 "Factory-built Assemblies of Switchgear and Control Gear for Voltage up to and including 1000 AC and 1200V DC.

B. All factory built assemblies shall be capable of withstanding the electrical, mechanical and thermal stresses of the prospective fault level experience. The prospective fault levels of the various factory built assemblies shall be as indicated in the Drawings.

C. All equipment used in the factory built assemblies shall have been type tested/partial type tested. Type set certificates shall be submitted for all major equipment at the time of technical submission.
Besides, a full type test report as specified under IEC 61439, the Low voltage switchboard shall also be tested for electromagnetic compatibility (EMC), internal arcing-fault test and seismic withstand test under the relevant standards.

D. All factory built assemblies, as a complete unit shall have a rating equal to or greater than the integrated equipment rating as indicated in the Drawing.

E. All factory built assemblies subject to rain or wet conditions or located outside electrical switch room shall be weatherproof constructed to IP 66, able to withstand high impact strength of 60 KN/m^2 (min), temperature resistant with consideration of Ambient temperature 45 degrees C and average switch room temperature 30 degrees C. Flame retardant and corrosion resistant.

4.7.2 STANDARDS

A. The LV switchboards and distribution boards shall be constructed in accordance with the latest revision of the following standards:

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Technical Specifications

1.	BS 88-2	:	Cartridge fuses for voltages up to and including 1000V AC and 1500V DC.
2.	BS 89-2	:	Direct acting electrical indicating analogue electrical measuring instruments and their accessories.
3.	BS 142	:	Electrical protection relays
4.	BS 159	:	Busbars and busbar connections
5.	BS 13601	:	Copper for electrical purposes. Rods and bars.
6.	BS EN 60898	:	Circuit-breakers for over current protection for household and similar installations.
7.	BS 61869	:	Current transformers
8.	BS EN 60947-2	:	Low-voltage switchgear and controlgear. Circuit-breakers.
9.	BS EN 60947-2	:	Control switches (switching devices, including contactor relays, for control and auxiliary circuits, for voltages up to and including 1000V AC and 1200V DC).
10.	BS EN 60947	:	Air-break switches, air-break disconnectors, air break switch disconnectors and fuse combination units for voltages up to and including 1000V AC and 1200V DC.
11.	BS EN 60947	:	Degrees of protection of enclosures of switchgear and control gear for voltages up to and including 1000V AC and 1200V DC.
12.	BS 5424	:	Control gear for voltages up to and including 1000V AC and 1200V DC Contactors.
13.	BS 61439	:	Low-voltage switchgear and control gear assemblies. Specification for type tested and partially type tested assemblies.(General requirements)
14.	BS EN 62053-11	:	Electricity meters – Specification for Class 0.5, 1 and 2 single phase and polyphase, single-rate and multi-rate watt-hour meters.
15.	BS EN 61810-2	:	Electrical relays.
16.	BS 6004	:	PVC insulated cables, non-armoured, for electric power, lighting and internal wiring.
17.	BS 6231		PVC insulated cables for switchgear and controlgear wiring.
18.	BS 7430		Code of practice for Earthing
19.	IEC 61439	:	Low-voltage switchgear and control gear assemblies Type-tested and partially type-tested assemblies
20.	AS 3439-1	:	Low-voltage switchgear and control gear assemblies. Type-tested and partially type-tested assemblies
21.	IEC 60068-3-3	:	Environment testing: Guidance Seismic test methods for equipment.

B. BS/IEC or other National standards not mentioned above but are applicable to this installation shall also apply.

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4.7.3 SUBMISSION

A. A component list and catalogues.

B. Detailed shop drawings of all factory built assemblies shall be submitted for approval before construction commences.

C. Such drawings shall show the proposed method of construction of the cubicles, method of supporting equipment and busbars, full details of busbar layout, method of support, electrical control wiring diagrams, equipment weight, colors, surface treatment and mounting type etc.

D. The drawings shall also incorporate a full list of proposed materials. The construction shall not commence until the drawings are approved for construction.

E. Factory and site testing procedures and report formats shall also be included.

PART 2 – PRODUCTS

4.7.4 GENERAL

A. The factory built assemblies shall be of the totally enclosed, modular cubicle type, which are extensible and suitable for floor mounting as indicated in the drawings. The assemblies shall be manufactured in a facility that is ISO 9000 certified.

B. The factory built assemblies shall be compartmented and utilize sheet steel plates of thickness as detailed below. The panels shall be vermin proof and constructed to a minimum degree of protection of IP ratings to BS 60529. The IP ratings indicated below shall be applicable unless otherwise indicated in the drawing.

C. Main and Sub-Switchboards
   1. 2mm thick sheet steel
   2. Form 4a, Type 3 for Main Board and for Emergency Board and Form 2b, Type 2 for Distribution Board unless otherwise specified to BS 61439 with separation of busbars from the functional units and separation of all functional units from one another
   3. Minimum IP 44 and IP 2X after opening of doors & panels (of external covers) unless otherwise specified.
   4. IP66 for location subject to rain wet conditions or located outside electrical switch room.
   5. Switchboard frame shall be of modular detail and extensible.
   6. The interior of each cubicle shall be dust inert and vermin resistant.

D. Switchboard frames shall be fabrication of 2.0mm thick electro-galvanized steel. All joints shall be neatly formed and finished flush with the adjacent surfaces by grinding and/or machining. No joints shall be located on a corner and all bare edges shall be lipped.

E. Structural members and bracing, where necessary, shall be welded or bolted to the frame.

4.7.5 DOORS AND PANELS

A. Full access shall be provided to service and maintain all equipment inside each cubicle by means of a suitable hinged door that shall open a minimum of 120 degrees. All hinged doors shall have an earth braid connected to the cubicle.

B. Doors and panels shall be constructed of 2 mm electro-galvanized sheet steel, pressed or rolled so that edges are given a neat round finish and shall reinforced with a suitable frame welded to the inside folded edge of the door. An approved stiffener shall be welded to the inside of each door and/or panel.

C. Doors shall hang on substantially concealed non-corrosive hinges and shall be fitted with good quality door handles to Engineer's approval which shall be lockable and operable by the same key. The door handles shall be fitted with toggles to operate rods to latch with suitable

slots in both the top and bottom of the switchboards. Latching rods shall be guided by brackets. The latching rods and associated brackets shall be cadmium plated.

D. All front, side and top panels shall be constructed in a manner similar to that specified for doors above. They shall be fitted to the frame from the outside with captive, hand tightened screw. Panels longer than 1.2 meters shall be provided with 3 point locking system

4.7.6 BASEPLATE AND INSULATING PANELS

A. The switchboards shall be mounted on 50mm X 50mm C-channel. Wherever insulating panels are required to mount special equipment, they shall be of high quality black bakelite, polished on the front.

B. All edges must be cut straight and square and shall be chamfered on the front edge with a 3mm chamfer.

4.7.7 FINISHING OF METAL WORK

A. Panel work of the switchboards shall be finished with electrostatic epoxy powder coating of minimum 50 microns all treat with 180 ^{0}C, 12 minute oven backing. All metal work shall be rust inhibited and sprayed with two coats of primer. The painting shall be of best quality oven-bake epoxy powder coated, of Grey colour.

B. After erection on site and after all inspection and tests have been carried out, the Contractor shall thoroughly clean all painted parts, touch-up with application of an additional coat of anti-corrosive structural priming paint to any part of the originally painted surfaces that have been scratched or otherwise marked and at least one additional touch-up finishing coat of Grey colour.

4.7.8 BUSBARS AND CURRENT CARRYING PARTS

A. The manufacturing of the busbar system shall comply to the latest edition of BS 159. All busbars and current carrying parts shall be manufactured to carry a current density of not more than 1.55 A/mm^2 and shall be capable of carrying normal current continuously without the temperature rise of any part exceeding 30^{0}C. Their location shall be such as to ensure adequate spacing between conductors and they shall be securely fastened and braced to withstand all stress set up during transportation, erection and normal operation, and under short circuit conditions. The busbars shall not be damaged in any way under a fault of short circuit experience with minimum 46 MVA for 3 seconds. Where two or more conductors are used to form a phase, it shall be separated with an air gap sufficient to allow for the ventilation of the individual conductors all round. Busbar supports shall be made of slotted first grade "Bakelite" or glass fiber reinforced polymer able to withstand minimum operating temperature of 110^{0}C.

B. All connections in current carrying parts shall be made by means of bolts with lock nuts. The use of tapped holes and studs or any other alternative method of connection in current carrying parts shall not be employed without the express approval of the Engineer prior to manufacture.

C. Busbars shall be provided with approved shrinkable tube of adhesive stickers of appropriate phase colour to indicate phases.

D. All connections, tapping and clamping shall be made in an approved manner to ensure minimum contact resistance. All connections in the busbars shall be firmly bolted and clamped with even tension. Before assembly, all busbar joint surfaces shall be filed or finished to remove burrs, dents and oxides and silvered to maintain good continuity at all joints.

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E. All intermediate conducting material shall be used when there is a possibility of electrolytic action when contacts of the copper busbars with dissimilar metals are made.

F. An earth bar minimum size comply with BS 7671 and BS 7430 with minimum 50mm x 10mm to each vertical section of the cubicle units and shall run the full length at the bottom of each switchboard. All metal parts of the switchboards and associated equipment shall be bonded and connected to this earth bar. Minimum 2 connections to main earthing system shall be provided. The protective circuit shall have a rated conditional short circuit current of 39kA at 240V and a rated peak and short-circuit withstand current of 81.9kA and 39kA for 1 sec respectively.

G. The neutral busbar shall be the same size of that of the phase bars and shall be provided with an adequate number of terminals including cable lugs, bolts, etc. to suit the installation.

H. For circuits not less than 200A, busbar drops to moulded case circuit breakers or other apparatus shall be made of circular or rectangular busbar covered with Nylex tubing of appropriate colour and terminated in adequately sized concentric lug, of lug type, cone grip cable sockets or approved equal. Cables may be used for circuits less than 200A to type test configuration.

I. All visible rectangular busbars shall be bare tinned type size 1.55A/mm^2 based on current density. Rated current of assembly shall be based on tinned busbar and must be certified by type testing.

J. All screws, bolts, washers used for the busbars shall be cadmium plated. All contact parts of the busbars and connections shall be sanded and coated with a thin coat of chemical inert petroleum jelly. All bolts shall be tightened with an even tension. Approved spring washers shall be used at all joints complete with cadmium plated high tensile steel bolts.

K. All busbars and switchgear terminals to which outgoing or incoming cables are terminated shall be manufactured for a maximum temperature of 30^{0}C above ambient. Where there are two incomers to the Low voltage switchboard, the bus-coupler and the busbar works shall type tested to certify the integrity of the system.

4.7.9 INSULATION

A. The clearances and insulation shall be such as to withstand the standard 3 kV dielectric tests on the switchboard.

B. All insulation used shall be of the best quality and sufficiently strong to withstand all stresses which may be imposed on it in the ordinary erection and operation of the switchboards.

C. Where insulators are cemented or jointed to metal parts, such jointing shall be of such a nature that no dangerous stresses are set up in the insulators by the unequal expansion or contraction of the insulation and the metal through the range of temperatures stated.

4.7.10 CABLE OR BUSDUCT ENTRIES

A. Provision shall be made within the factory built assemblies for the proper support and bracing of outgoing and incoming cables or bus ducts.

B. Weatherproof cable glands and all necessary non-ferrous gland plates, etc. shall be provided for all cables entering or leaving the switchboards. Cable terminating end boxes shall be mounted from top of the switchgear in the cubicles. Cable supports shall be provided for the termination boxes.

C. Bus duct entries to the switchboard shall be liaised with bus duct vendor for the exact position and phasing.

D. Detail of cable or bus duct in and out of the switchboard shall take into the IP rating requirement as specified for the switchboard.

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4.7.11 PHASING

A. Phase rotation shall be strictly maintained throughout the project. Phase distinguishing colors shall be RED, YELLOW and BLUE.

4.7.12 LABELS

A. All factory built assemblies and equipment shall be clearly labeled in accordance with Local Authority's regulations and to indicate its functions by means of engraved 'Traffolite' labels. Plastic labels are not acceptable. Emergency Main Switch Board shall be "red-on-white" others shall be "black-on-white". Engraved lettering not less than 20mm high or as otherwise required and approved.
B. Labels shall be attached by means of chrome finished countersunk screws and nuts.
C. Prior to engraving the labels, a label schedule shall be submitted for approval. Allow for two spare sets of label blanks and the cost of engraving as directed by the Engineer. If not so directed, the spare sets of labels are to become the property of the Employer.

4.7.13 SPECIFICATION FOR SPARES

A. The switchboards shall incorporate a rack for mounting spares, moulded case circuit breakers and a minimum of 20 percent standby/space capacities shall be provided for future installation of circuit breakers.
B. End covers and pre-drilled holes at main busbars shall be manufactured for future extension of the switchboards at both ends.
C. Spare shall be provided according to those as specified in the DB schedule/Single line diagram.

4.7.14 BASE SUPPORTS

A. The base support shall be fabricated from 50mm x 50mm C-channel base sufficiently stiffened to adequately support the switchboard. The base shall be hot dip galvanized after fabrication. The base may be made as part of the switchboard.

4.7.15 VENTILATION

A. All switchboards shall be properly natural ventilated. Force ventilation to achieve the required rating of the assembly is prohibited.
B. Vents shall be provided with the consideration of IP rating as specified.
C. Detailed calculation shall be submitted to verify the total heat from the switchgear and switchboard and the amount of vents and ventilation fans size.

4.7.16 INDICATING INSTRUMENTS

A. Indicating instruments shall comply with BS 89. Meters for external panel mounting shall be of the flush pattern type with square escutcheon plate's finished matt black and polycarbonate cases.
B. The main low voltage switchboards shall be provided with High performance and high accuracy power meter/ Energy Analyzer with LCD display that capable of indicating real-time readings, demand reading, energy readings, set up and resets menus shall be installed for the main switchboards. Power meter shall be provided for the circuits above 100A or as specified on the drawings.
C. The reading shall include but not limit to current (per phase, neutral and earth), voltage (L-L, L-N), real power, reactive power, apparent power, power factor, frequency, energy, power

quality readings such as voltage and current THD, demand, date/time stamping, on-board memory for alarms/relay functions such as under/over conditions, phase unbalance conditions, data log, event log, etc.

D. The meter power shall accept inputs from standard 5A current transformers and has full-scale input of 10A. The voltage inputs shall be directly connected to 3 phase circuits of 600V and below without the need for Potential or current transformer. All reading shall be scaled to their actual values without the need for a multiplier.
E. The power meter set up and resets shall be password protected and easily done via the meter display or via network software.
F. In addition, unless otherwise specified, following analogue indicating instrument shall be installed for sub-board and distribution boards above 100A incoming or as specified on the drawings.
G. Ammeter and voltmeters shall be of moving iron coil spring controlled type with 96mm square dials, accuracy Class 1.5 with external zero adjustment screw that is accessible from the front.
H. Ammeters shall be selected such that full load current indications are not less than the two thirds of linear scale of the meter and have a suppressed upper scale.
I. Ammeters shall be capable of taking overloads of 2 times continuously and voltmeter 1.2 times continuously.
J. Ammeters at the main incoming feeders shall in addition to the moving iron mechanism be provided with thermal bimetal indicators with draw pointers to record maximum demands. The mechanism shall not respond to short current peaks and shall be manually resettable.
K. Frequency indicators shall be of the vibrating reed type. The meter shall be capable of proper operation for voltage variation of ± 10% rated voltage.
L. Power factor meters shall be of the electrodynamics crossed coil mechanism suitable for balance load, three phase four-wire system. The accuracy class shall be 1.5 and range 0.5 lag to 0.5 lead.
M. Monitoring Kilowatt-Hour Meters and current transformers where specified shall be provided. The kilowatt-hour meter shall have a digital display reading up to 100 million Kilowatt-Hours and to the nearest 100 KW-Hr. The overall accuracy shall be better than ± 2.0%.
N. The KWh meters shall be of flush mounting, rear connection type, current transformer operated and suitable for three phase balanced and unbalanced loads. The meter shall be complete with the three metering elements and shall have a cyclometer register with six rollers.
O. Instrument dials shall be white with black markings, and scales shall be of such material that ageing, peeling or discoloration will not take place under tropical conditions.
P. All instruments, when mounted on the switchboard, wired and ready for service, shall be in good order and condition in every way. The measuring elements shall be completely free from any discernible stickiness either at zero or upscale, and they shall be capable of attaining the performance guaranteed by the manufacturers of the respective instruments.
Q. All terminals shall be completely insulated and potential circuits shall be suitable fused.

4.7.17 SELECTOR SWITCHES

A. The switches shall be of the panel mounting type with totally enclosed contacts and stud connection. Ammeter selector switches shall have make before break contacts to ensure that the current transformers are never open circuited.
B. The ammeter selector switch shall be suitable for measuring the current in each phase independently.

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C. The voltmeter selector switcher shall be 7-way type. Voltmeter selector switches shall have break before make contacts.

4.7.18 CURRENT TRANSFORMERS

A. Current transformers necessary for the operation of instruments and meters shall comply with BS 61869 and be of the 'straight through' epoxy-resin type. Measuring current transformer shall be of accuracy class 1 and for metering of accuracy Class 0.2 (for energy metering).
B. They shall be adequately rated in V.A. to carry the summation of all V.A. burdens of connected loads, and shall be capable of carrying current of the corresponding circuit breakers and fuses. The output secondary current shall be 5 amperes.
C. They shall be capable of operation, without damage, with open circuited secondary and full load current flowing in the primary.
D. Current transformers shall be adequately supported and installed as to permit easy access and to be readily replaceable, if necessary, without dismantling of adjacent equipment.
E. All current transformers shall be provided with an identifying label giving type, ratio, class, output and serial number.
F. Current transformers provided for protective gear purposes shall have overcurrent and accuracy limit factors not less than those corresponding to the short circuit level of the system. The output of each current transformer shall be not less than that specified and the capacity of the current transformers provided shall be adequate for operation of the associated protective devices and instruments. Where double ratio secondary windings are specified, a label shall be provided at the secondary terminals of the current transformer indicating clearly the connection required for either ratio. These connections and the ratio in use shall be shown on the appropriate schematic and connection diagrams. Protection current transformer shall be of a accuracy Class 5P 10 and the burden in no case shall be less than 15VA.
G. Magnetization curves shall be submitted at the time of shop drawing submission.

4.7.19 CONTACTORS

A. Contactors shall be fully tropicalized and robust construction and shall comply with relevant parts of BS 5424 and be rated for the following duties.
B. Contactors for voltages up to and including 1000 volts A.C. and 1200 volts D.C. (BS 5424 Part 1).

1.	Rated duty	-	Uninterrupted
2.	Mechanical duty	-	Class I
3.	Making and Breaking	-	AC4 Category

C. Contactors shall be selected to suit the load such that a minimum electrical life of one million operations is ensured. The mechanical life shall be at least 5 million operations.
D. Contactors shall have at least 15 times making capacity and 10 times breaking capacity for contactors less than 100 amps and 10 times and 8 times respectively for contactors above 100 amps. The selection of contactors shall be coordinated with the prospective fault levels suitable at that point of installation.
E. Contactors shall generally be suitable for rail mounting and be of modular detail. The coil shall be suitable for +10% and --15% of nominal main voltage. Provision shall be made on the contactors for affixing of termination and contactor identification labels.
F. Contactors shall be provided in sheet steel enclosure of a tropical finish and vermin proof. Adequate ventilation shall be accordance with BS 5424, category IP 42 for indoor service and IP 65 for outdoor service.

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G. The contactor shall be located within the enclosure so that upon making or opening of the contactor under normal or fault conditions, damage will not be caused to other equipment and wiring within the enclosure.
H. An isolating switch shall be provided for each contactor circuit except that if there is more than one contactor and they are grouped together, one incoming supply isolating switch shall be provided to isolate all contactor circuits. Al mechanical interlocking device between the isolating switch and panel cover shall be provided to prevent access to live parts within the panel when the isolating switch is in the "ON" position.
I. Contactors equipped with both local and remote control shall have local/remote changeover switches capable of being locked by padlock in the either position.
J. Contactor shall be provided with spare auxiliary (2 No. + 2 NC) in addition to other required auxiliary contacts specified in the Contract.

PART 3 – RELAYS

4.7.20 Control Relays

A. All control and indication relays shall be of the heavy-duty pattern fully tropicalized type.
B. Relays shall be grouped conveniently in dust proof cases with removable covers given access for adjustment, cleaning, etc., without dismantling the relay.

4.7.21 PROTECTION RELAYS

A. Protection relays shall be approved types complying with BS 142 or equal and shall have approved characteristics and be flush mounted in dust proof cases. Relay cases shall generally be finished in black enamel.
B. Relays shall be of construction detail arranged so that adjustments, testing and replacements can be effected with the minimum of time and labour. Relays of the hand reset type shall be capable of being reset without opening the case.
C. Relay contacts shall make firmly without bounce and the whole of the relay mechanisms shall be as far as possible unaffected by vibration or external magnetic fields.
D. Relays, where appropriate shall be provided with flag indicators of approved type, phase colored where applicable. Flag indicators shall be of the hand-reset pattern and shall be capable of being reset without opening the case. Where two or more phase elements are included in one case separate indicator shall be provided for each element.
E. Relays with provision for manual operation from outside the case, other than resetting will not be accepted, and time delay relays shall not be of the dashpot type.
F. Relays shall be provided with clearly inscribed labels describing their application and rating in addition to the general-purpose labels.
G. Approved means shall be provided on the relay panels for the testing of protective relays and associated circuits. Withdraw able type cases and plug-in type test facilities being preferred.

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H. Full discrimination relay curves indicate relay setting shall be co-ordinate by the Contractor and submit for approval. The submission shall cover both O/C & E/F protection up to final circuit and shall be endorsed by the Contractor's Installation Engineer.

4.7.22 OVERCURRENT PROTECTION

A. Overcurrent protection shall be of the current transformers operated direct acting type. Where instantaneous trip is specified, the relay shall incorporate on electronic timer with adjustable time delay setting.
B. Where IDMT characteristic is required the time/current characteristic shall comply with BS 142. IDMT type relay shall consist of an electromagnet with shading rings on the pole pieces driving an induction disc. Current setting shall be of a plug and bridging socket arrangement and time lag setting shall be by setting screw located above the time scale.
C. Overload phase indicator shall be provided to show the phase overload condition.
D. The range of current setting adjustment for phase faults shall be 50% of 200% of rated full load with tapping at 25% intervals and the time setting adjustment shall be 0 to 3 seconds at 10 times the normal operating current. The current/time characteristics of the relays shall be in accordance with the British Standard Curve and shall be provided during the technical submission.
E. Both electromechanical and electronic type protective relays may be considered. Submission of full technical detail and approval shall be obtained prior to installation.

4.7.23 EARTH LEAKAGE PROTECTION

A. The earth leakage relays shall be of the instantaneous type with adjustable current settings from 5% to 40% in 5% steps.
B. The operating coils and contacts shall be adequately rated to carry the necessary load. Operating indicator and reset facilities shall be provided.
C. The relays shall house in dust proof sheet metal casings, provided with viewing glass.
D. Both electromechanical and electronic type protective relays may be considered. Submission of full technical detail and approval shall be obtained prior to installation.

PART 4 – CONTROL CIRCUIT WIRING AND AUXILLARY

4.7.24 CONTROL CIRCUIT WIRING

A. All wiring shall be arranged in a regular manner with bends set at 90 degree and securely held in position with suitable clips and where convenient shall be installed in the uprights and/or back-stays insulating bushes being used where necessary.
B. Control wiring of the switchboard shall be carried out in PVC insulated switchboard cable of size not less than 1.5mm^2 and those for current measurement shall be minimum 2.5mm^2. All meter wiring shall be of similar colors to those of the respective bus bars, etc., to which connections are made. The cable termination shall be made with cable lugs.
C. No wires/cables shall be tee-off or jointed between terminal points.
D. Wiring shall be carried out in such a manner as to make circuits and connections easily traceable. Cable marking ferrules or similar shall be used at each termination. Terminals shall be designated in an approved manner.
E. All terminals shall be fitted with brass washers and securely fixed with lock nuts.
F. Displacement Insulation push-in type termination for cable up to 2.5mm^2, tunnel type terminals shall be provided for cables up to and below 6mm^2. Cables larger than 6mm^2 shall

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be terminated with compression cable lugs or proprietary makes of termination approved by the Engineer.

4.7.25 ANTI-CONDENSATION HEATERS

A. Anti-condensation heaters shall be fitted in each cubicle together with an ON/OFF isolating switch and adjustable thermostat suitable for electrical operation at 230 volts A.C. 50 Hz single phase of sufficient capacity to raise the internal ambient temperature by 5^0C. The electrical apparatus so protected shall be detailed so that the maximum permitted rise in temperature is not exceeded if the heaters are energized while the switchboard is in operation.
B. As a general rule, the heaters shall be placed at the bottom of the cubicle.

4.7.26 TERMINAL BOARDS

A. All terminal boards shall be mounted in accessible positions and, when in enclosed cubicles shall be inclined downwards towards the door. Spacing of adjacent terminal boards shall not be less than 100 mm and the bottom of each board shall not be less than 200 mm above the incoming cable gland plate. Separate studs shall be provided on each terminal strip for the cores of incoming and outgoing cables including all spare cores.
B. Brass bolts and studs shall be of not less than 6 mm diameter size but stainless steel and bronze down to 4.5 mm diameter may be used provided that the current carrying capacity is adequate. All studs shall be provided with nuts, washers and lock nuts or lock washers. Where pinch type terminations shall be provided. They shall have adequate current carrying capacity and shall be provided with locking devices. Insulated barriers shall be fitted between adjacent terminals.
C. 400/230 volt and higher voltage circuit terminals shall be segregated from other terminals and shall be fitted with non-flammable transparent plastic covers to prevent contact with any live parts. They shall have warning labels with red lettering, mounted thereof in a conspicuous position.
D. All connections shall be made at the front of the terminal boards and no live metal shall be exposed at the back.

4.7.27 Fuses and Disconnecting Links

A. All fuse link and disconnecting link assemblies associated with electrical installation, instrument, protection and control circuits shall be of approved type and grouped as far as possible according to their functions. They shall be clearly labeled, both on the panels and the associated wiring diagrams.
B. Fuse link and disconnecting link assemblies associated with tripping circuits shall preferably be mounted on the outside of controlling compartment. All others shall be mounted internally.
C. Carriers and base for flush links shall be black. Disconnecting link carriers and bases shall be white.

D. All fuse links shall be High Rupturing Capacity (HRC) cartridge type and all fuse switches and distribution boards and the like shall be suitable for the accommodation of these fuses.
E. Each cartridge shall incorporate a fuse element of appropriate current rating and fusing factor in order that adequate protection and discrimination is provided to the circuit.
F. The high rupturing capacity (HRC) cartridge fuses of rating shown shall conform to BS 88 Part 2 Class Q1 with minimum breaking capacity of 80 KA. When fuses are used for motor protection they shall have Class R rating. Fuse bases and carriers shall be made of high-grade phenolic moulding.

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4.7.28 PUSH BUTTON

A. All the push buttons shall be made of non-hygroscopic material, non-swelling and fitted to avoid any possibility of sticking. Unless otherwise specified, they shall be of the non-retaining type. All push buttons shall have minimum IP54 ingress protection rating.
B. The contacts of all push buttons shall be of adequate strength and have a positive wiping action when in operation.

4.7.29 INDICATING LAMPS AND FITTINGS

A. Indicating lamps fitted to the fascia of switch and instrument cubicles or panels shall be adequately ventilated.
B. Lamps shall be easily removed and replaced from the front of the panel by manual means not requiring the use of extractors.
C. The bezel of metal holding the lamp glass shall be easily removable from the body of the fitting so as to permit access to the lamp and lamp glass.
D. The lamps shall be LED type. The rated lamp voltage shall be 4% in excess of the auxiliary supply voltage AC 230V and DC 48V
E. The lamp glasses/lens shall be in the standard colors, red, yellow, blue and amber. The color shall be in the glass/lens and not an applied coating and the different colored glasses/lens shall be interchangeable.
F. Neon indicating lamps shall not be used with coloured lens.
G. Unless otherwise indicated or agreed with the Engineer, all lamp colours shall conform to the following practice:
   1. Red - red phase;
   2. Yellow - yellow phase;
   3. Blue - blue phase;
   4. White - supply available.

4.7.30 RADIO INTERFERENCE SUPPRESSION

A. All Plant and apparatus, including such items as contactors, starters, relays and the like where the normal operation is such that interruption of low frequency or direct current occur, shall be fitted with means of suppressing all interference frequencies caused.
B. The standard of interference suppression shall be in accordance with the current edition of BS 800 incorporating all amendments but extended to include the frequency ranges 300 to 360 MHz and 1.000 to 3,400 MHz.
C. Details of the equipment and methods to be used in quantitative assessment of the level of radio interference shall be as specified in BS 55016-1-4.
D. For guidance in the installation of electrical equipment to meet the foregoing standards, reference shall be made to BS Code of Practice CP:1006 "General Aspects of Radio Interference Suppression: which deals with interference caused by electrical apparatus and installations.

4.7.31 SURGE PROTECTION DEVICES

A. Surge Protection devices shall be provided whichever cable route from external or to external of the building.

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PART 5 - EXECUTION

4.7.32 5.01 TESTING AND COMMISSIONING

A. All switchboards shall be tested and certified by the installation Engineer that it is safe before supply is energized, and that all the equipment comply with the requirements of the Specification.

B. Generally such tests in the factory and repeated at site are as follows:
   1. Insulation resistance tests;
   2. Earth continuity tests;
   3. Dielectric test – 3 kV DC for 1 minute;
   4. Check of clearance and creep age distances;
   5. Tests to prove correct operation of controls, interlocks, tripping and closing circuits, indications, etc.;
   6. Phasing tests;
   7. Operation of all protective gear circuits by primary injection and system fault tests to check sensitivity and stability;
   8. Test of accuracy of all measuring instruments;
   9. Test operation of alarm devices;
   10. Interfacing test with BMS
   11. Checking of all internal cabling and function operation;
   12. Above tests are minimum requirement and shall include all other tests required by the Engineer to verify compliance with the Specification.

C. Triplicate sets of all principal test records and test certificates are to be supplied for all the tests carried out in accordance with the Specification to the Engineer for approval before dispatch from the switchboard factory.

D. All costs, materials, equipment, labor, etc. necessary for the execution of the testing shall be included in this portion of work.

E. The Contractor shall include the cost for allowing the Engineer or his representative to witness the factory tests.

4.7.33 TRANSPORTATION

A. Switchboards are not allow to be delivered to site until the electrical room or switch room is in a clean and acceptable condition with lockable doors.

B. Switchboards transported to site shall be fully covered with weatherproof covers and transportation eye bolts shall be provided for handling at site.

C. Switchboards which are poorly packed and result in signs of corrosion will be rejected.

D. All necessary measures to cover and protect the switchboards at site shall be provided. Such measures shall include a complete PVC blanket over the whole switchboard or distribution board.

4.7.34 REJECTION OF SWITCHBOARD

A. If any of the above tests fail to comply with the requirements of this Specification in any respect whatsoever at any stage of manufacture, test, erection or on completion at site, the Engineer may reject the item or defective component thereof, whichever is considered necessary, and after adjustment or modification as directed by the Engineer, the Contractor shall submit that item for further inspection and/or test. In the event of the defective item being of such nature that the requirements of this Specification cannot be fulfilled by

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adjustment or modification, such item is to be replaced by the Contractor at his own expense, to the entire satisfaction of the Engineer. Delivery of switchboard on site without significant cable connection (Say 80%) shall not entitle progress payment certified for material delivery on site.

4.7.35 EARTHING

A. Suitable earthing terminals or studs shall be provided on the frame for the connection of 25 mm x 3 mm copper strip to the main earthing bar in the switchroom.

B. A main earthing bar of HDHC copper with cross-sectional area in compliance with BS 7671 and BS 7430 50 mm x 6 mm shall be provided in the switchroom and to which all earthing connections shall be made. This earthing bar shall run along the wall adjacent to the full length of the main switchboard. Two connections to main earthing system shall be provided.

4.7.36 PROVISION OF ELECTRICAL SERVICES AND EQUIPMENT TO MEET LOCAL AUTHORITIES' REQUIREMENT

A. All other requirements by Local Authority that are imposed in the course of execution of the work, particularly those listed below shall be provided.
   1. Danger signs;
   2. Rubber floor mat of 6m thickness and 1 meter width provided for the full length of the switchboard;
   3. A dry chemical type fire extinguisher of 9 kg capacity with approved label;
   4. Framed single line diagram with minimum A1 size endorsed by Contractor's Qualified personnel;
   5. 'First-Aid' Demonstration sign;
   6. Sand for cable trenches after completion of all cable installation work, if applicable.

4.8 LUMINAIRES AND ACCESSORIES

4.8.1 General

4.8.2 Work Description

A. The luminaires schedule indicates the detail requirement of the luminaires selection. The exact luminaires of the installation subject to Engineer approval on the sample. The Contractor shall be responsible to ensure the selected luminaires suit the location of installation. No time and cost adjustment for the Contractor to provide the approved selected luminaires.

B. The Contractor shall co-ordinate the fixing detail of the luminaires, any accessories, brackets, waterproof termination box etc, required to complete the installation shall be included in the Contract

C. Certain types of electrical equipment or systems involving sudden changes, or low frequency or of direct electric current such as fluorescent lamps, contactors, etc. shall be fitted with radio and television interference suppression components suitable to meet the levels specified in BS 800 "Limits of Radio Interference characteristics of household electrical appliances".

III

4.8.3 Standards

A. The manufacturing of the luminaires shall also conform to the requirements of all relevant local codes, as applicable, together with the additional requirements referred to in this Specification and Drawings, whichever is the more stringent and acceptable to the Engineer.

B. Following Standards to be followed

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- IEC 62031 - LED used in Luminaries
- IEC 62471 - Photo-biological Safety
- IEC 61347-1 / 2 - LED drivers
- IEC 62384 - Independent driver Performance
- IESNA LM 80:2008 - Lumen Maintenance of LED light source

C. In the adoption of standards and requirements, the Contractor shall take the following precedence
   1. Engineer's decision;
   2. Local codes of practice;
   3. Drawings;
   4. Specification;
   5. International standards and requirements.

4.8.4 Submission

A. All technical submissions shall be approved by the Engineer prior to he respective stages of construction.

B. As a minimum requirement, the submission shall include the following:

1. Luminaires colour cut sheet submission with manufacturer's data, lamp date, IP rating, location of installation, quantity.
2. Sample submission;
3. Lit-up sample submission as required by Engineer.
4. Lit-up sample for all lamp with indication of location of installation and manufacturer recommended lamp life span.
5. Illumination computer print out for area as required by Engineer.
6. Shop Drawings of the fixing details showing the coordinated installation details.
7. test reports for all emergency use luminaires.
8. Builder's works requirement.

4.8.5 Product

4.8.5.1 Internal Wiring within Luminaires

A. Cables interconnecting components shall be heat resisting cables and shall be neatly bundled by nylon self-locking cable ties and shall be properly routed and secured away from heat generating accessories like control gear, etc.
B. Cables used for internal wiring of the luminaires shall be of appropriate type and size. The insulation of the cables shall be able to withstand throughout the life of the luminaires the maximum temperature of not less than 105^0 C.
C. Where wiring passes through the edge of any metal section of the fitting, it shall be protected by an approved grommet. All connections of wires to terminals shall be of approved types. All wirings shall be concealed from view with the luminaires installed.

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D. All cable terminations within the luminaires shall be suitably shrouded. At every luminaires, an earthing terminal shall be provided for connection to the circuit protective conductor.

4.8.5.2 led LIGHT FIXTURE

A. The LED lamp / light fixture shall comply and conform the following specification:

Luminous Efficacy	> 90 lumens/Watt
CRI	> 80
Colour Temperature	Inter Lighting Fixture 4000k External Lighting Fixture 3000k (as per BOQ & drawings)
UGR	Within the prescribed limits.
Useful Life	3000hr to 3500hr
Warranty	1 years or above

B. The body of the light fixtures shall be minimum 18 SWG sheet steel or die cast, properly de-rusted, degreased, finished in heat resistant paint, stove enamelled. Appropriate size bushed wire entry holes, fixing holes, and earth terminal shall be provided. The lamps for these fixtures shall be made with Light Emitting Diodes capable to emit the desired colour as mentioned in drawings or BOQ. The fixture shall be supplied with appropriate driver either fixed or detached and shall be selected according to the wattage/type as indicated on drawings/ Documents.

C. Weatherproof light fixtures shall comprise of UV treated plastic body or aluminium body and gasketted clear glass cover secured to the body by means of wing nuts/screws to give a weatherproof and watertight fit. The gasket shall be weather resistance type.

D. The glass shade of the light fixtures shall be opal white or clear as furnished by the manufacturer with the light fixture unless specified and free from any air bubbles or voids. The shade may be spherical, cylindrical, flattened bottom or any other shape as specified in the drawings or BOQ.

4.8.5.3 LED FIXTURE FITTING & INSTALLATION

A. The mounting heights of light fixtures are indicated on the drawings, and position of fixtures are according to the mentioned scale.

B. The Contractor must ensure that the light fixtures are installed uniformly with respect to the dimensions of the area. Any modifications due to site conditions may be made with the approval of Engineer. All fixtures shall be carefully aligned before fixing in position.

C. Glasses, shades, reflectors, diffusers, etc., must be in a clear condition after installation. An earth wire connected to the earth terminal in the fitting shall earth all light fixtures.

D. The LED light fixtures on the surface of ceiling shall be installed with the back of the body flush with the ceiling surface, and in a manner so as to facilitate wiring. Nylon plugs and galvanized steel bolts or screws shall be used for fixing the light fixture to the ceiling. For light fixtures installation on false ceiling the installation method/detail shall be coordinated with ceiling design and submitted for approval of Engineer. Care shall be taken to prevent the weight of the fixture from being transferred to the false ceiling

E. After fabrication, metal surfaces shall be thoroughly cleaned back to the parent metal and all dust, moisture grease or oil shall be removed.

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F. Except where specified or shown as being aluminium, metalware for LED Panel fittings, reflectors, channels, etc., shall be constructed from mild steel or zinc anneal sheet not less than 20SWG thickness. All corners and joints exposed to normal view shall be welded, ground smooth and filled where necessary before painting.

G. All scale and corrosion products shall be removed after which the finished article shall be cleaned with trichloroethylene.

H. The metalware shall be spray painted with high grade polyester powder coat on both sides and stoved. Total thickness of paint build up shall be not less than 50 micron. Finished colour shall be to approval on all surfaces.

I. All plastic diffuser shall be of non-deteriorating, colour stable material and of acrylic material.

J. Recessed lighting fittings shall be supported from the RC ceiling slabs using appropriate fixing accessories such as steel rod, spring clips, ceiling brackets, suspension hooks, profile brackets, etc. to ensure proper Installation of the fittings on different types of ceiling panels. Where light fittings are installed directly below large ductworks etc., the Contractor shall install suitable brackets, channels, etc. to facilitate suspension/support of the light fittings from the ceiling slabs. An adjustable resilient spring-clip shall be provided to enable the suspension length to be adjusted to fine tolerances. Suspension sets shall be adjustable proprietary make type manufactured to carry the weight of the lighting fittings and shall be of adequate lengths for installation on the false ceiling panels concerned. Suspension rods shall be of least 5mm diameter and shall fixed at positions recommended by the lighting fitting manufacturers.

K. At least four (4) suspension rods shall be provided for each fitting (Hanging Type). Lighting fittings shall be supported in a manner that will ensure that the weight of each fitting is equally distributed to all supporting rods with the fitting remaining in level position. Suspension sets where exposed to sight shall be of adjustable rod type of minimum diameter 20mm with all necessary accessories

L. All diffusers shall be hinged at one side of the fitting for maintenance purposes and snap fit back into position.

M. All light fittings used as emergency lights including exit signs shall be constructed and installed In accordance with the current edition of BS5266 Code of Practice for the Design, Installation and Maintenance of Emergency Evacuation Lighting and Power Supply Systems in Buildings. Exit signs shall be complied with Civil Defence requirements.

N. Identification symbol in accordance with BS5266 shall be displayed on or adjacent to each emergency lighting fitting. The symbol shall not be fixed to the diffuser of an emergency lighting fitting or to removable ceiling tiles.

4.8.5.4 EXTERNAL LIGHTING

A. Lighting poles for the pole lights shall be constructed using hot-dip octagonal steel columns with the base compartment housing the lamp fusegear which shall consist of a single fully shrouded single pole and neutral single entry type cut-out with HRC fuse, appropriate size MCB complete with cable sealing box, armour clamps and compression gland, where required, suitable for reception of looping PVC/SWA/PVC cables or PVC cables of the sizes as required. The finishing colour coat shall be subject to the Engineer's approval.

B. Wiring between lamp and cut-out MCB shall be three core 2.5sq mm tinned annealed circular copper conductor PVC insulated black PVC sheathed.

C. Weather proof connection board shell be provided for the supply of landscape lighting as indicated on the drawings.

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D. Lightning protection earth electrode for pole lighting higher than 6 m shall be provided by the Contractor.

A. Electronic ballasts shall be of high frequency fixed output type, low loss of less than 5 watts, suitable for T5 slim fluorescent tubes. All electronic ballasts shall comply with IEC928, IEC929 and BSEN55015 where required.

4.8.5.5 ***LED FIXTURE LIFE SPAN***

A. The selection of luminaires shall take into account the requirements for heat dissipation, weatherproofing, insect proofing and the vibrations at the location of the installation. All luminaires installed in the Works shall have a minimum fixture operation life of not less than 80% of the average lamp life stated by the lamp manufacturer. If any lamps fail before this time, this will be treated as evidence of non-compliance of all the lamps of the same type in the installation concerned and in other installations which have the same performance criteria. The Contractor will be held responsible for the replacement cost of the affected lamps and all lamps of the same type in installations with the same performance criteria.

4.8.5.6 ***Led Tube***

A. Master LED should be capable to operate between -20°C to 45°C ambient temperature. While its storage temperature should be in the range of -40°C to 65° .
B. Rated average life of LED shall be 40,000 hours. There shall be no mercury and glass in LED. LED should not have any breakage and pollution risk.
C. Led should has 50,000 switching cycles and 80 CRI. Master LED tube should contains only visible light.
D. Master LED should be suitable to be fix in any fluorescent fitting / fixture. But MAS LED tube STD 1200mm should be 100% comply with IEC requirement on T8 dimension.

4.8.5.7 ***Decorative Poles***

E. The pole shall be made of hot dip galvanized having wall thickness minimum 4mm. The material grade shall be LM3.The length and other dimensions of the pole shall be as per drawings.
F. Poles shall be electrically welded (if required) with the joints. Excessive porosity and lack of fusion in welding may be removed by chipping and the joints should be re-welded so as to ensure dependable operation of the poles. The decorative pole shall be hot dip galvanized with fiber coated with black finish, while conventional poles shall be hot dip galvanized and octagonal shape suitable for highly corrosive area (as per Architect/client requirement). The pole shall be Corrosion resistant. The Pole structure should be suitable for safe wind pressure of 160 Km/hr.
G. Contractor shall submit the following details.

- Details and its welding procedure and material used in the welding.
- Shop drawings of the offered pole.

H. The manufacturer/supplier shall provide quality assurance certificate.

I. The transport and storage of poles at site shall be carried out in a neat and clean manner. Wooden rack with appropriate grooves shall be provided for stacking of poles to prevent any

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direct contact with ground. Any pole damaged during transportation or storage or installation shall be replaced by the contractor without additional cost to the Employer. Any damage to paint work shall be made good before installation by the contractor free of cost. Poles shall have self-locking inspection door operable with special key only. Pole inner compartment or pole inside diameter in front of inspection door shall be suitable to hold cable connection box. The details of pole shall be as per drawings.

4.8.5.8 Pole Light Fixtures

A. Material

The Road light fixture shall be as per international standard and made of non-corrosive high pressure molded aluminum housing, minimal glare, body in silver / grey/black color, achromatizing treatment, Operation Life minimum 50,000 hours and made by one of the approved manufacturers, complete in all respects. Metalized high purity aluminum reflector, complete with following components:

1. LED Lamp suitable for automation system.
2. Vertically & horizontally adjustable, plastic or porcelain lamp holder,
3. Color temperature 3000k
4. LED driver
5. Lamp compartment shall be IP-66
6. The light fixture should be fully comply with safety norms according to IEC 598/ ENEC 60598.
7. All imported and factory assembled, as per sample approved by the Engineer.
8. Minimum Lumen output 120 lumen/01watt
9. Power Factor not less than 0.9
10. The light fixture shall be posted on pole as shown in drawings.
11. All fixing screws, nuts, bolts shall be stainless steel.

Contractor shall submit certification of the fixture that reflector shall not get dull due to excessive heat in lamp compartment. 2% aging per year is the acceptable tolerance.

B. LED Driver

LED driver shall be of the removable type for operation at 230 volts, 50 Hz, power factor compensation at least 0.85. Minimum life of driver shall not be less than five years.

4.8.5.9 POWER SUPPLY / WIRING FROM TERMINAL BOX TO LIGHT FIXTURE

The wiring between the line conductor and light fitting shall be made with 2.5mm2 three core PVC/PVC insulated wire .The 6 amp SP breaker of 6 kA rating shall be used for lamp protection (for one lamp) and shall be installed in terminal box. The connection terminal shall be built-in type as shown in drawing. The conductor separate earth conductor shall earth the pole. Every pole of street light circuit shall be earth by rod driven into the ground as shown in drawings.

External lighting shall be controlled automatically or manually as specified and indicated on the drawings. Automatic control shall be installed comprising time switch, time relay, photo sensor, contactor, dimming controller etc.

4.9 SWITCHES & SOCKET

4.9.1 LOCAL SWITCHES

a. The local switches shall be 10/20 amp. Gang type , one-way, two-way, intermediate or double pole as indicated on the drawings. Where more than one switch is indicated at any position multiple gang units shall be used.

b. Switches shall be of the quick start make; slow break type specially designed for AC circuits to BS Standards. The operation of the switch shall not depend wholly on the action of the spring. The switches shall generally be of the rocker operated type.

c. All switch boxes shall be supplied with adjustable steel grids and earthing terminals.

d. Generally, switch units shall be of the adjustable grid pattern and to be secured to the adjustable grid by means of screws. For flush mounting switches the switch-plate shall overlap all edges of the box by not less than 7mm. For surface mounting switches the switch plate shall finish flush with the edges of the switch boxes. Switches for water heaters and fan coil units shall be complete with neon indicator lights.

e. In Plant rooms the switch units shall be surface or flush as required.

f. Local switches shall be arranged in convenient positions for switching the various circuits and generally as indicated on the drawings.

g. The switches shall be of the same manufacture for a particular type of switch throughout the installation. All accessories in wet and damp areas shall be of the splash-proof type to IP54 protection standard.

h. All switch boxes should be galvanized steel.

i. To ensure easy and correct connection of the conductors during installation, the necessary terminal shall be easily identified, grouped in line, upward facing, captive and backed out prior to the installation.

j. All dimmer switches shall be suitably rated to the lighting load being Controlled with 25% spare capacity and shall be adequate for tungsten and / or fluorescent lighting as specified.

4.9.2 POWER OUTLETS

a. The switch socket outlets, shall be in accordance with BS1363 Standard as appropriate and shall be of the three-pin grounding type.

b. Switch socket outlet in the different areas shall comply with section 607 BS7671 :2001

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c. Live contact of the socket shall be completely shuttered such that it is not possible to engage any pin of the plug into a live contact whilst any other pin of the plug is exposed.

d. All floor mounted socket outlets shall be fixed as part of the under floor trunking service boxes.

e. These outlets shall be of the same manufacturer throughout the installation.

f. The sockets should provide a double earth terminal as per latest BS7671, 2001, Section 607.

4.9.3 FUSE CONNECTION UNITS / DP SWITCHES

a. 3.1 These shall be of flush or surface mounting type as manufactured in compliance with BS Standard as appropriate. The fuse connection units shall incorporate integral switch, neon indicator and 20-amp fuse links. The DP switches supplied for water heaters shall be incorporated with neon indicator lights, and these also shall be engraved 'Water Heater'.

b. 3.2 These shall be of the same manufacturer for a particular type of switch throughout the installation and shall be complete with the other accessories installed.

c. 3.3 Fuse selection shall be based on actual requirement of equipments.

4.9.4 G.I BOXES

GI boxes to be provided with brass earth terminal to facilitate earth wire connection. The boxes to have sufficient number of 20mm and 25mm knockout. The boxes thickness shall be 1.1mm minimum and shall comply with BS 4662. Boxes to have adjustable lug for proper installations of wiring accessories. Extension ring to be used along with GI boxes, in places where the box is deep inside the wall, marble or concrete.

4.9.5 ISOLATORS

All external isolators must have IP-65 protection with aluminum alloy or die-cast aluminum housing with bolt on drip proof canopy. Isolators must be de-rated for 50 deg. Ambient temperature. Internal isolators shall be IP 54 / IP 65 depending on the location with polycarbonate housing for non-armored cables.

4.9.6 Floor Service Boxes

Floor Service Boxes shall be two-compartment type of the size 300 x 300 x 75-90mm (or as specified in BOQ) and shall be constructed from high-pressure Zinc Alloy die casting base frame pillars. This shall be fixed on to heavy gauge galvanized steel base plate for support by support frame. Other materials adequate in strength and performance shall be used and these shall be protected against corrosion. The boxes shall be constructed with provisions for ducting or conduit access on all four sides. Unwanted entries shall be blanked off with detachable side blanks.

Cover for floor service boxes shall be made of high-pressure zinc alloy die casting provided with

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suitable hinges designed to enable the trap cover to open through 180 degrees and giving access at all times to the power and telephone outlets.

Covers for junction boxes shall be made of high-pressure Zinc Alloy die casting with 12mm recess to receive ceramic tiles or carpet tiles. Counter sunk screws shall secure the covers of boxes. All exposed portions of the boxes shall be epoxy coated in grey color.

All boxes shall have extra wide gaskets in order to minimize water seepage. Gaskets shall be made of material that is durable in order to withstand loads.

All boxes shall be adjustable in height independently of the ducting system to take account of difference in floor thickness.

Adequate segregation shall be provided between service runs within boxes by using cross-over bridges and rigid compartments.

Circuit protective conductors shall be provided between the covers and the boxes.

Cable emerging for service boxes shall be protected against damage by means of nylon cables exit grommets or equivalent and shall be reversible to close position when not in use.

4.9.7 ACCESSORIES PLATE FINISH

All the wiring accessories shall be vandal proof. The accessories plate shall have the following finishes depending on the location where it is installed and on the feeding arrangement.

Switches to comply with BS 3676:2000, and sockets to BS 1363, ceiling rose to BS67 : 1999.

a) All external outlets and outlets in pump room and parking shall be weatherproof to IP-66.

b) Weatherproof range should be suitable for semi recessed mounting and supplied with back boxes.

c) All outlets above false ceiling, store, etc. shall be white plastic.

d) Switches and outlets in apartments shall be white plastic slim type.

c) Main entrance, common area and lift lobbies shall be matt chrome steel face plate slim type.

f) Outlets in Electrical rooms, Mechanical floors, Tel. Rooms, etc shall be metal clad.

g) All switch plates including SSOs are to be coordinated with tiling layouts by prior agreement with the Architect on site.

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4.9.8 MOUNTING HEIGHTS

The mounting heights for the electrical equipment and accessories shall be coordinated with the furniture layout and shall be as per site requirements to Engineer's / ID's instruction and approval. In general, the mounting heights from FFL to center of fixtures shall be as shown in legend.

4.10 LOW VOLTAGE POWER CABLE

PART 1 - GENERAL

4.10.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, apply to this Section.

4.10.2 DESCRIPTION OF WORK:

A. Work Included: Provide low voltage electrical conductor, cable, wire, and connector work as shown, scheduled, indicated, and as specified.

B. Types: The types of low voltage electrical conductor, cables, wire, and connectors required for the project include, but are not limited to, the following:

1. 600/1000 volt building wire and cable.
2. 600/1000 volt building wire and cable connectors.
4. 300/500 volt control/signal wire and cable.
5. 300/500 volt control/signal wire and cable connectors.

C. Application: The applications for cable, wire, and connectors required on the project are as follows:

1. Power distribution circuitry.
2. Lighting branch circuitry.
3. Appliance, receptacle and equipment branch circuitry.
4. Motor branch circuitry.
5. Control wiring.
6. Outdoor lighting and power.

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4.10.3 STANDARDS:

A.Products shall be designed, manufactured, tested, and installed in compliance with the following standards:

BS 6346 PVC insulated, armoured cables for voltages of 600/1000V and 1900/3300 V

BS6004 Polyvinyl Chloride (PVC) insulated and PVC over sheathed cables - up to 300/500V -- for electric power and lighting.

BS6724 Thermosetting insulated armoured cables - 600/1000V to 1900/3300V - with low emission of smoke and corrosive gases when affected by fire.

B. Where application of applicable codes, Trade Association standards, or publications appears to be in conflict with the requirements of this Section, an interpretation shall be obtained from the Architect/ Engineer.

4.10.4 QUALITY ASSURANCE:

A. Manufacturers: Provide products complying with these specifications and produced by the manufactures provide in the list with BOQ.

4.10.5 SUBMITTALS:

A. Shop Drawing submittals shall include, but not be limited to, the following:

1. The Contractor shall submit to the Engineer for review, a list of the proposed manufacturers of wire and cable, cable lugs, cable connectors and termination fittings listed herein. The Contractor may install wire and cable, cable lugs, cable connectors and termination fittings furnished by any manufacturer listed on the approved submittal.

2. Cut sheets on all 300/500 and 600/1000 volt conductors with manufacturers name, ratings and capacities, insulation characteristics, and available colors, clearly listed.

3. Cut sheets indicating all cable lugs, termination fittings and cable connectors.

4. Cut sheets indicating types of conductor identification bands.

4.10.6 DELIVERY, STORAGE AND HANDLING:

A. Provide factory-wrapped waterproof flexible barrier material for covering wire and cable wood reels, where applicable; and weather resistant fiberboard containers for factory-packaging of cable, wire and connectors, to protect against physical damage in transit. Damaged cable, wire, or connectors shall be removed from project site.

B. Store cable, wire, and connectors in their factory-furnished coverings, and in a clean, dry indoor space which provides protection against the weather.

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PART 2 - EXECUTION

4.10.7 INSTALLATION

A. General: Install electrical cable, wire and connectors as shown, in accordance with the manufacturer's written instructions, the applicable requirements of "Standard of Installation", and recognized industry practices to ensure that products serve the intended functions.

B. Coordination:

1. Coordinate cable and wire installation work with electrical raceway and equipment installation work, as necessary for proper interface.

2. Installer shall examine the areas and conditions under which cable, wire and connectors are to be installed and notify the Contractor in writing of conditions detrimental to the proper and timely completion of the work. Inspect wire and cable for physical damage. Do not proceed with the work until unsatisfactory conditions have been corrected.

C. 600 Volt Building Wire and Cable:

1. Mains and feeders are to be run their entire length in continuous pieces without joints or splices[, unless otherwise indicated or noted].

2. Conductors may be run in multiple on sizes inclusive, provided all multiple conductors are the same size, length, and type of insulation, and are so arranged and terminated as to ensure equal division of the total current between all conductors involved.

3. Before any wire is pulled into any conduit, the conduit shall be thoroughly swabbed in such a manner as to remove all foreign material and to permit the wire itself to be pulled into a clean, dry conduit. All conductors shall be pulled into the conduit at the same time.

D. 300 Volt Control/Signal Cable and Wire:

1. Install all low voltage wiring in a suitable raceway except in areas with accessible (lay-in) ceilings unless otherwise noted on Drawings Where cable is routed without a raceway, bundle all cables and suspend to one foot above ceiling using loop rings on 5' centers. Do not run cable loose on top of suspended ceilings. Do not attach cables to suspended ceiling supports or any mechanical, plumbing, or sprinkler piping. Conceal conduit except in mechanical rooms and areas where other conduit and piping are exposed. Fasten flexible conductors, which bridge cabinets and doors, neatly along hinge side and protect against abrasion. Tie and support the conductors neatly.

2. Number code or color code conductors appropriately for future identification and servicing of the system. Refer to consultants advice for additional requirements.

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4.10.8 TESTING:

A. Feeder Insulation Resistance Test: Each new [and reused existing] 600 volt feeder conductor shall have its insulation resistance tested after the installation is complete except for connection at its source and point of termination.

1. Tests shall be made using a Biddle Megger or equivalent test instrument at a voltage of not less than 1000 volt dc. Resistance shall be measured between phase, neutral, and ground conductors and from conductors to raceway (ground). Readings shall be taken after 30 seconds and 60 seconds of Megger operation at slip speed and insulation resistance shall not be less than the 1 MΩ

2. New conductors which do not meet or exceed the insulation resistance values listed above shall be removed, replaced, and retested.

3. Where reused existing feeders fail to meet the above insulation requirements, notify the Engineer in writing for direction prior to placing the existing feeders back in service.]

B. Neutral Testing: After all feeder and branch circuit conductors are terminated, neutral to ground testing shall comply with the following:

1. The resistance of the system's neutral to ground shall be greater than 10 kΩ with the system-bonding jumper disconnected.
2. Repeat neutral to ground test for neutrals of separately derived systems.

C. Pre-energization Check: Prior to energization, check all new [and reused existing] branch circuit cable and wire for continuity of circuitry and for short circuits. Correct malfunction when detected. No submittal is required for this test.

D. Voltage and Current Values: The voltage and current in each main feeder conductor shall be measured and recorded after all connections have been made and the feeder is under load.

E. Submittals: Contractor shall furnish all instruments and personnel required for tests. Submit four copies of certified test results to Architect for review. Test reports shall include conductor tested, date and time of test, test results, relative humidity, temperature, and weather conditions.

4.10.9 AS BUILT DRAWINGS

A. As-Built Drawings: Refer to Section, "Electrical General Provisions", for applicable requirements.

4.11 INDOOR UNITS

CEILING CONCEALED DUCT TYPE

Ceiling concealed duct type indoor unit shall be two pipe. Basic unit shall be single skinned construction from high quality 1.3mm thick galvanized steel with 11mm glass cloth laminated PU foam.

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Technical Specifications

THE MAXIMUM HEIGHT FOR THE UNITS OF 4 TR SHALL NOT BE MORE THAN 380MM.

Unit to be equipped with factory installed brackets for hanging. Control box to be easy for replacement with an option of fixing on both side of the unit at site.

DRAIN

Wherever required, units to have optional drain pump to lift condensate water up to 700 mm height.

INDOOR AIR QUALITY

Units are to have accessible filters designed for obtaining optimum air quality.
Standard filters: units shall have antibacterial and washable permanent filter.
Electronic filter (Neo Plasma Filter): wherever applicable units should have an option of factory installed & tested high Efficiency plasma filter to remove all the microscopic contaminants, dust, odor molecules etc. to maintain high level of indoor air quality in areas as specified in the schedule

COILS

Coated with special "MAGIC" coating to avoid formation of condensate water droplets and thereby ensure dry coil conditions. This will prevent corrosion and reduce resistance to airflow.
Coils shall be made of staggered seamless copper tubing mechanically bonded to 0.12 mm aluminum fins.
The evaporator coil shall be minimum two rows deep.

MOTORS

The motors shall be BLDC motor & have thermal overload protection. The motors shall be single phase and permanent split capacitor type. Further linear electronic adjustment of motor speed through remote controller It should be able to precisely balance airflow as per actual external static pressures.

CONTROLS

The units shall be equipped with Auto Restart function, which allows the unit to start in the same mode prior to the power failure

SMART CONTROLS

The units shall have the following state of the art features.
Twin thermistor sensor to sense temperature in the room and in the return air with an option of selecting one or both depending on the application for uniform and precise temperature control.
Group control to control up to 16 units from single LCD wired remote controller.
Central control to control up to 128 units from a central location.
Optional Tele control to operate individual units via telephone line for units if required.
Flexible temperature control at Night mode.
Optional BMS gateway for connectivity to third party BMS system.
The controller should be capable to provide error or alert code for refrigerant leakage.
Energy monitoring for each system through indicating accumulated power consumption.

DIGITAL THERMOSTAT:

Units shall be controlled with user friendly, wall mounted microprocessor based LCD, wired remote controller. The wired remote controller shall be slim having the following features:

- 24 hour ON / OFF timer in 1 hour interval.
- Test run mode.
- Self-diagnosis function.
- Operation indication.
- Room temperature display.
- Weekly programming.

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- Child-lock function.
- Speed fan control.
- Linear control of E.S.P/Airflow.

The wireless remote control should be available as an option, if required.

CEILING CASSETTE TYPE (4 WAY, 2 WAY & 1 WAY)

The Ceiling Cassette shall be factory assembled, wired and run tested. The unit shall have a self-diagnostic function, 3 minute time delay relay, auto restart function, and test run switch.
Four way grill shall be fixed to bottom of cabinet allowing, two or four way blow

FAN

The evaporator fan shall be an assembly with a turbo fan direct driven by a single motor. The fan shall be statically and dynamically balanced and run on a motor with permanently lubricated bearings. The indoor fan shall have three speeds; High, medium and Low. The controller shall have a selector switch to increase the rpm of the motor in case of the height of ceiling is increased.
The indoor unit shall have adjustable air outlet system offering 4-way, 2-way or 1-way airflow. The auto air swing vanes shall be capable of automatically swinging up and down for uniform air distribution.

FILTER:

Return air shall be filtered by means of a long life permanent filter. The option of plasma filter should be available for better filtering efficiency.

COIL

The tubing shall have inner grooves for high efficiency heat exchange. The pipe connection to the Indoor units shall be flare connection. Brazing at the pipe connection shall not be permissible. The condensate pump shall be able to raise the drain water 700 mm above the condensate pan.

CONTROLS:

The units shall be equipped with Auto Restart function, which allows the unit to start in the same mode prior to the power failure.
SMART CONTROLS:
The units shall have the following state of the art features:
Twin thermistor sensor to sense temperature in the room and in the return air with a option of selecting one or both depending on the application for uniform and precise temperature control.
Group control to control up to 16 units from single LCD wired remote controller.
PC Central control - 2048 units, Deluxe Central Control-256, SCC-128 units can be controlled from a central location.
ACP & AC Manager central controller shall be able to control upto 4096 indoor unit either through LAN or Wired.
DIGITAL THERMOSTAT:
Units shall be controlled with user friendly, wall mounted microprocessor based LCD, wired remote controller. The wired
Remote controller shall be slim having the following features:

- Test run mode.
- Self-diagnosis function.
- Operation indication.
- Room temperature display.
- Weekly programming.

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Technical Specifications

- Child-lock function.
- Speed fan control.
- Linear control of E.S.P/Airflow.
- Auto swing
- Clean filter indication

The wireless remote control should be available as an option, if required.
The tenderer shall supply the following information.
(a) Capacity of unit.
(b) Power Consumption.
(c) Air Flow and static pressure of DX evaporator.
(d) Manufacturer's performance guarantee certificate. (e) Over all dimensions.

CENTRAL CONTROLLER (ACP)

The central controller shall be 7" touch screen module, wall mounted and should have the following feature:
Mode control, temperature control etc and monitoring of up to 64 unit (A/C & Ventilation) is possible by Zone/Group/Unit

i. You can monitor the operating status by Icon or List View so you can operate the controller very easily 2.AC Smart is directly connected to Outdoor unit (Internet A and B).
ii. Individual indoor Function control locking so that except administrator nobody can change the function. (Temperature, Mode, Fan Speed separately)
iii. Temperature Setting Range restriction on individual controller, so management is very powerful and energy saving is possible
iv. v) In schedule setup administrator can schedule the indoor Operating as well as the function locking
v. Operating and error history is saved in AC Smart
vi. It has Automatic control function, Auto changeover and temperature limit, Auto Changeover function is automatically change operating mode cool and heat, so no need of changing the mode in season change period Temperature limit function. Protect the building from freezing and overheat by auto operation and auto stop
vii. You can select the AC Smart displays language [English, Spanish, French, German, Dutch, Italian, and Russian]
viii. By using Emergency Stop Interlocking function. You can connect fire detect sensor to AC Smart, when fire happened, all air conditioner
ix. will be stop automatically
x. Easy upgrade the software by using USB
xi. Compatible with VRF System as well as single unit, also, connect with Simple Central controller
xii. By using Expansion Kit, Maximum 128 Indoor Unit can be connected

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xiii. When not using Central Controller, AC Smart can display Digital Watch

xiv. In AC Smart Monitoring, report of each indoors operation time & operation ratio, is available.

xv. By using this, you can distribute the power consumption by referring to the information

xvi. In Temperature Limit control, the setting range of temperature was expanded, so you can use it for more comfortable function.

xvii. For example, In the hotel, when customer key out the hotel card key, Indoor temperature will be increased, then AC Smart will operate the indoor, and automatically turn off after temperature is decreased,

xviii. New Auto control of AC Smart, Time Limit control: You can set the time limit from1~4Hrs and set available day of week.

xix. In time limit function for available period, indoors can operate up to maxim setting time continuously. For example: Set as 2 Hr and available on Saturday & Sunday.

xx. When someone operates the indoor, AC Smart will check the continuous operating time. If the time is over 2hr, AC Smart will automatically stop the indoor operation.

xxi. Web Access Function is available basically, so you can access AC Smart anywhere by using Internet Explorer. Web Access level is distinguished to 2 Level: Administrator and User.

xxii. When logged in as administrator: Can register user ID & Password, and allocate accessible address for each user; can operate all indoor. When login to user: Can operate allocated indoor for each user.

xxiii. New e-mail function was applied: By using this function, you can register e-mail address. So when error occurs or some fixed time automatic e-mail will be executed, so customer can easily maintain all connected air conditioners status

ELECTRICAL WIRING

TRANSMISSION AND POWER CABLE

i. Transmission cable shall be shielding wire CVVS or CPEVS, diameter shall be over

ii. 1.25mm2, insulation material shall be PVC, Maximum allowable temperature shall be 60

iii. and Maximum allowable line

iv. Length shall be 1,000m.

v. Remote Control cable shall be 3-core type

vi. iii) Simple central control cable shall be 4-core type (Shielding wire), Diameter shall be over 0.75mm2 and insulation material shall be PVC.

vii. Separation of transmission and power lines to prevent interferences is required.

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WIRING OF MAIN POWER SUPPLY AND EQUIPMENT CAPACITY
Use a separate power supply for the Outdoor Unit and Indoor Unit.
Power & Control wiring for the indoor & outdoors shall follow the arrangement proposed by the manufacturer of the equipment.

4.12 MAIN DISTRIBUTION BOARD (MDB) FOR PUMP ROOM

Description

The **Main Distribution Board (MDB)** for a pump room is an electrical panel that distributes and controls power to water pumps, control panels, and auxiliary electrical equipment. It ensures the safe and efficient operation of pumps by providing protection against overload, short circuits, and power surges. The MDB houses circuit breakers, switches, contactors, and meters to regulate the electrical supply.

Material

- **Panel Enclosure:**
  - Fabricated from **mild steel (MS) sheet**, minimum **14 SWG (2 mm thick)**, powder-coated for corrosion resistance.
  - Protection rating: **IP54/IP55 (Indoor use), IP65 (Outdoor use)** as per **IEC 60529**.
  - **Ventilation louvers** or cooling fans for heat dissipation.
- **Busbars:**
  - High-conductivity **electrolytic copper** or aluminum, **99.9% pure copper**.
  - **Current density:** 1.6 A/mm² for copper, 1.0 A/mm² for aluminum.
  - Color-coded with **heat-shrinkable sleeves** (Red, Yellow, Blue for phases, Black for Neutral, Green for Earth).
- **Circuit Protection Devices:**
  - **Air Circuit Breaker (ACB) / Molded Case Circuit Breaker (MCCB):** Rated as per pump load requirements.
  - **Miniature Circuit Breakers (MCB):** For small auxiliary loads.
  - **Residual Current Circuit Breaker (RCCB) / Earth Leakage Circuit Breaker (ELCB):** For protection against leakage currents.
  - **Surge Protection Device (SPD):** For voltage surge protection.
- **Control Components:**
  - **Pump Starter (DOL/Star-Delta/VFD Panel)** based on motor type.
  - **Relays and Contactors:** Heavy-duty, rated for motor loads.
  - **Digital Multifunction Meter (V, A, Hz, kW, kWh, PF).**
- **Wiring & Terminals:**
  - **Cables:** Flame-retardant, low-smoke **XLPE insulated copper cables** as per IS 7098.
  - **Terminals:** Heavy-duty, brass or copper-plated lugs.

Job Conditions

- **Environmental Considerations:** Temperature should not exceed **40°C**; humidity <95%.
- **Space & Accessibility:** Ensure sufficient clearance for easy operation and maintenance.
- **Ventilation:** Proper cooling or exhaust fans for heat dissipation in enclosed rooms.
- **Earthing System:** Dedicated earthing connection as per **IS 3043**.

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Technical Specifications

- **Load Calculation:** MDB rating must be sized based on pump motor load demand and future expansions.

Installation

a. Preparation & Handling

- Inspect the panel for physical damage before installation.
- Verify MDB rating and components as per approved electrical design.
- Transport carefully to avoid damage to busbars and components.

b. Mounting & Positioning

- Install the **MDB at a suitable height (1.5m - 1.8m from the ground)** for easy operation.
- Fix securely on a **vibration-free foundation** using anchor bolts.
- Maintain **clearance space (minimum 1 meter in front and 600mm on sides)** for maintenance.

c. Wiring & Connections

- Ensure all connections are **torque-tightened** as per manufacturer guidelines.
- Separate **power and control wiring** to avoid electromagnetic interference.
- Use proper **gland and ferrule identification** for all cables.

d. Earthing & Testing

- Connect **earthing busbar** to the main earthing system (Earth resistance <5 ohms).
- Conduct **Insulation Resistance Test (Megger Test)** before energizing.
- Perform **load testing** to check the voltage drop and power factor.

Adjusting and Fixing

- **Voltage & Load Balancing:** Ensure uniform load distribution across all phases.
- **Breaker Calibration:** Adjust circuit breakers and relays as per motor startup current.
- **Protection Testing:** Simulate **overload, short circuit, and earth leakage faults** to verify protection settings.
- **Final Inspection:** Verify all electrical connections, labeling, and safety features before commissioning.

4.13 ENERGY SAVERS

Description

Energy savers are devices or systems designed to **optimize power consumption, reduce energy losses, and enhance efficiency** in electrical installations, including pump rooms. These systems help in **power factor correction, voltage stabilization, load balancing, and harmonic filtration**, ultimately lowering energy costs and extending the lifespan of electrical components. Common energy-saving technologies include:

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Technical Specifications

- **Variable Frequency Drives (VFDs):** Regulate pump speed based on demand, reducing power wastage.
- **Power Factor Correction (PFC) Units:** Improve power factor to minimize reactive power losses.
- **Harmonic Filters:** Reduce harmonic distortions and improve power quality.
- **Automatic Voltage Regulators (AVR):** Maintain a stable voltage supply, preventing energy losses.
- **Energy Management Systems (EMS):** Monitor and control power consumption efficiently.

Material

- **Enclosure:**
  - Fabricated from **mild steel (MS) sheet, 2 mm thick**, powder-coated for **corrosion resistance**.
  - Protection rating: **IP54/IP55 (Indoor use), IP65 (Outdoor use)** as per **IEC 60529**.
  - Equipped with **ventilation louvers or cooling fans** to prevent overheating.
- **Electrical Components:**
  - **Capacitors:** Low-loss, self-healing, oil-filled or dry type, rated as per **IEC 60831**.
  - **Contactors & Relays:** Heavy-duty, electrically controlled, rated for continuous operation.
  - **Microcontrollers/Processors:** For real-time energy monitoring and optimization.
  - **Current Transformers (CTs):** For accurate energy measurement and load monitoring.
- **Wiring & Terminals:**
  - **Cables:** Flame-retardant, low-smoke **XLPE insulated copper cables** as per **IS 7098**.
  - **Busbars:** High-conductivity **electrolytic copper**, 99.9% purity.
  - **Terminals:** Brass or copper-plated heavy-duty lugs.

Job Conditions

- **Environmental Considerations:**
  - Operating temperature: **0°C to 50°C**.
  - Humidity level: **<95% (non-condensing)**.
- **Space & Accessibility:**
  - Ensure proper clearance for easy maintenance.
  - Ventilation or cooling system must be in place to **dissipate heat** generated by the equipment.
- **Electrical Load Considerations:**
  - Energy saver devices must be sized based on **pump motor ratings and system load requirements**.

Installation

a. Preparation & Handling

- Inspect all components for **physical damage or manufacturing defects** before installation.

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Technical Specifications

- Ensure proper grounding and **compliance with electrical safety standards**.
- Verify **device compatibility** with existing electrical infrastructure.

b. Mounting & Positioning

- Install the energy-saving system at an **accessible height (1.5m - 1.8m from the ground)**.
- Secure the unit on a **vibration-free foundation** using anchor bolts.
- Maintain a minimum clearance of **1 meter in front** and **600mm on sides** for easy maintenance.

c. Wiring & Connections

- Ensure **torque-tightened** connections to prevent overheating and electrical faults.
- Use **separate power and control wiring** to avoid electromagnetic interference.
- Label all terminals and cables with **ferrule identification** for easy troubleshooting.

d. Earthing & Testing

- Connect the **earthing busbar** to the main earthing system (**Earth resistance <5 ohms**).
- Conduct an **Insulation Resistance Test (Megger Test)** before energizing.
- Perform a **Load Test** to check power savings, power factor correction, and voltage regulation.

Adjusting and Fixing

- **Calibration & Load Balancing:**
  - Adjust settings to optimize **power factor and load distribution**.
  - Fine-tune **voltage stabilization and harmonic filtering** as per system needs.
- **Protection & Safety Testing:**
  - Simulate **overload and short circuit conditions** to verify the system's safety features.
- **Final Inspection & Commissioning:**
  - Ensure all connections, labeling, and safety measures comply with **electrical standards**.
  - Conduct **energy efficiency analysis** to verify power savings.

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SECTION 5: PLUMBING WORKS

7 PLUMBING SYSTEM

SCOPE OF WORKS

The work covered by this section consists of providing all material and equipment and performing all the work necessary for the complete execution and completion, including testing and commissioning of all systems of Plumbing works as specified in this document and as shown on the Drawings or as directed by the Engineer.

All the above mentioned systems complete in all respects including connection of the internal systems with the external systems are included in the scope of work.

All the materials and equipment shall be of the specifications mentioned herein and shall be limited to products regularly produced and recommended by the manufacturers for the service intended. Contractor shall submit samples, necessary catalogue, sketches, the name of manufacturer and guarantee, if necessary, before installation for approval by the Engineer. All material and equipment shall be new and unused.

All other equipment and material shall be installed in strict accordance with manufacturer's instructions. These instructions shall be considered as part of specifications.

It is specifically intended and shall be agreed to by the Contractor that any material or labor which is usually furnished as a part of such equipment and which is necessary for its proper completion and best operation shall be furnished as a part of this contract without any additional cost whether or not shown in detail on the drawings or described in detail in the specifications.

The Contractor shall be responsible for his work until its completion and final acceptance and shall replace any of the same which may be damaged, lost or stolen without any additional cost to the Employer.

All openings left in floor for passage of ducts, pipes and cables etc. shall be covered and protected.

All open ends of pipes shall be properly plugged off to prevent any foreign material from entering the pipe during installation.

The Contractor shall allow in his bid for the cost of all cutting, making of holes and subsequently making good to the desired finish as approved by the Engineer. No separate payment shall be made for this item. Also the Contractor shall allow in his bid for the cost of providing protective painting or coating as specified in the relevant sections and no claim shall be entertained for this item.

The arrangement, positions and connections of pipe fittings and appurtenances shall be as shown on the drawings but the Engineer reserves the rights to change the locations. Special precautions shall be taken for the installation of concealed pipes as shown on the drawings and/or as required. Should it be necessary to correct piping so installed, the Contractor shall be held liable for any injury caused to other work in the correction of piping. For any expedient change, the Contractor will correctly show it in shop drawings. A minimum distance between different services shall be maintained as shown in the contract documents or as approved by the Engineer.

All exterior openings provided for the passage of piping and ducting shall be properly sealed with snugly fittings collars of metal of other approved rat-proof material securely fastened in to place. Joints at the roof, around ducts and pipes, shall be made water-tight by the use of lead, copper, galvanized iron or other approved flashings of flashing material. Exterior wall openings shall be made water-tight.

Piping in ground shall be laid on a firm bed for its entire length. No separate payment shall be made for any earth work required in connection with laying of piping in ground. Piping shall be installed without undue strains and stresses. Vertical piping shall be securely held to keep the pipe in alignment and carry the weight of the pipe and contents. Horizontal piping shall be supported to keep it in alignment and prevent sagging. Hangers and anchors shall be of metal of sufficient

strength to maintain their proportional share of pipe alignments and prevent ratting. Hangers and anchors shall be securely attached to the building construction.
The Work shall conform in all respects to local Municipality, and any other authorities having jurisdiction.
The systems shall be in accordance with the requirements of the Civil Defense Department and National Fire Protection Association (NFPA).
These specifications are supplementary to the requirements above. All required approvals of shop drawings and materials shall be obtained by the Contractor from the appropriate authorities before proceeding with work on site.
All connections to/from city points of utilities supply/discharge shall be the mechanical Contractor's responsibility.

REGULATIONS

The Work shall accord strictly with all rules, regulations, By-laws and requirements of all authorities having jurisdiction.
Drawings and specifications should not conflict with the above regulations but where there are apparent discrepancies the Contractor shall notify the Engineer in writing and obtain clarification before proceeding with the Work.

CODES AND STANDARDS

The installation shall comply with all relevant statutory instruments and regulations and in particular with the following:

1. The IEE regulations for electrical equipment in buildings.
2. Any Regulations under Electricity.
3. Local Health and safety at work regulations.
4. Local Control of Pollution Regulations.
5. ASHRAE standards.
6. ASME standards.
7. British Standard.
8. National Plumbing Code
9. Standards mentioned elsewhere in these documents

The Tender shall be based on regulations and standards current on the date of return of tenders. If these regulations are amended or new regulations are enacted after that date, the Engineer shall be notified immediately.
The materials, equipment and installations detailed in this specification are based on the standards and codes of practice indicated in the Contract Documents. In the event of a contradiction between this specification and any applicable standard or Code of Practice, this specification shall govern and the Engineer shall be notified immediately.
Where material and equipment are specified under a particular standard and supplied under an equivalent standard, a certificate of compliance shall be provided to the Engineer at his request.

ABBREVIATIONS

Generally, the following abbreviations are used in this Division

a) ANSI : American National Standards Institute
b) ASHRAE : ASHRAE
c) ASME : American Society of Mechanical Engineers.
d) ASTM : American Society for Testing and Materials

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e)	AWWA	:	American Water Works Association
f)	bhp	:	boiler horsepower or brake horsepower
g)	BS	:	British Standard
h)	Btu/hr	:	British thermal units per hour
i)	BWG	:	British Wire Gauge
j)	CFM	:	cubic feet per minute
k)	CI	:	cast iron
l)	CSA	:	Canadian Standards Association
m)	Dia	:	diameter
n)	EEMAC	:	The Electrical and Electronics Manufacturers' Association of Canada
o)	° F	:	degree Fahrenheit
p)	° K	:	degree Kelvin
q)	ft	:	feet
r)	gpm	:	gallons per minute
s)	hp	:	high pressure or motor horsepower
t)	lbs	:	Pounds
u)	lbs/ft3	:	pounds per cubic feet
v)	NBS	:	National Bureau of Standards
w)	N.C.	:	Noise criterion as define by graph in ASHRAE.
x)	NFPA	:	National Fire Protection Association
y)	NPSH	:	Net positive Suction Head
z)	No.	:	Number
aa)	O.S. & Y	:	outside screw and yoke
ab)	ph	:	hydrogen ion concentration
ac)	ppm	:	parts per million
ad)	psi	:	pounds per square inch
ae)	rpm	:	revolutions per minute
af)	SMACNA	:	Sheet Metal and Air Conditioning Contractors National Association
ag)	SS	:	Stainless steel
ah)	UL	:	Underwriters' Laboratories
ai)	ULC	:	Underwriters' Laboratories of Canada
aj)	W	:	Watts
ak)	KW	:	Kilo Watts
al)	w.g.	:	water gauge
am)	w.p.	:	working pressure
an)	Lit	:	Liter
ao)	m3	:	Cubic Meter
ap)	L/s	:	Liters per sec

DRAWINGS, CHANGES AND INSTALLATION

The drawings shall be considered to show the general character and scope of the work and not the exact details of the installation. The installation shall be complete with all accessories required for a complete and operative installation.

The location, arrangement and connection of equipment and material as shown on the drawings represent a close approximation to the intent and requirements of the Contract. The right is reserved by the Engineer to make reasonable changes required to accommodate conditions arising during the progress of the work, at no extra cost to the Contract.

All piping and duct work in finished areas shall be concealed in ceiling spaces and shafts or chased into walls. No exposed piping or duct work shall be installed in such areas unless

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specifically accepted by the Engineer.

Any pipe or mechanical equipment mounted on roof, or housing for such equipment, shall not be closer to the edge of roof than a distance equal to the height of the pipe, hood or equipment; unless specifically accepted by the Engineer.

The actual location of sensing devices, thermostats, switches, etc., shall be reviewed by the Engineer before installation.

The location and size of existing services shown on the drawings are based on the best available information. The actual location of existing services shall be verified in the field before work is commenced.

Changes and modifications necessary to ensure coordination and to avoid interference and conflicts with other trades, or to accommodate existing conditions, shall be made at no extra cost to the Contract.

The Contractor shall ensure that all plant to be supplied by him can be installed in the available space and that there is adequate access to admit all plant to its position and enable maintenance to be carried out on the plant without difficulty.

Special care shall be taken in areas where pour-gaps take place. Coordinate the work schedule with the Contractor.

RECORD DRAWINGS

The Contractor shall clearly mark, as the job progresses, all changes and deviations from that shown on contract drawings on two sets of prints. After inspection and acceptance of service lines in trenches, the Contractor shall take 'as-built' measurements. Definite measurements shall be taken for each service line. Drawings shall be kept up-to-date during construction. On completion of the building, the Contractor shall forward to the Engineer, drawings (quantities as specified elsewhere) indicating all such changes and deviations. This Contractor shall include all existing information on the final record drawings.

The cost of furnishing above prints and preparing these record drawings shall be borne by the Contractor and shall be included in the Contract Price. When all revisions showing the work as finally installed are made, the corrected sepias shall be submitted for review by the Engineer, and delivered to the Consultants before final payment for the completed work will be made.

SHOP DRAWING

Shop Drawings shall indicate clearly all services and the materials and/or equipment actually being supplied, all details of construction, accurate dimensions, capacity operating characteristics and performance.

Each shop drawings for non-catalogue items shall be prepared specifically for this project.

Material submissions and brochures for catalogue items shall be marked clearly to show the Items being supplied.

This Contractor shall prepare all shop drawings related to the particular material submittal and shall submit both the shop drawings and the material submittal simultaneously.

Ensure that electrical coordination is complete before submitting drawings for review.

Installation of any equipment shall not be commenced until after the shop drawings have been reviewed by the Engineer.

When requested, shop drawings shall be supplemented by data explaining the theory of operation. The Engineer may also request that this information be added to the maintenance and operating manual.

DRAWING SUBMISSIONS

Builder's work drawings shall show fully dimensioned, all foundation, bases plinths, sumps, holes and sleeves details required and the overall size and weights of the plant concerned.

With the agreement of the Engineer, smaller holes, built-in fixings, etc., other than in plant rooms, may be marked out on site instead of on drawings.

Fully dimension plant room drawings shall detail for each plant room the location of each unit, pipe routes and connections with valves and fittings, duct routes and connection with accessories,

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drain connections, electrical connections and controls. All drawings shall include explanatory notes and shall show the required sizes of pipes and ducts with and without insulation as applicable.

If abbreviations are employed for the designation of components, an integral schedule shall be provided on the drawings to explain the meanings of the abbreviations.

Individual equipment drawings from the various manufacturers will not be accepted in lieu of these composite plant room drawings.

COORDINATION, INSTALLATION, INTERFERENCE AND SETTING DRAWINGS

Coordination, Installation, interference and setting drawings dimensioned and to scale, shall be submitted for the Engineer's review to make clear the work intended and to, show its relation to adjacent work and to the work of other trades. Three copies of such drawings shall be submitted for review, of which one will be retained by the Engineer.

The drawings must be comprehensive showing all details, dimensions, equipment, supports for services and sections through critical areas to properly coordinate all services and work of other trades. Unless accepted by the Engineer, all drawings must be to 1/8" : 1' scales for IP Units or 1:100 scales for SI Units.

Site services drawing shall be prepared to show all existing services, modification to existing services and all new services within the entire construction area. Location of all existing services shall be carefully detailed and dimensioned on the drawings showing all sizes and invert elevations.

Drawings shall be prepared with due regard to the construction schedule and shall be submitted to the Engineer, allowing reasonable time for examination and review.

Work shall not proceed in areas involved until after final approval of all such drawings has been obtained.

These drawings shall include all existing information.

EXAMINATION OF SITE

Before submitting tenders, each trade shall examine the site to determine the conditions which may affect the proposed work. No claims for extra payment will be considered, because of failure to fulfill this condition.

CONTRACTOR'S TECHNICAL RESPONSIBILITIES

This Contractor shall provide detailed calculations for flow and head requirements for all Pipes, pumps and etc. These calculations shall be done prior to ordering the equipment and shall be submitted to the Engineers for review prior to ordering such equipment. This Contractor shall bear full responsibility for the final equipment sizing and selection.

The cost of furnishing above calculations shall be borne by the Contractor and shall be included in the Contract Price.

EXCAVATIONS AND BACK FILLING

Excavations

Excavation for the drains in open trenches shall be to the line and depths indicated on the drawings or as directed. Great care shall be taken to excavate only to such depths as are correctly required for regular gradients. Grips for joint as required shall be formed, trench bottom shall have sufficient width to allow adequate working space for the pipe jointed and should in no case be less than 24 inches or the internal diameter of the pipe plus 18 inches. Trenches are to be kept clear of water including any necessary pumping. Perform all tunneling for pipe when required. Wherever soft places in excavated areas are encountered, the Contractor shall excavate such soil to hard foundation and replace with granular material before any drain are laid. In the event of the excavation being made deeper than necessary by error they shall be filled to proper level with cement concrete 1:4:8 at the Contractor's expense. Cement concrete 1:4:8 is to be laid before the pipes are placed in position.

1.13.2 Back Filling

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No filling or back filling shall be carried out until debris, trash and other foreign material from trenches have been removed and drains, manholes, etc. have been tested and approved by the Engineer-Incharge. Fill material shall be free from timber, rocks 3 inches or large, organic material and other unsuitable material as determine by the Engineer. Earth filling to the bottom of the trenches and to a height of 12 inches above the top of the pipes shall be of selected materials, hand backed, watered if necessary and well rammed on either side of the pipe. Special care shall be exercised where pipes are laid direct on the earth or on beds without benching or covers. The remainder of the earth filling shall be in 6 inches layers, each layer watered if necessary, and well rammed. Mechanical rammers are not to be used until atleast 24" of consolidated material has been returned over the pipes. Where vegetable soil has been removed, it shall be replaced at top of the trench and similarly consolidated. Heading shall be filled with the excavated materials, packed tightly in layers and rammed by hand (or concrete of mix.1:3:6) or broken rock or hard core kept to a stepped face as the work proceeds. Surplus earth shall be disposed of as directed. The trenches under pavings shall be back filled by local sand, well compacted. Existing pavements, roadways, walkways, curbs and landscaped areas disturbed during the programme of the excavation and backfill work shall be restored to original condition.

Planking Strutting and Staging

Excavated materials shall not be deposited within 1'-6" of the edge of the trench and sides of the excavation shall be supported by planking and strutting if necessary to ensure a proper and speedy execution of the work.

Blasting

No blasting shall be allowed near the rocks. The rocks shall be excavated by chiseling.

Buried Services

All pipes, ducts, cables, main and other service exposed by all excavation shall be effectively supported by timber or other means.

BEDDING AND ENCASTING PIPES

The concrete beds shall be of ratio 1:3:6 (6 inches thick for pipes more than 8" dia) and not less than 12 inches wider than the external diameter of the pipe. These shall be provided at all buried bends.

Where cast iron or steel (or concrete) pipes are specified to be haunched, the concrete shall be carried by from the outside edge of the bed to meet the pipe barrel tangentially, where the pipes are specified to be surrounded, the concrete shall be carried up from the beds in square section with a minimum of 6 inches in thickness over the barrel of the pipe.

The rest bend in the ground at the set of all soil, rain water, ventilating and other vertical pipes, to be embedded in solid concrete 6 inches thickness

PLUMBING AND DRAINAGE SERVICES CONNECTION

The cost of all service connections required for the plumbing and drainage system shall, be the responsibility of the Contractor. This includes the supply and installation of the water meter and all associated fitting, piping, etc.

Make any adjustments to piping systems necessary to suit the local requirements.

Coordinate routing and final points of connection with the external services layout and satisfaction of authorities having jurisdiction. Manholes and covers shall be installed to the municipality requirements.

Install water meters in meter cabinets and isolation valves to the local authority standards.

GAUGES AND METERS FOR PLUMBING SYSTEMS

GENERAL

CODE & COMPLIANCE

All materials and workmanship described herein shall be in accordance with the latest editions

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and addenda of the codes and standards listed below and all State, and local codes, and/or specifications, the more stringent shall be govern.
ASHRAE, ASME, ASPE, ASTM, BS, IPC, NFPA

QUALITY ASSURANCE

All materials and equipment to be used for this contract shall be standard products of a reputable manufacturer regularly engaged in the production of same. All material of the same type shall be provided from the same manufacturer. Any work or materials found to be defective or which do not meet the requirements of these specifications, shall be replaced by the Vendor at his own expense. All materials shall be new, unused and free of defects and imperfections.

COORDINATION

In selecting the units, the tenderer shall carefully check and confirm that the units can be installed and conveniently serviced and maintained within the respective spaces indicated on the drawings for unit installation.

SUBMITTALS

Submit manufacturer's technical product data, installation instructions and dimensioned drawings.

DELIVERY, STORAGE & HANDLING

Unit shall be delivered factory assembled with protective crating and covering and their delivery coordinated in sufficient time to allow movement into building. Vendor shall be solely responsible for the adequacy of the preparation for shipment provisions with respect to materials and applications. Adequate protection shall be provided against mechanical damage and atmospheric corrosion in transit and for a 6 month period of outdoor storage at job site prior to installation. Miscellaneous parts shall be tagged or marked with the equipment item number for which they are intended.

WARRANTY

Vendor shall guarantee and provide a written statement as proof that the unit shall perform as specified on the Data Sheets. All equipment shall be guaranteed for satisfactory performance and shall be warranted against faulty design, defective or improper materials. The Material and Workmanship Guarantees shall be extended for a period of eighteen months from the date of shipment or one year from the date the equipment is placed in service whichever occurs first.

PRODUCT

The Contractor shall supply and install all necessary indicating thermometers, pressure gauges etc. for easy checking of operation of the complete plant. Amongst others, the following instruments and measuring points shall be included but duplication of instruments and points is to be avoided. The selected scale range of instruments shall suit the anticipated operational range. The suggested ranges are 10-35°, 0-50°, 0-70°, 0-100° and 0-200°C for thermometers and 990mBarvacuum - 2Bar, 0-4, 0-7, 0-10 and 0-20 Bar for pressure gauges.
Insertion type duct mounted 75mm diameter dial thermometer shall be provided in each return air inlet and on the leaving side of each cooling and heating coil of air handling units, fresh air inlet and supply air of zones.
Industrial type pipe insertion thermometers at least 100mm diameter dial scale with external recalibration or 230mm long stem scale, separable copper wells and sockets with extension neck for insulated piping, shall be provided at each water inlet and outlet of water chiller, condenser, absorber, hot water boiler, heat exchanger, cooling coil, heating coil and pumps. Where only thermometer wells have been shown in the drawings only these shall be supplied.
Compound/pressure gauges, at least 100mm diameter with Bourdon tube type element and

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internal mechanism with individual bearings to give best accuracy under fluctuating pressure and vibrations shall be provided at suction and discharge of all water pumps, inlet and outlet of water chiller, condenser, absorber, hot water boiler, heat exchanger and cooling coil and heating coil. Where only gauge cocks have been shown in the drawings, only these shall be supplied.
At the chilled/hot water supply and return branch take-off from the main piping, a thermometer copper well and pressure gauge connection with cock, and a pressure gauge connection with cock across each pressure reducing valve should be provided so that when required the Operator can install thermometers and gauges for taking readings. The gauge connection shall further be capped.
The gauge cocks shall be of brass with lever handle and for steam gauges, a siphon filled with water shall be installed between the cock and gauge to prevent steam from entering the Bourdon tube.

EXECUTION

Furnish and install gauges and thermometers (including wells) as per manufacturer's recommendation as shown on drawings and as specified.
Instruments should be installed such that they are easily readable and parallax errors are minimized due to difficult locations of instruments.

7.1 VALVES

GENERAL

CODE & COMPLIANCE

All materials and workmanship described herein shall be in accordance with the latest editions and addenda of the codes and standards listed below and all State, and local codes, and/or specifications, the more stringent shall be govern.
ASHRAE, ASME, ASPE, ASTM, BS, IPC, NFPA

QUALITY ASSURANCE

All materials and equipment to be used for this contract shall be standard products of a reputable manufacturer regularly engaged in the production of same. All material of the same type shall be provided from the same manufacturer. Any work or materials found to be defective or which do not meet the requirements of these specifications, shall be replaced by the Vendor at his own expense. All materials shall be new, unused and free of defects and imperfections.

COORDINATION

In selecting the units, the tenderer shall carefully check and confirm that the units can be installed and conveniently serviced and maintained within the respective spaces indicated on the drawings for unit installation.

SUBMITTALS

Contractor shall produce and submit for approval detailed schedule of all valves covered by this Section indicating type of devices, dimensions, materials of construction, pressure/temperature ratings and attachment methods, for each pipe size and type of service. Temperature ratings specified are for continuous operation.

DELIVERY, STORAGE & HANDLING

Material shall be delivered factory assembled with protective crating and covering and their delivery coordinated in sufficient time to allow movement into building. Vendor shall be solely responsible for the adequacy of the preparation for shipment provisions with respect to materials and applications. Adequate protection shall be provided against mechanical damage and atmospheric corrosion in transit and for a 6 month period of outdoor storage at job site prior to

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installation. Miscellaneous parts shall be tagged or marked with the equipment item number for which they are intended.

WARRANTY

Vendor shall guarantee and provide a written statement as proof that the unit shall perform as specified on the Data Sheets. All equipment shall be guaranteed for satisfactory performance and shall be warranted against faulty design, defective or improper materials. The Material and Workmanship Guarantees shall be extended for a period of eighteen months from the date of shipment or one year from the date the equipment is placed in service whichever occurs first.

PRODUCT

MATERIALS

Generally, all valves of the same type shall be of the same manufacturer. All gate, globe, angle, and swing check valves as a group shall be of the same manufacturer. All valves 50 mm and smaller shall be threaded and have bronze bodies. All valves 65 mm and larger shall be Iron Body Bronze Mounted (IBBM) type, i.e. with bronze trim, and shall be flanged (or grooved for grooved coupling joints). All valves 100 mm and larger mounted in excess of 2.15 m above the floor in mechanical rooms shall be equipped with chain operators. Extend chains to within 2 m of floor. Each valve shall be marked (engraved, stamped, or cast on each valve or metal tag, permanently attached to the valve) at the factory with the following minimum information:

a) Manufacturer's Name.

b) Catalogue or Figure No.

c) Size and Pressure Class.

Arrows to indicate direction of flow on check, globe, angle, non-return, and eccentric plug valves.

GATE VALVES

Furnish valves 300 mm and smaller designed for minimum PN16 (or PN20 as specified) non shock water, oil and gas working pressure. Valves 350 mm through 610 mm, shall be designed for minimum PN10.

Size 50 mm and Smaller.

Furnish bronze valves with screwed-in bonnet, non-rising stem, solid wedge disc, and threaded ends. Pressure rating PN20.

Size 65 mm and Larger.

Furnish Iron Body Bronze Mounted (IBBM) valves, i.e. cast iron body bronze trim valves, with bolted bonnet, non-rising stem, solid wedge disc, flanged ends, and renewable seat

GLOBE VALVES

Size 50mm and Smaller.

Furnish valves designed for minimum PN20 nonshock water, oil, and gas working pressures. Valves shall have union bonnets, integral seats, and renewable teflon discs. Valves shall permit disc and bonnet replacement without removing valves from piping.

Size 65 mm and Larger.

Furnish valves designed for minimum PN16 water, oil, and gas working pressure. Valves shall have bolted bonnets, guided bronze or bronze faced disc, outside screw and yoke, (0 S and Y) and flanged ends. Discs and seats shall be renewable without removing valves from line.

DOUBLE REGULATING VALVES

Size 50mm and smaller.

Furnish bronze double regulating valve designed for minimum PN20. Parabolic and slotted disk

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double regulating device. Screwed bonnet, rising stem, hand wheel operated with micrometer style indicator.

Size 65mm and larger.

Furnish cast iron double regulating valve for minimum PN16. Fitted with EPDM coated regulating disk, double regulating device and indicator, flanged to BS 4504 PN16. Inside screw, non-rising copper alloy stem, back seating feature.

Balancing valves shall comprise a metering station and a close coupled double regulating valve. The metering station, containing an orifice shall be fitted with test points so that the pressure drop across the orifice can be measured. The commissioning set shall provide ±5% accuracy and should be installed with a minimum of 5 times pipe diameter uninterruped upstream length of straight pipe.

CHECK VALVES

Water, Oil, and Steam, size 50 mm and smaller.

Furnish swing valves designed for minimum PN20 non shock water, oil, and gas working pressures. Valves shall have renewable discs and side plugs and regrindable, integral seats. Discs shall be renewable and seats regrindable without removing valves from the line.

Size 65 mm and Larger Water Check Valves.

Valves shall be silent type spring loaded of the double door or wafer style. Valves shall be designed for minimum PN16 non shock water working pressure.

Double door valves shall have cast iron body, aluminum bronze or stainless steel disc, stainless steel spring and hinge pin, and Butyl rubber sheet. Wafer style valves shall have cast iron or semi-steel body, bronze disc, stainless steel spring, and Butyl rubber sheet.

BUTTERFLY VALVES

Furnish valves designed for minimum PN16 and 120 degrees C. water service. Valves shall have extended necks. Operator shall be 10-position lever lock for sizes 50 - 100 mm and totally enclosed and sealed worm gear actuators with 4-arm or wheel handle for sizes 150 mm and larger. Infinite adjustment and memory stop options shall be included. Valves shall be bi-directional suitable for drop-tight shut-off at full rated pressure with flow in either direction.

Materials.

Body: Cast or ductile iron.

Disc: Bronze, aluminum bronze or stainless steel.

Stem - Type 416 stainless steel.

Seat - Ethylene Propylene Diene Terpolymer (EPDM).

PRESSURE REDUCING VALVES

Pressure reducing valves shall be pilot controlled, hydraulically operated, diaphragm type with a low by-pass capability. The low-flow by-pass capability shall be achieved by using a balanced direct acting PRV as an integral part of the main valve. At very low flows when the main valve is almost completely closed, to percent the possibility of cavitation the direct acting valve shall by-pass the main valve and maintain flow. PRVs shall be bronze construction including the trim. The pressure reducing valves shall be suitable for maximum working pressure that exist within the system and downstream pressure should be site adjustable between 2 and 4 bar. Refer to Schematic drawings for the minimum locations at which PRV's shall be required.

RELIEF VALVES

Domestic Water Temperature and Pressure Relief Valve.

On hot water storage tanks provide an ASME rated thermostatic, self-closing, temperature and pressure relief valve, located in the relief valve openings of tanks. Valve shall have a minimum thermal discharge capacity equal to the input capacity of the heater standard pressure setting of 600 kPa and standard temperature setting of 100 degrees C. Relief valve pipe to discharge to floor

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drain.

BALL VALVES

General

Valves shall be non-blowout stem design. Quarter turn of handle shall fully open or close valve. Handle position shall indicate whether valve is open or closed. Handle stops shall be a permanent, integral part of the body.

Size 50 mm and Smaller.

a. Valves shall be standard port, 2-piece construction with screwed ends. Valves shall be designed for minimum PN25.

b. Valves shall have bronze or brass body, chromium plated or stainless steel ball, steel handle with vinyl grip, and replaceable Teflon seats.

Size 65 mm and Larger.

a. Valves shall be standard port, BS 5159 with flanged ends. Valves shall be designed for minimum PN16 working pressure.

b. Valves shall have steel body, chrome or nickel plated steel or stainless steel ball, replaceable Teflon seats, and steel stem and handle.

Where required for installation in the fire protection system, the ball valves shall be FM approved.

FLOAT VALVES

Float valves shall be installed as indicated in the drawings to provide consistent level control in reserve supply water storage tanks. The valve shall meet the requirements of the Water Byelaws for air gaps and shall be constructed throughout in approved materials and shall prevent back siphoning. Inlet flow shall be co-axial with the piston movement, to ensure high discharge capacity and smooth, quiet operation. The valve shall have 'O' ring piston seals, resilient seated disk, Dezincification resistant bronze fabricated approved solder and shall be hydraulically tested to ensure buoyancy and constructed in accordance with BS1968. Bronze equilibrium float valves 80 and above shall be flanged end, flat faced and drilled to suit BS4504 PN16. Bronze equilibrium float valves up to 50 shall be screwed end BS2779 parallel and shall be provided complete with back nut. Floats for valve sizes 80mm and above shall be of copper.

SOLENOID VALVES

Electrically operated solenoid valves shall be single phase 220V and shall be rated for the system pressure.

BIB TAPS

Bib-cocks shall be in accordance with BS 1010 : 1973. They shall be provided with hose union nosepiece and hand wheel operated.

AUTOMATIC AIR VALVES

Automatic air valves shall have a bronze body with bolted cover and a 9mm top outlet. They shall each incorporate a suitable float mounted on a stainless steel spindle terminating in a needle valve for closure against a stainless steel seating at the outlet. For low pressure systems the valve shall be provided with a test cock and a brazed float, but for medium and high pressure systems the float shall be of stainless steel. Automatic air valves for low pressure systems shall, incorporate an internal ball check valve at inlet to prevent air entry to the system. Automatic air valves for cold water services shall be to the approval of the local water authority.

STRAINERS

Up to and including DN50 strainers shall be manufactured from bronze and shall be of the 'Y' type with bolted cap, PN25 temperature/pressure rating. Strainers above DN50 shall be manufactured from cast iron and shall be of the 'Y' type with bolted cap, PN16

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temperature/pressure rating and shall be complete with drilled and tapped caps complete with drain cocks. Strainers shall be provided with a medium grade screen sized such that in their clean condition the maximum pressure drop at the design flow rate shall not exceed 6kPa. For chilled water the mesh shall be stainless steel and for water services the mesh shall be of copper.

EXECUTION

PREPARATION

Provide valves at each piece of equipment to isolate equipment from its connected system. Locate strainers and valves as necessary to provide easy isolation and cleaning of strainers. Strainers shall be installed ahead of all automatic valves and elsewhere as indicated on Drawings. Provide a ball valve and 1.5 m of rubber hose in the blow off opening of each strainer. Unions shall be provided adjacent to each screwed type valve and shall be on the outlet side of the valve.

INSTALLATION/APPLICATION/PERFORMANCE/ERECTION

Properly align piping before installation of valves in an upright position; operators installed below the valves will not be accepted. Install valves in strict accordance with valve manufacturer's installation recommendations. Do not support weight of piping system on valve ends. Install all valves with the stem in the upright position. Valves may be installed with the stem in the horizontal position only where space limitations do not allow installation in an upright position or where large valves are provided with chain wheel operators. Where valves 50-65mm and larger are located more than 4m above mechanical room floors, install valve with stem in the horizontal position and provide a chain wheel operator. Valves installed with the stems down, will not be accepted. Prior to flushing of piping systems, place all valves in the full-open position. Flanged valves shall be installed between flanges.

Shut-Off Valves

Install shut-off valves at all equipment, at each branch take-off from mains, and at each automatic valve for isolation or repair.

Balancing Valves

Provide balancing valves for all major equipment and at each major branch takeoff and at the discharge of each pump as indicated on drawings and details.

Calibrated balance valves:

Install where indicated on the drawings and details for balancing of hydronic systems.

Drain Valves

Provide drain valves for complete drainage of all systems. Locations of drain valves include low points of piping systems, equipment locations specified or other locations required for drainage of systems.

Safety Relief Valves

a. Use air pressure to clean piping prior to installation of safety relief valves.

b. Install relief valves in locations indicated on drawings, downstream of all pressure reducing valves.

c. Install valves in the vertical position, with drain holes, including those from dip pan elbows, piped to the nearest drain. Inlet and outlet piping connecting to valves must be the same size as valve

d. Install drip pan elbow as detailed at first vertical rise of the vent pipe. Keep pipe between safety valve and drip pan elbow as short and straight as possible. Support piping and drip pan elbow independently to prevent stress at connections to safety valves. Install vent pipe so that its weight does not rest on the drip pan elbow. Extend drain line from drip pan elbow and relief valve to

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nearest drain. Pipe discharge from water system relief valves to nearest drain.

Spring Loaded Check Valves
Install a spring loaded check valve in each pump discharge line where two pumps operate in parallel and no combination shutoff, check and balancing valve is being used.

Swing Check Valves
Provide swing check valves where specified, detailed. In such cases, provide isolation valves to allow repair or replacement of check valve.

Combination Shut-Off, Check, And Balancing Valves
Contractor may use combination shut-off, check and balancing valves where separate shut-off valve, check valve, and balancing valve are specified or detailed in pump discharge piping.

Pressure Reducing Valves

a. Provide gate valve and strainer at inlet. Provide gate valve at outlet. Install pressure gauges to indicate inlet and outlet pressure at each pressure reducing valve.
b. Use concentric reducers at inlet and outlet of reducing valves where connections are not the same size as adjacent piping.

ADJUSTMENT AND CLEANING

Valves and stops shall be adjusted, packed, and repacked as may be required to eliminate leaks and produce proper flow.

7.2 FACILITY SEWAGE DRAIN MANHOLES

GENERAL

CODE & COMPLIANCE

All materials and workmanship described herein shall be in accordance with the latest editions and addenda of the codes and standards listed below and all State, and local codes, and/or specifications, the more stringent shall be govern.
ASHRAE, ASME, ASPE, ASTM, BS, IPC, NFPA

QUALITY ASSURANCE

All materials and equipment to be used for this contract shall be standard products of a reputable manufacturer regularly engaged in the production of same. All material of the same type shall be provided from the same manufacturer. Any work or materials found to be defective or which do not meet the requirements of these specifications, shall be replaced by the Vendor at his own expense. All materials shall be new, unused and free of defects and imperfections.

COORDINATION

In selecting the units, the tenderer shall carefully check and confirm that the units can be installed and conveniently serviced and maintained within the respective spaces indicated on the drawings for unit installation.

SUBMITTALS

Submit manufacturer's technical product data, installation instructions and dimensioned drawings, pressure/temperature ratings.

DELIVERY, STORAGE & HANDLING

Material shall be delivered factory assembled with protective crating and covering and their delivery coordinated in sufficient time to allow movement into building.
Vendor shall be solely responsible for the adequacy of the preparation for shipment provisions

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with respect to materials and applications.
Adequate protection shall be provided against mechanical damage and atmospheric corrosion in transit and for a 6 month period of outdoor storage at job site prior to installation.
Miscellaneous parts shall be tagged or marked with the equipment item number for which they are intended.

WARRANTY

Vendor shall guarantee and provide a written statement as proof that the unit shall perform as specified on the Data Sheets. All equipment shall be guaranteed for satisfactory performance and shall be warranted against faulty design, defective or improper materials. The Material and Workmanship Guarantees shall be extended for a period of eighteen months from the date of shipment or one year from the date the equipment is placed in service whichever occurs first.

PRODUCT

Manholes shall have the minimum inside dimensions shown on the Drawings. Manhole walls shall be of poured-in-place reinforced concrete or as shown in drawings. Top section must be cast such as to suit elevation and accommodate size of manhole frame and cover. Manhole floor shall be of reinforced concrete and inverts stream lined with cement and mortar into a semi-circular path with sanitary turns and have their corners filled and sloped towards the water path to prevent any settlements of solids as detailed on the Drawings. Concrete foundation and benching for manholes shall be constructed in accordance with details as shown on the Drawings.
All pipes or castings to be embedded in the manhole walls shall be accurately set, and if so required, headers shall be laid round the casting so embedded. All work must be carried out in a manner to ensure watertight work, and any leaks shall be caulked, repaired, or the entire work shall be removed and rebuilt. Attention is particularly called to the necessity of keeping the water level below all parts of the foundation and walls until the concrete has obtained adequate setting.
The Contractor shall furnish and set level and to the proper grade, a cast iron frame and cover or frame and grating of the form and dimensions shown on the Drawings. The concrete shall be neatly and accurately brought to the dimensions of the base of the frame. The frames shall be thoroughly embedded in mortar. All covers and frames shall be heavy-duty quality.
The nominated sub Contractor shall supply and fix cast iron manhole covers and frames bitumen coated as follows:

Situation	**Grade of Cover (BS 497)**	**Specification**	**Clear Opening**
Road, car parks, public footpaths	A2	Double Triangular, Heavy Duty, D.I	600x600
Private footpaths	C	Single seat air tight solid top heavy duty	600x600
Inside building	C	Double seat double cover air tight recess top screw down tight duty	600x600

The invert channels shall be smooth and accurately shaped to a semicircular bottom conforming to the inside of the adjacent sewer section. Inverts shall be formed directly in the concrete of the manhole base. Steep slopes outside the invert channels shall be avoided. Changes in size and grade shall be made gradually and evenly. Changes in direction of the sewer and entering branches or branch shall have true curves of as large a radius as the size of the manholes will

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permit.

Manholes shall be provided with built-in steps of galvanized, wrought iron. The rungs shall be not less than 250mm in width and spaced approximately 300mm apart, and alternate rungs shall be staggered or offset 150mm. Bars or rods when used for steps shall not be less than 25mm diameter.

Manhole frames and covers shall be in accordance with the requirements shown on the drawings. The manhole frames and covers shall be so set that the top of the cover will be flush with the finished grade.

Concrete foundations for manholes shall be constructed of 1000 kg concrete, proportioned 1 cubic meter cement, 2 cubic meter sand, 3½ cubic meter stone, not less than 22 bags of cement per cubic metre of concrete in place and maximum water content of 90 litres/m³ (quantity includes water in aggregates). The manhole walls shall be constructed from 200mm thick concrete internally rendered on a 200 concrete base.

Heavy duty C.I. covers or grating as per requirement with frame shall be provided. The weight of the cover with frame shall not be less than 1 Cwt. The dimensions shall be as indicated on the drawings. If no dimension are provided in drawing and BOQ a minimum if 450mm x 450mm cover shall be installed.

EXECUTION

Install systems to the approval of the local Drainage Department. Manholes and gully-traps shall be vented in accordance with local authority and/or BS requirements.

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7.3 FACILITY STORM DRAINAGE MANHOLES AND CATCH BASIN

GENERAL

CODE & COMPLIANCE

All materials and workmanship described herein shall be in accordance with the latest editions and addenda of the codes and standards listed below and all State, and local codes, and/or specifications, the more stringent shall be govern.
ASHRAE, ASME, ASPE, ASTM, BS, IPC, NFPA

QUALITY ASSURANCE

All materials and equipment to be used for this contract shall be standard products of a reputable manufacturer regularly engaged in the production of same. All material of the same type shall be provided from the same manufacturer. Any work or materials found to be defective or which do not meet the requirements of these specifications, shall be replaced by the Vendor at his own expense. All materials shall be new, unused and free of defects and imperfections.

COORDINATION

In selecting the units, the tenderer shall carefully check and confirm that the units can be installed and conveniently serviced and maintained within the respective spaces indicated on the drawings for unit installation.

SUBMITTALS

Submit manufacturer's technical product data, installation instructions and dimensioned drawings, pressure/temperature ratings.

DELIVERY, STORAGE & HANDLING

Material shall be delivered factory assembled with protective crating and covering and their delivery coordinated in sufficient time to allow movement into building. Vendor shall be solely responsible for the adequacy of the preparation for shipment provisions with respect to materials and applications. Adequate protection shall be provided against mechanical damage and atmospheric corrosion in transit and for a 6 month period of outdoor storage at job site prior to installation. Miscellaneous parts shall be tagged or marked with the equipment item number for which they are intended.

WARRANTY

Vendor shall guarantee and provide a written statement as proof that the unit shall perform as specified on the Data Sheets. All equipment shall be guaranteed for satisfactory performance and shall be warranted against faulty design, defective or improper materials. The Material and Workmanship Guarantees shall be extended for a period of eighteen months from the date of shipment or one year from the date the equipment is placed in service whichever occurs first.

PRODUCT

Manholes shall have the minimum inside dimensions shown on the Drawings. Manhole walls shall be of poured-in-place reinforced concrete or as shown in drawings. Top section must be cast such as to suit elevation and accommodate size of manhole frame and cover. Manhole floor shall be of reinforced concrete and inverts stream lined with cement and mortar into a semi-circular path with sanitary turns and have their corners filled and sloped towards the water path to prevent any settlements of solids as detailed on the Drawings.
Concrete foundation and benching for manholes shall be constructed in accordance with details as

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shown on the Drawings.
All pipes or castings to be embedded in the manhole walls shall be accurately set, and if so required, headers shall be laid round the casting so embedded. All work must be carried out in a manner to ensure watertight work, and any leaks shall be caulked, repaired, or the entire work shall be removed and rebuilt. Attention is particularly called to the necessity of keeping the water level below all parts of the foundation and walls until the concrete has obtained adequate setting.
The Contractor shall furnish and set level and to the proper grade, a cast iron frame and cover or frame and grating of the form and dimensions shown on the Drawings. The concrete shall be neatly and accurately brought to the dimensions of the base of the frame. The frames shall be thoroughly embedded in mortar. All covers and frames shall be heavy-duty quality.
The nominated sub Contractor shall supply and fix cast iron manhole covers and frames bitumen coated as follows:

Situation	**Grade of Cover (BS 497)**	**Specification**	**Clear Opening**
Road, car parks, public footpaths	A2	Double Triangular, Heavy Duty, D.I	600x600
Private footpaths	C	Single seat air tight solid top heavy duty	600x600
Inside building	C	Double seat double cover air tight recess top screw down tight duty	600x600

The invert channels shall be smooth and accurately shaped to a semicircular bottom conforming to the inside of the adjacent sewer section. Inverts shall be formed directly in the concrete of the manhole base. Steep slopes outside the invert channels shall be avoided. Changes in size and grade shall be made gradually and evenly. Changes in direction of the sewer and entering branches or branch shall have true curves of as large a radius as the size of the manholes will permit.

Manholes shall be provided with built-in steps of galvanized, wrought iron. The rungs shall be not less than 250mm in width and spaced approximately 300mm apart, and alternate rungs shall be staggered or offset 150mm. Bars or rods when used for steps shall not be less than 25mm diameter.
Manhole frames and covers shall be in accordance with the requirements shown on the drawings. The manhole frames and covers shall be so set that the top of the cover will be flush with the finished grade.
Concrete foundations for manholes shall be constructed of 1000 kg concrete, proportioned 1 cubic meter cement, 2 cubic meter sand, 3½ cubic meter stone, not less than 22 bags of cement per cubic metre of concrete in place and maximum water content of 90 litres/m³ (quantity includes water in aggregates). The manhole walls shall be constructed from 200mm thick concrete internally rendered on a 200 concrete base.
Heavy duty C.I. covers or grating as per requirement with frame shall be provided. The weight of the cover with frame shall not be less than 1 Cwt. The dimensions shall be as indicated on the drawings. If no dimension are provided in drawing and BOQ a minimum if 450mm x 450mm cover shall be installed.

EXECUTION

Install systems to the approval of the local Drainage Department

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7.4 PVC WATER STOPPER

Description

PVC Water Stopper is a flexible, extruded sealing element used in concrete structures to prevent the passage of water through construction and expansion joints. It is commonly used in water retaining structures such as dams, reservoirs, tunnels, basements, swimming pools, and sewage treatment plants. The water stopper provides a watertight seal and accommodates minor structural movements.

Material

- Material: High-grade Polyvinyl Chloride (PVC)
- Tensile Strength: Minimum 12 MPa (as per ASTM D412)
- Elongation at Break: Minimum 250% (as per ASTM D412)
- Hardness: Shore A 60–80 (as per ASTM D2240)
- Water Absorption: Less than 0.5% (as per ASTM D570)
- Chemical Resistance: Resistant to alkalis, acids, and most chemicals
- Operating Temperature Range: -10°C to 60°C

Job Conditions

- The installation area should be clean and free from debris, oils, and other contaminants.
- Temperature and humidity should be within the recommended range to ensure proper adhesion.
- The concrete pour should be planned to avoid excessive displacement of the water stopper.
- The water stopper should be stored in a cool, dry place away from direct sunlight.

Installation

- **Positioning:** Place the PVC water stopper in the center of the joint, ensuring equal embedment on both sides.
- **Fixing Method:** Secure the water stopper in place using metal clamps, wire ties, or factory-made eyelets attached to reinforcement bars.
- **Concrete Pouring:** Carefully pour concrete in layers to prevent displacement of the water stopper. Vibrate concrete adequately to ensure proper bonding around the stopper.
- **Junctions & Splicing:** Heat welding or factory-made junction pieces should be used for connecting multiple lengths to maintain continuity.
- **Inspection:** Ensure proper alignment and full embedment in concrete before proceeding with the next construction phase.

Adjusting and Fixing

- In case of displacement, carefully reposition the water stopper before the concrete sets.
- Ensure tight joints between two sections using heat welding for a continuous water barrier.
- Any damage to the water stopper should be repaired or replaced before final concrete placement.

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Technical Specifications

QUALITY ASSURANCE (QA) & QUALITY CONTROL (QC) TESTS FOR PVC WATER STOPPERS

To ensure that **PVC water stoppers** meet industry standards and perform effectively in waterproofing applications, various tests are conducted. These tests evaluate their **physical, mechanical, and chemical properties** for durability, flexibility, and resistance to environmental factors.

TESTS					
Physical Tests	**Mechanical Tests**	**Chemical Tests**	**Heat and Cold Resistance Tests**	**Bonding & Adhesion Tests**	**Electrical Test**
(a) Visual Inspection	a) Tensile Strength Test (ASTM D412)	a) Water Absorption Test (ASTM D570)	a) Heat Aging Test (ASTM D573)	a) Bond Strength Test (ASTM C836)	a) Electrical Resistance Test (ASTM D257
(b) Dimensional Accuracy Test	b) Elongation at Break Test (ASTM D412)	b) Chemical Resistance Test (ASTM D543)	b) Cold Flexibility Test (ASTM D746)	b) Joint Efficiency Test *(ASTM D3833)*	
	c) Hardness Test*(ASTM D2240)*	c) UV Resistance Test (ASTM G154)			
	d) Tear Resistance Test (ASTM D624)				
	c) Compression Set Test (ASTM D395				

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7.5 RCC PIPES

Description

Reinforced Cement Concrete (RCC) Pipes are used for underground drainage, sewage, stormwater management, culverts, and irrigation systems. These pipes are manufactured using a centrifugal or vibrated casting process to ensure high strength, durability, and water-tightness. They are designed to withstand heavy loads, external pressures, and varying environmental conditions.

Material

- **Cement:** Ordinary Portland Cement (OPC) conforming to IS 269 or equivalent.
- **Aggregates:** Crushed stone aggregates, free from organic impurities, meeting IS 383.
- **Reinforcement:** High-strength steel wire or bars as per IS 432 / IS 1786.
- **Water:** Clean, potable water, free from impurities.
- **Concrete Grade:** Minimum M40 for pressure pipes and M30 for non-pressure pipes as per IS 458.

Job Conditions

- The trench or foundation should be prepared as per design specifications before pipe laying.
- Proper dewatering should be done in case of high water table conditions.
- Pipes should be handled carefully to avoid damage during transportation and installation.
- RCC pipes should be stored on level ground with adequate support to prevent cracks or deformation.

Installation

a. Trench Preparation

- The trench should be excavated to the required depth and width, ensuring a firm and stable foundation.
- A bedding layer (sand, granular material, or concrete) should be provided as per the design.
- The trench bottom should be well-compacted and free from loose materials.

b. Pipe Laying

- Pipes should be placed in position using proper lifting equipment to avoid damage.
- The spigot end should be inserted into the socket end of the adjacent pipe.
- Proper alignment should be maintained during installation to ensure a smooth flow.

c. Jointing

- **Collar & Socket Joint:** Use cement mortar (1:2 ratio) or rubber rings for watertight sealing.
- **Reinforced Collar Joint:** Use a concrete collar and reinforcement cage to provide additional strength.
- **Flush Joint:** Suitable for non-pressure drainage pipes, sealed with mortar or bituminous material.

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d. Backfilling

- Initial backfill should be done with fine soil or sand up to a specified height to prevent direct load on pipes.
- Subsequent layers should be compacted in stages to avoid pipe displacement.
- Heavy machinery should not be used for compaction directly over the pipes until sufficient cover is achieved.

Adjusting and Fixing

- **Alignment Check:** Ensure pipes are in proper alignment before final joint sealing.
- **Leakage Test:** Conduct a hydraulic or air pressure test to check for leaks before backfilling.
- **Damaged Pipes:** Any pipe found with cracks or defects should be replaced immediately.
- **Final Inspection:** Ensure all joints are properly sealed and backfilled before allowing traffic or structural loads.

7.6 MILD STEEL (MS) PIPES

Description

Mild Steel (MS) pipes are widely used for water supply, sewage systems, fire-fighting networks, structural applications, and industrial pipelines. They are made from low-carbon steel, offering high strength, ductility, and ease of welding. MS pipes are available in seamless or welded forms, with protective coatings like galvanization or epoxy to prevent corrosion.

Material

- **Steel Grade:** Mild Steel (Low Carbon Steel) as per IS 1239 / IS 3589 / ASTM A53 / API 5L.
- **Carbon Content:** Typically less than 0.25%.
- **Tensile Strength:** Minimum 330 MPa (as per IS standards).
- **Yield Strength:** Minimum 210 MPa.
- **Coatings (if required):**
  - Galvanized (Hot-dip) for corrosion resistance.
  - Epoxy/Paint Coating for underground or marine applications.
  - Bituminous Coating for buried pipelines.

Job Conditions

- Ensure pipes are stored in a dry, covered area to prevent rusting before installation.
- Pipes should be transported carefully to avoid dents or damage.
- The trench or foundation should be prepared before installation for underground pipelines.
- Ensure proper alignment and support for above-ground installations.

Technical Specifications

Installation

a. Preparation & Handling

- Inspect pipes for any defects or damages before installation.
- Clean pipe ends to remove rust, dirt, and debris.
- Ensure correct pipe alignment before welding or jointing.

b. Jointing Methods

- **Welded Joints:** Preferred for permanent connections using arc or gas welding.
- **Flanged Joints:** Used for easy disassembly, secured with gaskets and bolts.
- **Threaded Joints:** Used for small-diameter pipes, sealed with Teflon tape or sealant.
- **Grooved Coupling:** Used for quick assembly and disassembly in fire-fighting or HVAC systems.

c. Pipe Laying

- For underground pipelines, ensure proper bedding (sand/cement cushion) to prevent damage.
- For above-ground installations, use proper supports and clamps to avoid sagging.
- Ensure slope and gradient as per design specifications for drainage or sewage systems.

d. Corrosion Protection (if applicable)

- Apply protective coatings (galvanized, epoxy, or bituminous) for pipes exposed to moisture or chemicals.
- Wrapping with protective tape for buried pipelines.

Adjusting and Fixing

- **Alignment Check:** Ensure pipes are correctly aligned before welding or fixing joints.
- **Leakage Testing:** Conduct hydrostatic or pneumatic pressure tests as per design requirements.
- **Support & Anchoring:** Install pipe supports, hangers, or clamps to prevent movement.
- **Repair & Replacement:** Replace damaged pipes or apply necessary repairs (e.g., welding patches for minor cracks).
- **Final Inspection:** Ensure proper joint sealing and alignment before commissioning the system.

7.7 PLUMBING FITTINGS

Description

Plumbing fittings are components used to connect, redirect, control, and regulate the flow of water, gas, and waste in a plumbing system. These fittings are available in various materials such as PVC, CPVC, PEX, brass, copper, stainless steel, and galvanized iron, depending on the application. They include elbows, tees, couplings, reducers, valves, and traps for use in residential, commercial, and industrial plumbing networks.

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Technical Specifications

Material

Plumbing fittings are manufactured from different materials based on the intended use and environmental conditions:

- **PVC (Polyvinyl Chloride):** Used for cold water supply and drainage, resistant to corrosion.
- **CPVC (Chlorinated Polyvinyl Chloride):** Suitable for both hot and cold water applications.
- **PEX (Cross-linked Polyethylene):** Flexible, used for water supply lines.
- **Brass:** Corrosion-resistant, used for potable water and gas supply.
- **Copper:** Durable, widely used for both hot and cold water supply.
- **Stainless Steel:** High strength and corrosion resistance, used in industrial applications.
- **Galvanized Iron (GI):** Used in older plumbing systems, but prone to corrosion over time.

Job Conditions

- Plumbing work should be performed under dry conditions to prevent contamination.
- Pipework should be free from debris, dust, and moisture before fitting installation.
- Ensure compatibility between the pipe and fitting materials to avoid corrosion or leakage.
- Proper tools should be used for cutting, threading, and jointing to avoid damage.
- Adequate space should be available for easy installation and maintenance access.

Installation

a. Preparation & Handling

- Inspect fittings for any defects or damage before installation.
- Clean pipe ends and fittings to remove dirt, oil, and rust.
- Cut pipes to the required length and deburr edges to ensure a smooth fit.

b. Jointing Methods

- **Threaded Joints:** Used for brass, GI, and stainless steel fittings with Teflon tape or sealant.
- **Solvent Cement Welding:** Used for PVC and CPVC fittings, requiring proper cleaning and glue application.
- **Compression Fittings:** Used for PEX and copper pipes, secured with compression rings.
- **Soldering/Brazing:** Used for copper fittings, requiring heat and solder for a leak-proof connection.
- **Push-Fit (SharkBite) Fittings:** Used for PEX, copper, and CPVC, providing quick installation.

c. Installation Process

- Ensure correct alignment and orientation of fittings before final connection.
- Use appropriate support clamps and brackets to prevent stress on the fittings.
- Do not overtighten fittings to prevent cracks or deformation.
- Allow adequate curing time for solvent-cemented joints before testing.

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Adjusting and Fixing

- **Leak Testing:** Conduct pressure tests to check for leaks before covering pipes with walls or flooring.
- **Alignment Check:** Ensure fittings are properly aligned to avoid undue stress on the plumbing system.
- **Support & Anchoring:** Secure fittings and pipes with appropriate clamps or hangers.
- **Repair & Replacement:** If leaks or damage occur, fittings should be adjusted, resealed, or replaced as necessary.
- **Final Inspection:** Ensure all fittings are properly installed and functioning before system commissioning.

7.8 CATCHPIT RCC GRATING

Description

Catchpit RCC (Reinforced Cement Concrete) Grating is a durable and high-strength drainage cover designed for stormwater drainage, sewer systems, and surface water management. It is used to prevent debris from entering drainage systems while allowing water to flow efficiently. These gratings are typically installed in roads, pedestrian areas, industrial zones, and parking lots to ensure proper drainage and prevent clogging.

Material

- **Concrete Grade:** Minimum **M30 or M40** as per ASTM C94/C94M.
- **Reinforcement:** High-strength steel reinforcement conforming to ASTM A615/A615M.
- **Cement:** OPC 43/53 grade conforming to ASTM C150.
- **Aggregates:** Well-graded crushed stone aggregates as per ASTM C33/C33M
- **Water:** Potable, clean water free from impurities.
- **Surface Finish:** Smooth finish with anti-slip texture for pedestrian safety.

Job Conditions

- The site should be prepared with proper leveling before installation.
- The catchpit should be free of debris, dirt, and stagnant water before placing the RCC grating.
- Ensure proper alignment of the grating with the catchpit opening for efficient drainage.
- Suitable lifting equipment should be used to handle heavy RCC gratings to prevent damage.

Installation

a. Preparation & Handling

- Inspect the grating for cracks or defects before installation.
- Clean the installation area and ensure the surface is level.
- Check the dimensions of the grating to match the catchpit opening.

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Technical Specifications

b. Placement & Fixing

- **Positioning:** Carefully place the RCC grating over the catchpit opening, ensuring a firm and even fit.
- **Seating Bed:** A cement mortar (1:3 mix) or precast concrete seating should be used to hold the grating in place.
- **Alignment:** Adjust the grating to align with the drainage flow direction.
- **Load Distribution:** Ensure even contact with the support structure to prevent cracking under load.

c. Anchoring (If Required)

- If additional securing is needed, RCC gratings can be fixed with anchor bolts or embedded in concrete frames.
- For heavy-duty traffic areas, reinforced edging should be provided to prevent movement.

Adjusting and Fixing

- **Level Check:** Ensure the grating is flush with surrounding surfaces to prevent tripping hazards.
- **Load Testing:** Check the load-bearing capacity, especially in vehicular traffic areas.
- **Cleaning & Maintenance:** Ensure easy removal for periodic cleaning and maintenance of the drainage system.
- **Replacement:** If any grating is damaged, it should be replaced immediately to maintain drainage efficiency.

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8 MATERIAL TESTING

8.1 GENERAL

Notwithstanding the requirements stated in the detailed specifications for individual items, the following minimum tests shall be performed in the laboratories (NED University Laboratory or Karachi Shipyard & Engineering Works Laboratory) or as directed by the Engineer.
Contractor's Materials Engineer will be responsible for liaison and coordination with the Site laboratory, the Engineer, field sampling/testing staff and off-Site laboratories to ensure that all sampling, specified tests and inspections are carried out in a timely manner.
No inspection or approval by the Engineer shall relieve the Contractor of any of his duties and obligations under the Contract.
All test types and quantities described in the following Sub-sections are considered "Normal Testing" and anything beyond that in type and quantity is considered as "Special Testing". The Engineer may increase the frequency of testing as per requirement.

8.2 TESTS

8.2.1 BRICKS

For each consignment not exceeding 100,000 bricks, minimum 6 (six) bricks shall be tested to ascertain:

i. Dimensions and unit weight
ii. Compressive strength
iii. Water absorption
iv. Efflorescence

8.2.2 COARSE AGGREGATE

The tests mentioned below shall be carried out for each day's casting or per 15 cubic meter of concrete whichever provides the greater number of tests.

i. Gradation
ii. Unit weight
iii. Water absorption
iv. Specific gravity
v. Abrasion loss/Crushing loss

8.2.3 FINE AGGREGATE

The tests mentioned below shall be carried out for each day's casting or per 15 cubic meter of concrete whichever provides the greater number of tests.
Gradation

i. Fineness Modulus (F.M.).
ii. Specific Gravity
iii. Water absorption
iv. Surface moisture

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8.2.4 CEMENT

For each consignment of a particular brand not exceeding 25 tons, at least 3 (three) samples collected random shall be tested prior to the cement be incorporated in to the works to ascertain:

i. Consistency
ii. Setting time
iii. Compressive strength
iv. Fineness

8.2.5 REINFORCEMENT

For each consignment not exceeding 10 (ten) tons or as directed, 3 (three) representative samples of each size of M.S. bar shall be tested for:

i. Cross sectional area
ii. Unit weight
iii. Measurement of deformation
iv. Yield strength
v. Tensile strength
vi. Elongation
vii. Bending

Only Test Certificates issued by NED University Laboratory or Karachi Shipyard & Engineering Works Laboratory shall be accepted by the Engineer.

8.2.6 TEST FOR WATER

Water will be tested to ensure that it remains free of oil, salt, acid, alkali, sugar, vegetable or other injurious substances

8.2.7 WORKABILITY TEST FOR CONCRETE

The Slump Test shall be carried out as frequently as required by the Engineer and not less than one per hour during placing of concrete

8.2.8 STRENGTH TEST FOR CONCRETE

The compressive strength of the concrete shall be determined by Cylinder Test. The Cylinder molds shall be 150mm in diameter and 300mm long. Each class of concrete shall be represented by at least six Cylinders. Not less than one group of six test Cylinders shall be made for each 30 cubic meter of structural concrete, but there shall be at least one group of six test Cylinders for each day's concrete work. For columns and girders, one set of test Cylinders would be made from each batch of concrete not exceeding one cubic meter. Samples from which compression test specimen are molded, shall be obtained in accordance with the Method of Sampling Fresh Concrete (ASTM C 172). The concrete samples would be collected from a point just before final placement or as directed by the Engineer. Cylinders may be collected from any batch (load) including the first. Specimens made to check the adequacy of the proportions for strength of concrete or as a basis for acceptance of concrete shall be made and cured in accordance with methods and curing, concrete compression and flexure test specimens in the field (ASTM C 31 or equal). Strength tests shall be made in accordance with the method of test for compressive strength of molded concrete cylinders (ASTM C 39 or equal).
Six Cylinders would form a set of sample for strength determination. Three Cylinders shall be tested at seven days and three cylinders shall be tested at twenty-eight days. Every twenty-eight days Cylinders

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shall attain the minimum specified compressive strength. The Contractor shall perform trial mix of his own to determine the characteristic strength or mean strength that has to be attained.
The twenty-eight days' strength tests shall be used as a basis for acceptance of the concrete. Seven days' tests are made to obtain advance information on the adequacy of strength development. Age- strength relationships shall be pre-established for the materials and proportion used.

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9 QUALITY ASSURANCE

A. Quality System: Comply with ISO 9001/9002 Quality System as a minimum. Incorporate all the standard procedures supplied by the Engineer and the Employer.

DELIVERY, STORAGE AND HANDLING

Keep materials under cover and dry. Protect from weather and contact with damp or wet surfaces. Stack lumber, plywood, and other panels. Provide for air circulation within and around stacks and under temporary coverings.

PRODUCTS TIMBER

- Timber shall be well seasoned and free from decay, insect attack except pinhole borers, and knots wider than half of the width of the section.
- Timber shall be kiln dried to a maximum moisture content of 12% by weight.
- Timber required to be treated with preservatives or fire retardant shall be seasoned and kiln dried before treatment, and re-dried after treatment.
- Softwood shall be free from decay and insect attack, except pinhole borers, with no knots wider than half the width of the section. Softwood shall comply with BS EN 942 softwood spices to be used in external locations are to be recommended for the purpose.
- Hardwood shall comply with BS EN 942. Hard wood to be used in internal locations are to be recommended for the purpose.

Wood used for exterior applications or for interior applications in wet areas shall be factory treated to prevent moisture absorption.

SOFTWOOD

- To be either:
- Douglas Fir (Standard Grade)
- European Redwood
- Or as suggested by the Architect.

HARDWOOD

- Teakwood
- White American Oakwood
- Or as suggested by the Architect.

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10 OFFICE SPACE AND FACILITIES FOR ENGINEER

10.1 FIELD OFFICE (Not Applicable)

In addition to the office space required for his own use, the Contractor shall provide and maintain Field Office with toilet facilities, furniture and office equipment for the use of the Engineer and his staff.
Field Office for the Engineer shall mean a building having a minimum 150 square feet net clear internal floor area exclusive of walls and partitions, staircase and toilet and have number of rooms as required by the Engineer. It shall be constructed in 250mm thick brick wall in appropriate cement mortar with C.I. sheet roofing and a protective ceiling made of hard board and timber to the satisfaction of the Engineer. The floor shall be 75mm thick lean concrete with 30mm thick mortar on the top with a neat cement finish to give a smooth look. The foundation of this building shall be sound to the satisfaction of the Engineer. The building shall have required number of doors and windows. Uninterrupted power supply facility, if necessary, shall be made available by means of arranging a stand-by generator.
Access road to the Field Office, sufficient parking accommodation and hard standing sheds for vehicles along with boundary fencing shall be constructed by the Contractor.
The Contractor shall provide, for each office, one office table and four chairs of standard, approved by the Engineer. Safety helmets in adequate numbers be always made available for use of the staff and the visitors.
Offices shall be maintained watertight and shall be provided with ventilation. All doors shall be fitted with approved locks. Windows shall be provided with separate screens and blinds and shall have interior locking devices too.
All offices, complete with furnishings, fittings, access roads and hard standings, shall be ready, for occupation by the Engineer within four weeks of the date when the Contractor first occupies the Site.
All offices shall be regularly and properly cleaned as long as they are in use.
All access roads and hard standings shall be maintained in a convenient trafficable condition throughout the Contract period.
The general location of the Field Office shall be decided by the Engineer in consideration of the Contractor's Work Plans. The Field Office shall be situated at locations that shall be free from flooding.
The Contractor shall submit for the approval of the Engineer, along with the Tender, Plans and Drawings showing the details for the building including plans and designs for foundations, access roads, sheds, etc. Plans shall also be submitted showing architectural and structural details and the proposed layout of electrical and running water supply, roads and hard standings thereto. The Engineer may require revision of the said plan prior to the approval for construction.
Prior to the occupation of the office, the Engineer may specify to the Contractor the defects in the work whereupon he may occupy the office and withhold payment for the work in this item until the Contractor remedies and makes good the said defects to the satisfaction of the Engineer.
On completion of the Contract the Field Office including furnishings shall become the property of the Employer.

10.2 OFFICE EQUIPMENT AND STATIONARY ARTICLE

The Contractor shall require to purchase and supply the following Office equipment and consumables to the Engineer:

i. One Laptop core I3 sixth Generation of approved brand with printer, internet facilities.

ii. One Mobile Phones with monthly billing limit upto 5,000 PKR/phone.

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iii. Minor items of field office equipment such as file trays, punches, staplers etc. in reasonable number/quantities as requested by the Engineer.

iv. Consumables such as papers, pens, files etc. in reasonable number/quantities as requested from time to time by the Engineer.

10.3 VEHICLE FACILITY (Not Applicable)

The Contractor shall provide 1 new Suzuki Swift DLX Automatic with fuel limit of 20,000 PKR/month or similar with comprehensive insurance and driver for the duration of the contract. They shall be available for the full time use of the Consultant's Representative and his staff. The contractor shall maintain, repair and service the vehicles regularly and provide immediately, at his own expense, an equivalent or better replacement when a vehicle becomes unusable for any reason.

10.4 SURVEY EQUIPMENT

As per requirement of the program, survey equipment shall be provided on each contract Site for use by the staff of the Contractor and the Engineer. A tentative list of such survey equipment is given below:

Optical Square	1 no.
Spirit level (metal 1m long)	1 no.
Steel measuring tape 25m long	1 no.
Steel measuring tape 5m long	1 no.
Levelling staff 3m long	1 no.
Ranging Poles	5 nos.
Surveyor's plumb bob	1 no.
Wild T-1A Theodolite with tripod (or equivalent)	1 no.
Wild NA-2A Automatic Level with tripod (or equivalent)	1 no.
Total Station with Tripod	1no.
Traversing targets with tripods	1 no.
Magnetic Compass	1 no.

Miscellaneous tools and minor items of survey equipment such as umbrellas, hammers, knives etc. shall be made available at Site in reasonable numbers at all times for use by the staff of the Contractor and the Engineer.

Consumables such as pegs, stakes, string lines, paint, marking crayons, etc., shall be made available at Site in reasonable numbers and quantities at all times for use by the staff of the Contractor and the Engineer.

Upon completion of the Contract, the survey equipment listed above shall remain the property of the Contractor

10.5 OFFICES AND EQUIPMENT

The Contractor shall provide and maintain an inventory of all furnishings and equipment and shall replace any equipment, which is lost or irreparably damaged subject to the condition that the Engineer shall ensure his staff to take all reasonable precautions in the handling, operation and transportation of such equipment.

The Contractor shall pay all expenses in respect of water, electricity (where available), garbage cleaning etc. necessary for running the Office and maintaining conducive environment.

The Contractor shall place all necessary support staff such as office boys, cleaners, messengers, road-men, chain-men etc. in required number to the Engineer and his personnel in smooth performing of his responsibilities.

10.6 SIGNBOARDS

The Contractor shall supply, erect and maintain in good condition at least two Identification Signboards of sizes to be specified by the Engineer to be fixed one at each end of the Work at a place clearly visible

to the public. The Signboards shall be mounted on steel pipe frames with the required sizes at a height 2m above the ground and shall be sufficiently strong to withstand the wind forces. The board shall be fabricated from steel angle and plates and painted with suitable colors and written in English as per direction of the Engineer.

Each board shall display:

i. The name of the Project
ii. The name of the Work
iii. The name of the Employer
iv. The name of the Consultant
v. Contract value
vi. Date of commencement of work
vii. Date of completion of work
viii. Other particulars, which will be asked by the Engineer.

10.7 PROGRESS IN PHOTOGRAPHS AND VIDEOS

Photographs and videos showing the progress of works and special photographs showing particular features or other matters of interest in connection with the Work or their surroundings shall be taken every month by an approved qualified photographer/cameraman to the choice of the Engineer. Number of photographs/video clips will not exceed 10 (ten) per month.

Four color un-mounted prints of a size 250mm on approved photographic paper of every such photograph inscribed with its serial number, date of shooting and a short title shall be furnished to the Engineer every month.

All negatives and video clips shall be numbered, filed and retained at the Site. On completion of the Contract, those shall become the properties of the Employer and shall be handed over to the Employer by the Contractor.

6 (six) complete sets of color prints of the finished permanent Work, not exceeding 20 (twenty) photographs in number, shall be taken when and as directed by the Engineer prior to finally granting the Contractor the Certificate of Completion and shall be suitably mounted, titled and supplied to the Engineer.

10.8 MEASUREMENT AND PAYMENT

Provisions for Office space and facilities for the Engineer shall not be measured.

Payment for all the items as stated below shall be for the full period of the Contract including any extension, if allowed. At the end of contract period all items listed will be Client's Property.

Payment for all equipment, signboards, photographs, video clips, services etc. of the Field Office detailed in this Sub-section shall be made as described below, where price and payment shall be the full compensation for complying with this Section of the Specification and the Conditions of the Contract.

Payment of rates for the pay items shall be the full compensation for supplying, erecting and maintaining the Field Office for the Engineer including all furniture, fixtures and fittings, access roads, office equipment, signboards, photographs, video clips etc. all in full compliance with the requirements of this Section.

No separate payment shall be made to the Contractor for providing the requisite tools, minor items and the consumables. Compensation for these items shall be deemed to be included in the other pay items of the BOQ.

Item of Payment	Unit
Supply , erection and maintenance of Signboards	Lump sum
Providing, erection and maintenance of office	

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for the Engineer including all office equipment and consumables	Lump sum
Providing Vehicles	Lump Sum
Providing photographs	Lump sum

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11 SITE PREPARATION

11.1 SITE PREPARATION

11.1.1 DESCRIPTION

This item of work shall consist of clearing the Site, undertaking general type of earthworks, setting out, etc. as shown on the Drawings, stated in the BOQ and/or as instructed by the Engineer.

11.1.2 COMMENCEMENT

The Contractor shall give the Engineer at least 7 (seven) days written notice of his intention to commence work on any part of the Site. Works shall not be commenced until written approval has been received by the Contractor from the Engineer.

11.1.3 DRAWINGS

The works are to be carried out in accordance with the Drawings and as directed by the Engineer. It may become necessary or desirable, during the progress of the Work, to change any feature shown on the Drawings in accordance with the actual field conditions. Whenever this may occur, the Contractor shall perform the required works to the revised dimensions in accordance with the written instructions of the Engineer.

11.1.4 SETTING OUT

Prior to the commencement of the Work, the Contractor shall study the Drawings and fully understand all aspects of the Work and co-relate the same with the dimensions shown on the Structural Drawings and shall fix up the alignment, set the Bench Mark (B.M) pillars, levels, pegs etc.
The Contractor shall check all the vital measurements of the layout plan of the building and submit a report to the Engineer the deviation, if required any from the dimensions shown in the approved Drawings for the building before starting construction works. In case of any deviation of unacceptable amount, the Engineer will inform the Contractor of the remedial measures, which may be necessary under a particular situation.
Cutting or filling charts, prepared by the Engineer, will be given to the Contractor to sign as a token of his agreement

11.1.5 EARTHWORKS, GENERAL

Earthwork shall be undertaken to the lines and levels shown on the Drawings unless directed otherwise by the Engineer. In carrying out the earthworks, the Contractor shall take all necessary precautions to avoid damage to or deterioration of the earthwork materials and existing ground

11.1.6 CLEARING OF SITE

The Site shall be cleared as required to remove all stumps, roots, vegetable and other objectionable materials specifically within the areas for construction of structure, appurtenance and any other facilities indicated on the Drawings or designated by the Engineer. The cleared materials shall be deposited on the approved off-Site areas or burnt as directed by the Engineer.

11.1.7 MEASUREMENT

The works on Site preparation shall not be measured.

11.1.8 PAYMENT

No direct payment shall be made for works required under this Section. Costs for such works shall be deemed included in the related items of the BOQ.

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12 LIST OF APPROVED MANUFACTURER

CIVIL WORKS

S.NO	ITEM DESCRIPTION	APPROVED MANUFACTURER
1	Water Dispenser	a) Dawlance b) Homage
2	RCC PIPES	a) Banu Mukhtar
4	UPVC Windows & Door System	a) Excel Profile b) Alfapen c) RKITECT UPVC
7	Floor Mounted/ Wall Cabinet	a) AH Enterprises b) Dimension Office c) Wood art

ELECTRICAL WORKS

1.	Distribution Board and Load Break Switch	a) Hussain & Co b) Ra Engineering c) Or Approved Equivalent
2.	Molded Case Circuit Breakers. (M.C.C.B.)/ Miniature Circuit Breakers. (M.C.B.)	a) Schneider Electric b) Siemens c) Ge d) Abb e) Terasaki f) Or Approved Equivalent
3.	Voltmeter. / Ammeter.	a) Revalco b) Saci c) Or Approved Equivalent
4.	C.T.(Current Transformer)	a) Revalco b) Fico c) Circutor d) Or Approved Equivalent

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5.	Auto-Off-Manual Selector Switchs. / A.S.S. / V.S.S.	a) Breter b) Kraus & Naimer c) Bremas d) Or Approved Equivalent
6.	Indication Lights. / ON. / OFF. Push Buttons.	a) Schneider Electric b) Maruyasu c) Lovato d) Or Approved Equivalent
7.	Light Fixture	a) Philips b) Eae c) Pierlite d) Or Approved Equivalent
8.	Single and Multicore LT cables.	a) Pakistan Cables b) Newage Cables c) Fast Cables d) Or Approved Equivalent
9.	PVC Conduits & Accessories. / uPVC Pipes & accessories.	a) Dadex b) Jeddah Polymer c) Civic d) Or Approved Equivalent
10.	Earthing.	a) Furse b) Erico c) Or Approved Equivalent
11.	Wiring Accessories.	a) Clipsal b) Mk c) Or Approved Equivalent
12.	Back Box.	a) Hussain & Co b) Ezzi Engineering c) Or Approved Equivalent
13.	Fire resistant cable	a) Prysmian b) Cavicel / Firecell c) Or Approved Equivalent

PLUMBING WORKS

1. Subject to compliance with requirements, provide products by one of the following manufacturers.
2. This list supersedes any Brand name which may appear in the specification section.

Description	**Approved Manufacturer**
Motor Control Centre (MCC)	• Sunbeam • Libra • Siemens

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	• Taj Engineering
Molded Case Circuit Breakers (MCCB's)	• Terasaki • Legrand • ABB • General Electric
Miniature Circuit Breakers (MCB's)	• Terasaki Hage • Legrand • ABB • General Electric
Meters and CT's	• Revalco, Italy.
Magnetic Contractor	• ABB • National Green Power Japan
Wires, cables, conduits and cable tray	
Lt cable and wires	• Pakistan Cable (Pakistan) • Newage Cables
Steel conduit	• Hilal (Pakistan) • Premier (Pakistan)
PVC conduit	• Galco • Beta • Dadex • Civic
Expansion fittings & loops for plumbing piping	• Metraflex
Gauges and meters for plumbing systems	• Trerice • Ashcroft • Mueller

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	• Weiss • Weskler manufacture.
Valves	• Hattersley • Crane • Owentrop • Schon • Econosto
Hangers and supports	
Vibration and Seismic Controls for Plumbing Piping and Equipment	• COOPER B-Line or approved equal.
Painting and identification works	• Jotun, Nippon paints
Facility sewage drain manholes	• Envicrete
Facility Storm Drainage Manholes and Catch Basin	• Envicrete
Through-penetration firestopping for MEP systems	• Hilti • 3M • Nullifire
Plumbing equipment insulation	• George Fischer • Terrain • Hepworth • Dadex • Marley Or approved quality
Plumbing piping insulation	• George Fischer

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	• Terrain • Hepworth • Dadex • Marley Or approved quality
Level sensors	• Danfoss • Honey well • National (Japan) or approved equivalent.
Automatic air vents	• George Fischer • Terrain • Hepworth • Dadex • Marley • Or approved quality
Facility water distribution piping and fitting (UPVC class E)	• George Fischer • Terrain • Hepworth • Dadex • Marley • Or approved quality
Transfer pump piping and fittings (G.I)	• ILL or approved equivalent.
Domestic water piping and fittings for cold water and hot water (PPR)	• Polydex Dadex • Firat • Retti • Pilsa • Vesbo
	• ITT Lowara, Italy

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Water booster unit	• Bell & Gossett, USA • Ebara, Japan • Grundfoss • Aurrora, USA • KSB, Germany • Willo, Germany
Domestic water inline pump-motor	• ITT Lowara, Italy • Bell & Gossett • Ebara, Japan • Grundfoss • Aurrora • KSB • Willo
Domestic water transfer end suction pump-motor	• ITT Lowara, Italy • Bell & Gossett • Ebara, Japan • Grundfoss • Aurrora • KSB • Willo
Facility external sanitary sewage piping and fittings (UPVC class D)	• George Fischer • Terrain • Hepworth • Dadex • Marley • Or approved quality
	• George Fischer

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Soil, waste and vent piping inside building (UPVC Class B)	• Terrain • Hepworth • Dadex • Marley • Or approved quality
Cleanouts	• Local equivalent to Jay Smith
Floor drains	• Local equivalent to Josam
Grease trap	Master Sanitary pipes & fittings
Gully traps	Master Sanitary pipes & fittings
Sump pump discharge piping and fittings (UPVC class D)	• George Fischer • Terrain • Hepworth • Dadex • Marley or approved quality
Sump pit for sanitary sewage system	Master Sanitary pipes & fittings
Sanitary sewage pumps	• ITT Lowara, Italy • Bell & Gossett • Ebara, Japan • Grundfoss • Aurrora • KSB • Willo
Facility external storm drainage piping UPVC class D	• George Fischer • Terrain • Hepworth

	• Dadex • Marley or approved quality
Facility external storm drainage piping RC	• Razia or approved quality
Rain water leaders and piping UPVC class B piping	• George Fischer • Terrain • Hepworth • Dadex • Marley • Or approved quality
Sump pump discharge piping UPVC class D	• George Fischer • Terrain • Hepworth • Dadex • Marley • Or approved quality
Roof drains	• Local equivalent to Josam
Facility area drains	• Local equivalent to Josam
Facility trench drain	• Frost • Freedrain • ACO • Ancon • Cresent • Eccles • Josam
	• ITT Lowara, Italy • Bell & Gossett

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Technical Specifications

Sump pump	• Ebara, Japan • Grundfoss • Aurrora • KSB • Willo
Sump pit with sand trap for storm drainage	
Natural gas piping	• PE pipe shall be of Dadex or approved equal
Hot water Geyser	• SINGER or approved quality
Plumbing fixtures	• Rak Ceramics • Toto • Ideal Standards • Twyford • Doulton • Ceramag • Kohler • American Standard • Valery and Boch
PVC water stopper	• Aqua Tech