



**GOVERNMENT OF SINDH
SINDH MASS TRANSIT AUTHORITY
TRANSPORT & MASS TRANSIT DEPARTMENT**



**Sindh
Mass Transit
Authority**

MAINTENANCE OF BRTS GREEN AND ORANGE LINES

**“MISCELLANEOUS REPAIR/REPLACEMENT/MAINTENANCE
WORKS OF ROAD, BUILDINGS, ELECTRICAL, HVAC AND MEP
WORKS AT BRT GREEN & ORANGE LINE CORRIDORS”**

BID DOCUMENTS VOLUME- I

TECHNICAL BID (SINGLE STAGE TWO ENVELOPE)

September 2026

INVITATION FOR BIDS

NOTICE INVITING TENDERS

Refer Notice published in News papers

INSTRUCTIONS TO BIDDERS

INSTRUCTIONS TO BIDDERS

A. GENERAL

IB.1 Scope of Bid

- 1.1 Procuring agency as defined in the bidding data hereinafter called “the procuring agency” wishes to receive bids for the construction and completion of works as described in these bidding documents, and summarized in the bidding data hereinafter referred to as the “Works”.
- 1.2 The successful bidder will be expected to complete the works within the time specified in Appendix-A to Bid.

IB.2 Source of Funds

- 2.1 Procuring agency has received/allocated/ applied for loan/grant/Federal/ Provincial/Local Government funds from the source(s) indicated in the bidding data in various currencies towards the cost of the project /scheme specified in the bidding data, and it is intended that part of the proceeds of this loan/grant/funds will be applied to eligible payments under the contract for which these bidding documents are issued.

IB.3 Eligible Bidders

- 3.1 This Invitation for Bids is open to all interested bidders who are eligible under provisions of Sindh Public Procurement Rules as mentioned below and the criteria given in the Notice Inviting Tender (NIT)/ Bidding Document.

Firms and individuals, national or international, may be allowed to bid for any project where international competitive bidding is feasible. Any conditions for participation shall be limited to those that are essential to ensure the bidder's capability to fulfill the contract in question.

- (a) Bidders may be excluded if;
 - (i) as a matter of law or official regulations, commercial relations are prohibited with the bidder's country by the federal government in case of ICB, or
 - (ii) a firm is blacklisted/ debarred by the procuring agency and the matter has been reported to the Authority, subject to Rule 30 of Sindh Public Procurement Rules 2010.
- (b) Government-owned enterprises or institutions may participate only if they can establish that they are;
 - (i) legally and financially autonomous, and
 - (ii) operate under commercial law.

Provided that where government-owned universities or research centers in the country are of a unique and exceptional nature, and their participation is critical to project implementation, they may be allowed to participate; and

Bidders shall include all those contractors who are registered or incorporated in Pakistan, irrespective of the nationality of their owners and professional staff, or

(c) Bidders are: -

- (i) pre-qualified with procuring agency for particular project/scheme;
- (ii) registered with Pakistan Engineering Council in particular category and discipline,
- (iii) registered with relevant tax authorities (income/sales tax, wherever applicable)

IB.4 One Bid per Bidder

4.1 Each bidder shall submit only one bid either by himself, or as a partner in a joint venture. A bidder who submits or participates in more than one bid (other than alternatives pursuant to Clause IB.16) will be disqualified.

IB.5 Cost of Bidding

5.1 The bidders shall bear all costs associated with the preparation and submission of their respective bids, and the procuring agency will in no case be responsible or liable for those costs, regardless of the conduct or outcome of the bidding process.

IB.6 Site Visit

- 6.1 The bidders are advised to visit and examine the site of works and its surroundings and obtain all information that may be necessary for preparing the bid and entering into a contract for construction of the works. All cost in this respect shall be at the bidder's own expense.
- 6.2 The bidders and any of their personnel or agents will be granted permission by the procuring agency to enter upon his premises and lands for the purpose of such inspection, but only upon the express condition that the bidders, their personnel and agents, will release and indemnify the procuring agency, his personnel and agents from and against all liability in respect thereof and will be responsible for death or personal injury, loss of or damage to property and any other loss, damage, costs and expenses incurred as a result of such inspection.

B. BIDDING DOCUMENTS

IB.7 Contents of Bidding Documents (SPP RULE 21)

- 7.1 The bidding documents, in addition to invitation for bids, are those stated below and should be read in conjunction with any addenda issued in accordance with Clause IB.9.
 - a. Instructions to Bidders.
 - b. Bidding Data.
 - c. General Conditions of Contract, Part-I (GCC).
 - d. Special Conditions of Contract, Part-II (SCC)
 - e. Specifications.
 - f. Form of Bid and Appendices to Bid.
 - g. Bill of Quantities (Appendix-D to Bid).
 - h. Form of Bid Security.
 - i. Form of Contract Agreement.

- j. Forms of Performance Security, Mobilization Advance Guarantee, Integrity Pact and Indenture bond for secured advance.
 - k. Drawings.
- 7.2 The bidders are expected to examine carefully the contents of all the above documents. Failure to comply with the requirements of bid submission will be at the bidder's own risk. Pursuant to Clause IB.26, bids which are not substantially responsive to the requirements of the BD will be rejected.

IB.8 Clarification of Bidding Documents (SPP RULE 23(1)):

Any interested bidder requiring any clarification(s) in respect of the bidding documents may notify the procuring agency in writing at the procuring agency's address indicated in the Invitation for Bids/NIT. Procuring agency will respond to any request for clarification provided they are received at least five calendar days prior to the date of opening of bid.

Provided that any clarification in response to query by any bidder; shall be communicated to all parties who have obtained bidding documents.

IB.9 Addendum/Modification of Bidding Documents:

- 9.1 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.
- 9.2 Any addendum thus issued shall be part of the bidding documents pursuant to sub-clause IB 7.1 hereof and shall be communicated in writing to all bidders. Interested bidders shall acknowledge receipt of each addendum in writing to the procuring agency.
- 9.3 To afford bidders reasonable time in which to take an addendum into account in preparing their bids, the procuring agency may extend the deadline for submission of bids in accordance with IB.20

C. PREPARATION OF BIDS

IB.10 Language of Bid

- 10.1 The bid and all correspondence and documents related to the bid exchanged by a bidder and the procuring agency shall be in the language stipulated in the bidding data and Special Conditions of the Contract. Supporting documents and printed literature furnished by the bidders may be in any other language provided the same are accompanied by an accurate translation of the relevant parts in the bid language, in which case, for purposes of evaluation of the bid, the translation in bid language shall prevail.

IB.11 Documents Accompanying the Bid

- 11.1 Each bidder shall:
 - (a) submit a written authorization on the letterhead of the bidding firm, authorizing the signatory of the bid to act for and on behalf of the bidder;

- (b) update the information indicated and listed in the bidding data and previously submitted with the application for prequalification, and continue to meet the minimum criteria set out in the prequalification documents, which as a minimum, would include the following:
 - (i) Evidence of access to financial resources along with average annual construction turnover;
 - (ii) Financial predictions for the current year and the following two years, including the effect of known commitments;
 - (iii) Work commitments since prequalification;
 - (iv) Current litigation information; and
 - (v) Availability of critical equipment.

And

- (c) furnish a technical proposal taking into account the various Appendices to Bid specially the following:

Appendix-E to Bid Proposed Construction Schedule

Appendix-F to Bid Method of Performing the Work

Appendix-G to Bid List of Major Equipment

Appendix-K to Bid Organization Chart for Supervisory Staff

and other pertinent information such as mobilization programme etc;

11.2 Bids submitted by a joint venture of two (2) or more firms shall comply with the following requirements:

- (a) one of the joint venture partners shall be nominated as being in charge; and this authorization shall be evidenced by submitting a power of attorney signed by legally authorized signatories of all the joint venture partners;
- (b) the bid, and in case of a successful bid, the Form of Contract Agreement shall be signed by the authorized partner so as to be legally binding on all partners;
- (c) the partner-in-charge shall always be duly authorized to deal with the procuring agency regarding all matters related with and/or incidental to the execution of works as per the terms and Conditions of Contract and in this regard to incur any and all liabilities, receive instructions, give binding undertakings and receive payments on behalf of the joint venture;
- (d) all partners of the joint venture shall at all times and under all circumstances be liable jointly and severally for the execution of the contract in accordance with the contract terms and a statement to this effect shall be included in the authorization mentioned under Sub-Para (a) above as well as in the Form of Bid and in the Form of Contract Agreement (in case of a successful bid);
- (e) a copy of the agreement entered into by the joint venture partners shall be submitted with the bid stating the conditions under which it will function, its period of duration, the persons authorized to represent and obligate it

and which persons will be directly responsible for due performance of the contract and can give valid receipts on behalf of the joint venture, the proportionate participation of the several firms forming the joint venture, and any other information necessary to permit a full appraisal of its functioning. No amendments / modifications whatsoever in the joint venture agreement shall be agreed to between the joint venture partners without prior written consent of the procuring agency;

- (f) submission of an alternative Letter of Intent to execute a Joint Venture Agreement shall be mandatory.

- 11.3 Bidders shall also submit proposals of work methods and schedule, in sufficient detail to demonstrate the adequacy of the bidders' proposals to meet the technical specifications and the completion time referred to sub-clause IB 1.2 hereof.

IB.12 Bid Prices

- 12.1 Unless stated otherwise in the bidding documents, the contract shall be for the whole of the works as described in IB 1.1 hereof, based on the unit rates or prices submitted by the bidder or percentage quoted above or below on the rates of Composite Schedule of Rates (CSR), as the case may be.
- 12.2 The bidders shall fill in rates and prices for all items of the works described in the Bill of Quantities. Items against which no rate or price is entered by a bidder will not be paid for by the procuring agency when executed and shall be deemed to be covered by rates and prices for other items in the Bill of Quantities. In case of Composite Schedule of Rates, if the bidder fails to mention the percentage above or below, it shall be deemed to be at par with the rates of Composite Schedule of Rates.
- 12.3 The bid price submitted by the contractor shall include all rates and prices including the taxes. All duties, taxes and other levies payable by the contractor under the contract, or for any other cause during the currency of the execution of the work or otherwise specified in the contract as on the date seven days prior to the deadline for submission of bids.

Additional / reduced duties, taxes and levies due to subsequent additions or changes in legislation shall be reimbursed / deducted as per Sub-Clause 13.7 of the General Conditions of Contract Part-I.

- 12.4 The rates and prices quoted by the bidders are subject to adjustment during the performance of the contract in accordance with the provisions of Clause 13.7 of GCC. The bidders shall furnish the prescribed information for the price adjustment formulae in Appendix-C to Bid, and shall submit with their bids such other supporting information as required under the said Clause. Adjustment in prices quoted by bidders shall be allowed as per Sub-Para 4(ii) of Section C of Instructions to bidders and bidding data.

IB.13 Currencies of Bid and Payment

- 13.1 The unit rates and the prices shall be quoted by the bidder entirely in Pak rupees. A bidder expecting to incur expenditures in other currencies for inputs to the works supplied from outside the procuring agency's country (referred to as the

“Foreign Currency Requirements”) shall indicate the same in Appendix-B to Bid. The proportion of the bid price (excluding Provisional Sums) needed by him for the payment of such Foreign Currency Requirements either (i) entirely in the currency of the bidder’s home country or, (ii) at the bidder’s option, entirely in Pak rupees provided always that a bidder expecting to incur expenditures in a currency or currencies other than those stated in (i) and (ii) above for a portion of the foreign currency requirements, and wishing to be paid accordingly, shall indicate the respective portions in the bid.

- 13.2 The rates of exchange to be used by the bidder for currency conversion shall be the selling rates published and authorized by the State Bank of Pakistan prevailing on the date, 07 (seven) days prior to the deadline for submission of bids. For the purpose of payments, the exchange rates used in bid preparation shall apply for the duration of the contract.

IB.14 Bid Validity

- 14.1 Bids shall remain valid for the period stipulated in the bidding data from the date of opening of bid specified in clause IB.23.
- 14.2 In exceptional circumstances, prior to expiry of the original, the procuring agency may request the bidders to extend the period of validity for a specified additional period, which shall not be for more than one third of the original period of bid validity. The request and the responses thereto, shall be made in writing. A bidder may refuse the request without the forfeiture of the bid security. In case, a bidder agreed to the request, shall not be required or permitted to modify the bid, but will be required to extend the validity of the bid security for the period of the extension, and in compliance with Clause IB.15 in all respects.

IB.15 Bid Security

- 15.1 Each bidder shall furnish, as part of the bid, a bid security in the amount stipulated in the bidding data in Pak Rupees or an equivalent amount in a freely convertible currency.
- 15.2 The bid security shall be at the option of the bidder, in the form of deposit at call, Pay order or a bank guarantee issued by a Scheduled Bank in Pakistan or from a foreign bank duly counter guaranteed by a Scheduled Bank in Pakistan in favour of the procuring agency, which should commensurate with the bid validity period. The bank guarantee for bid security shall be acceptable in the manner as provided at Annexure BS-1
- 15.3 Any bid not accompanied by an acceptable bid security shall be rejected by the procuring agency as non-responsive.
- 15.4 Bid security shall be released to the unsuccessful bidders once the contract has been signed with the successful bidder or the validity period has expired.
- 15.5 The bid security of the successful bidder shall be returned when the bidder has furnished the required Performance Security and signed the Contract Agreement.
- 15.6 The bid security may be forfeited:
- (a) if the bidder withdraws his bid except as provided in sub- clause IB 22.1;

- (b) if the bidder does not accept the correction of his bid price pursuant to sub-clause IB 27.2 hereof; or
- (c) In the case of successful bidder, if he fails within the specified time limit to:
 - (i) furnish the required Performance Security; or
 - (ii) sign the Contract Agreement.

IB.16 Alternate Proposals/Bids

- 16.1 Each bidder shall submit only one bid either by himself, or as a member of a joint venture, until and unless they have been requested or permitted for alternative bid, then he has to purchase separate bidding documents and alternate bid shall be treated as separate bid.
- 16.2 Alternate proposals are allowed only for procurement of works where technical complexity is involved and more than one designs or technical solutions are being offered. Two stage two envelope bidding procedure will be appropriate when alternate proposal is required.
- 16.3 Alternate bid(s) shall contain (a) relevant design calculations; (b) technical specifications; (c) proposed construction methodology; and (d) any other relevant details / conditions, provided that the total sum entered on the Form of Bid shall be that which represents complete compliance with the bidding documents.

IB.17 Pre-Bid Meeting

- 17.1 Procuring agency may, on his own motion or at the request of any bidder, hold a pre-bid meeting to clarify issues and to answer any questions on matters related to the bidding documents. The date, time and venue of pre-bid meeting, if convened, shall be communicated to all bidders. All bidders or their authorized representatives shall be invited to attend such a pre-bid meeting at their own expense.
- 17.2 The bidders are requested to submit questions, if any, in writing so as to reach the Procuring agency not later than seven (7) days before the proposed pre-bid meeting.
- 17.3 Minutes of the pre-bid meeting, including the text of the questions raised and the replies given, will be transmitted without delay to all bidders. Any modification of the bidding documents listed in sub-clause IB 7.1 hereof, which may become necessary as a result of the pre-bid meeting shall be made by the procuring agency exclusively through the issue of an Addendum pursuant to Clause IB.9 and not through the minutes of the pre-bid meeting.
- 17.4 Absence at the pre-bid meeting will not be a cause for disqualification of a bidder.

IB.18 Format and Signing of Bid

- 18.1 Bidders are particularly directed that the amount entered on the Form of Bid shall be for performing the contract strictly in accordance with the bidding documents.
- 18.2 All appendices to bid are to be properly completed and signed.

- 18.3 Alteration is not to be made neither in the form of bid nor in the Appendices thereto except in filling up the blanks as directed. If any such alterations be made or if these instructions be not fully complied with, the bid may be rejected.
- 18.4 Each bidder shall prepare by filling out the forms without alterations and shall provide an original copy along with photocopies as per the requirement of the procuring agency specified in the bidding data. The original as well as copies of the document shall be clearly marked as “ORIGINAL” and „COPY”, as the case may be. If there is any discrepancy between original and copy(ies) then the original shall prevail.
- 18.5 The original and all copies of the bid shall be typed or written in indelible ink (in the case of copies, Photostats are also acceptable) and shall be signed by a person(s) duly authorized to sign on behalf of the bidder pursuant to sub- clause IB 11.1(a) hereof. All pages of the bid shall be initialled and stamped by the person(s) signing the bid.
- 18.6 The bid shall contain no alterations, omissions or additions, except to comply with instructions issued by the procuring agency, or as are necessary to correct errors made by the bidder. Such corrections shall be initialled by the person(s) signing the bid.
- 18.7 Bidders shall indicate in the space provided in the Form of Bid their full and proper postal addresses at which notices may be legally served on them and to which all correspondence in connection with their bids and the contract is to be sent.
- 18.8 Bidders should retain a copy of the bidding documents as their file copy.

D. SUBMISSION OF BIDS

IB.19 Sealing and Marking of Bids

- 19.1 Each bidder shall submit his bid as under:
- (a) ORIGINAL and _____ COPIES of the bid shall be separately sealed and put in separate envelopes and marked as such.
 - (b) The envelopes containing the ORIGINAL and COPIES shall be put in one sealed envelope and addressed as given in sub – clause IB 19.2 hereof.
- 19.2 The inner and outer envelopes shall:
- (a) be addressed to the procuring agency at the address provided in the bidding data;
 - (b) bear the name and identification number of the contract as defined in the bidding data; and
 - (c) provide a warning not to open before the time and date for bid opening, as specified in the bidding data.
- 19.3 In addition to the identification required in sub-clause IB 19.2 hereof, the inner envelope shall indicate the name and postal address of the bidder to enable the bid to be returned unopened in case it is declared “late” pursuant to Clause IB.21

- 19.4 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.

IB.20 Deadline for Submission of Bids

- 20.1 (a) Bids must be received by the procuring agency at the address specified not later than the time and date stipulated in the bidding data,
- (b) Bids with charges payable will not be accepted, nor will arrangements be undertaken to collect the bids from any delivery point other than that specified above. Bidders shall bear all expenses incurred in the preparation and delivery of bids. No claims shall be entertained for refund of such expenses,
- (c) Where delivery of a bid is by mail and the bidder wishes to receive an acknowledgment of receipt of such bid, he shall make a request for such acknowledgment in a separate letter attached to but not included in the sealed bid package,
- (d) Upon request, acknowledgment of receipt of bids will be provided to those making delivery in person or by messenger.
- 20.2 The Procuring Agency may, at its discretion, extend the deadline for submission of bids by issuing an amendment in accordance with IB 09. In such case, all rights and obligations of the procuring agency and the bidders shall remain the same as mentioned in the original deadline.

IB.21 Late Bids

- (a) any bid received by the procuring agency after the deadline for submission of bids prescribed in to clause IB 20 shall be returned unopened to such bidder.
- (b) delays in the mail, person in transit, or delivery of a bid to the wrong office shall not be accepted as an excuse for failure to deliver a bid at the proper place and time. It shall be the bidder's responsibility to submit the bid intime.

IB.22 Modification, Substitution and Withdrawal of Bids

- 22.1 Any bidder may modify, substitute or withdraw his bid after bid submission provided that the modification, substitution or written notice of withdrawal is received by the procuring agency prior to the deadline for submission of bids.
- 22.2 The modification, substitution, or notice for withdrawal of any bid shall be prepared, sealed, marked and delivered in accordance with the provisions of Clause IB.19 with the outer and inner envelopes additionally marked "MODIFICATION", "SUBSTITUTION" or "WITHDRAWAL" as appropriate.
- 22.3 No bid may be modified by a bidder after the deadline for submission of bids except in accordance with to sub - clauses IB 22.1 and IB 27.2.
- 22.4 Withdrawal of a bid during the interval between the deadlines for submission of bids and the expiration of the period of bid validity specified in the Form of Bid may result in forfeiture of the bid security in pursuance to clause IB 15.

E. BID OPENING AND EVALUATION.

IB.23 Bid Opening

- 23.1 Procuring agency will open the bids, including withdrawals, substitution and modifications made pursuant to Clause IB.22, in the presence of bidders' representatives who choose to attend, at the time, date and location stipulated in the bidding data. The bidders or their representatives who are in attendance shall sign an attendance sheet.
- 23.2 Envelopes marked "MODIFICATION", "SUBSTITUTION" or "WITHDRAWAL" shall be opened and read out first. Bids for which an acceptable notice of withdrawal has been submitted pursuant to clause IB.22 shall not be opened.
- 23.3 Procuring agency shall read aloud the name of the bidder, total bid price and price of any Alternate Proposal(s), if any, discounts, bid modifications, substitution and withdrawals, the presence or absence of bid security, and such other details as the procuring agency may consider appropriate, and total amount of each bid, and of any alternative bids if they have been requested or permitted, shall be read aloud and recorded when opened.
- 23.4 Procuring Agency shall prepare minutes of the bid opening, including the information disclosed to those present in accordance with the sub-clause IB.23.3.

IB.24 Process to be Confidential. (SPP Rule 53)

- 24.1 Information relating to the examination, clarification, evaluation and comparison of bid and recommendations for the award of a contract shall not be disclosed to bidders or any other person not officially concerned with such process before the announcement of bid evaluation report in accordance with the requirements of Rule 45, which states that Procuring agencies shall announce the results of bid evaluation in the form of a report giving reasons for acceptance or rejection of bids. The report shall be hoisted on website of authority and that of procuring agency if it website exists and intimated to all bidders at least seven (7) days prior to the award of contract. 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. Any effort by a bidder to influence the procuring agency's processing of bids or award decisions may result in the rejection of such bidder's bid. Whereas, any bidder feeling aggrieved, may lodge a written complaint as per Rule 31; however mere fact of lodging a complaint shall not warrant suspension of the procurement process.

IB.25 Clarification of Bid (SPP Rule 43)

- 25.1 To assist in the examination, evaluation and comparison of bids, the procuring agency may, at its discretion, ask any bidder for clarification of the bid, including breakdowns of unit rates. The request for clarification and the response shall be in writing but no change in the price or substance of the bid shall be sought, offered or permitted except as required to confirm the correction of arithmetic errors discovered by the procuring agency in the evaluation of the bids in accordance with clause IB 28.

IB.26 Examination of Bids and Determination of Responsiveness

- 26.1 Prior to the detailed evaluation of bids, the procuring agency will determine whether the bidder fulfils all codal requirements of eligibility criteria given in the tender notice such as registration with tax authorities, registration with PEC (where applicable), turnover statement, experience statement, and any other condition mentioned in the NIT and bidding document. If the bidder does not fulfill any of these conditions, it shall not be evaluated further.
- 26.2 Once found to be fulfilling the eligibility criteria, as mentioned in sub- clause 26.1, the bids of eligible bidders will be evaluated for technical responsiveness as per specification and criteria given in the bidding documents. Technical and financial evaluations may be carried out in accordance with single stage-single one envelope, single stage-two envelopes, two stage or two stage-two envelopes bidding procedures, depending on the selection procedure adopted by the procuring agency.
- 26.3 A bid will be considered technically responsive if it (i) has been properly signed; (ii) is accompanied by the required bid security; and (iii) conforms to all the terms, conditions and specifications of the bidding documents, without material deviation or reservation. A material deviation or reservation is one (i) which affect in any substantial way the scope, quality or performance of the works; (ii) which limits in any substantial way, inconsistent with the bidding documents, the procuring agency's rights or the bidder's obligations under the contract; or (iii) adoption/rectification whereof would affect unfairly the competitive position of other bidders presenting substantially responsive bids.
- 26.4 If a bid has major deviations to the commercial requirements and technical specifications will be considered technically non responsive. As a general rule, major deviations are those that if accepted, would not fulfil the purposes for which the bid is requested, or would prevent a fair comparison or affect the ranking of the bids that are compliant with the bidding documents.

(A). Major (material) Deviations include: -

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

- 26.5 If a bid is not substantially responsive, it will be rejected by the procuring agency, and may not subsequently be made responsive by correction or withdrawal of the non-conforming deviation or reservation.

IB.27 Correction of Errors before Financial Evaluation

- 27.1 Bids determined to be substantially responsive will be checked by the procuring agency for any arithmetic errors. Errors will be corrected by the procuring agency as follows:

- (a) where there is a discrepancy between the amounts in figures and in words, the amount in words will govern; and
- (b) where there is a discrepancy between the unit rate and the line item total resulting from multiplying the unit rate by the quantity, the unit rate as quoted will govern, unless in the opinion of the procuring agency there is an obviously gross misplacement of the decimal point in the unit rate, in which case the line item total as quoted will govern and the unit rate will be corrected.

- 27.2 The amount stated in the Form of Bid will be adjusted by the procuring agency in accordance with the above procedure for the correction of errors and with the concurrence of the bidders. The amount thus corrected shall be considered as binding upon the bidder. If the bidder does not accept the corrected bid price, his bid will be rejected, and the bid security shall be forfeited in accordance with sub-clause IB 15.6(b) hereof.

IB.28 Financial Evaluation and Comparison of Bids

- 28.1 The procuring agency will evaluate and compare only the Bids determined to be substantially responsive in accordance with clause IB 26.

- 28.2 In evaluating the Bids, the procuring agency will determine for each bid the evaluated bid price by adjusting the bid price as follows:

- (a) making any correction for errors pursuant to clause IB 27;
- (b) excluding provisional sums (if any), for contingencies in the Summary Bill of Quantities, but including competitively priced Day work; and
- (c) making an appropriate adjustment for any other acceptable variation or deviation.

- 28.3 The estimated effect of the price adjustment provisions of the conditions of contract, applied over the period of execution of the contract, shall not be taken into account in bid evaluation.
- 28.4 If the bid of the successful bidder is seriously unbalanced in relation to the procuring agency's estimate of the cost of work to be performed under the contract, the procuring agency may require the bidder to produce detailed price analyses for any or all items of the Bill of Quantities to demonstrate the internal consistency of those prices with the construction methods and schedule proposed. After evaluation of the price analyses, the procuring agency may require that the amount of the Performance Security set forth in clause IB.32 be increased at the expense of the successful bidder to a level sufficient to protect the procuring agency against financial loss in the event of default of the successful bidder under the contract.
- 28.5 Bidders may be excluded if involved in **“Corrupt and Fraudulent Practices”** means either one or any combination of the practices given below SPP Rule2(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.

28.6 Evaluation Report (SPP Rule 45)

After the completion of evaluation process, as described in clauses IB 27 and IB 28, the procuring agency shall announce the results of bid evaluation in the form of report (available on the website of the authority) giving reasons for acceptance and rejection of bid. The report shall be hoisted on website of the authority and that of procuring agencies if its website exists and intimated to all bidders at least seven (7) days prior to the award of contract.

F. AWARD OF CONTRACT

IB.29 Award (SPP Rule 49)

- 29.1 Subject to clauses IB 30 and IB 34 and provision of the rule: The procuring agency shall award the contract to the bidder whose bid has been determined to be substantially responsive to the bidding documents, and who has offered the lowest evaluated bid, but not necessarily the lowest submitted price, within the original or extended period of bid validity. Provided that such bidder has been determined to be eligible in accordance with the provisions of clause IB 03 and qualify pursuant to sub-clause IB 29.2.
- 29.2 Procuring agency, at any stage of the bid evaluation, having credible reasons for or having prima facie evidence of any deficiency(ies) in contractor's capacities, may require the contractor to provide information concerning their professional, technical, financial, legal or managerial competence whether already pre-qualified or not for the said project.

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

IB.30 Procuring Agency's Right to reject all Bids or Annul/Cancellation the Bidding Process (SPP Rule 25)

Notwithstanding clause IB 29 and provision of the rule: (1) A procuring agency reserves may cancel the bidding process at any time prior to the acceptance of a bid or proposal; (2) The procuring agency shall incur no liability towards bidders solely by virtue of its invoking sub-rule (1); (3) Intimation of the cancellation of bidding process shall be given promptly to all bidders and bid security shall be returned along with such intimation; (4) The procuring agency shall, upon request by any of the bidders, communicate to such bidder, grounds for cancellation of the bidding process, but is not required to justify such grounds.

IB.31 Notification/Publication of the Award of Contract (SPP Rule 25)

- 31.1 Prior to expiry of the period of bid validity, including extension, prescribed by the procuring agency, the procuring agency shall notify the successful bidder in writing ("Letter of Acceptance") that his bid has been accepted. This letter shall mention the sum which the procuring agency will pay to the contractor in consideration of the execution and completion of the works by the contractor as prescribed by the contract (hereinafter and in the conditions of contract called the "Contract Price").
- 31.2 No negotiation with the bidder having evaluated as lowest responsive or any other bidder shall be permitted, however, procuring agency may hold meetings to clarify any item in the bid evaluation report.
- 31.3 The notification of award and its acceptance by the bidder will constitute the formation of the contract, binding the procuring agency and the bidder till signing of the formal Contract Agreement.

- 31.4 Upon furnishing by the successful bidder of a Performance Security and signing of the contract, the procuring agency will promptly notify the name of the successful bidder to all bidders and return their bid securities accordingly.
- 31.5 Within seven days of the award of contract, procuring agency shall publish on the website of the Authority and on its own website, if such a website exists, the results of the bidding process, identify the bid through procurement identifying numbers, and the following information:
- (1) Evaluation Report;
 - (2) Form of Contract and letter of Award;
 - (3) Bill of Quantities or Schedule of Requirement.

31.6 Debriefing (SPP Rule 51).

- (a) A bidder may ask the procuring agency for reasons for non acceptance of his bid and may request for a debriefing meeting and procuring agency shall give him the reasons for such non acceptance, either in writing or by holding a debriefing meeting with such a bidder.
- (b) The requesting bidder shall bear all the costs of attending such a debriefing.

IB.32 Performance Security (SPP Rule 39)

- 32.1 The successful bidder shall furnish to the procuring agency a Performance Security in the form of pay order or demand draft or bank guarantee, and the amount stipulated in the bidding data and the Conditions of Contract within a period of 28 days after the receipt of Letter of Acceptance.
- 32.2 Failure of the successful bidder to comply with the requirements of Sub-clause IB.32.1 or clauses IB 33 or IB 35 shall constitute sufficient grounds for the annulment of the award and forfeiture of the bid security.
- 32.3 Validity of performance security shall extend at least ninety days beyond the date of completion of contract, or as mentioned in the bidding data to cover defects liability period or maintenance period subject to final acceptance by the procuring agency.

IB.33 Signing of Contract Agreement (SPP Rule 39)

- 33.1 Within 14 days from the date of furnishing of acceptable Performance Security under the Conditions of Contract, the procuring agency will send the successful bidder the Contract Agreement in the form provided in the bidding documents, incorporating all agreements between the parties.
- 33.2 The formal Agreement between the procuring agency and the successful bidder shall be executed within 14 days of the receipt of the Contract Agreement by the successful bidder from the procuring agency.
- 33.3 A procurement contract shall come into force when the procuring agency requires signs contract, the date on which the signatures of both the procuring agency and the successful bidder are affixed to the written contract. Such affixing of signatures shall take place within the time prescribed in the bidding documents.

Provided that the procuring agency may reduce the maximum time limit for signing of contract, as and when required, and shall be mentioned in the bidding documents.

33.4 Stamp Duty

The formal Agreement between the Procuring Agency and the successful bidder shall be duly stamped at rate of **0.35%** of bid price (updated from time to time) stated in Letter of Acceptance.

IB.34 General Performance of the Bidders

Procuring agency may in case of consistent poor performance of the contractor and his failure to remedy the underperforming contract may take such action as may be deemed appropriate under the circumstances of the case including the rescinding the contract and/or black listing of such contractor and debarring him from participation in future bidding process.

IB.35 Integrity Pact (SPP Rule 89)

The bidder shall sign and stamp the Integrity Pact provided at Appendix-L to the bidding documents for all Provincial/Local Government procurement contracts exceeding Rupees ten million. Failure to provide such Integrity Pact shall make the bidder non-responsive.

IB.36 Instructions not Part of Contract

Bids shall be prepared and submitted in accordance with these Instructions which are provided to assist bidders in preparing their bids, and do not constitute part of the bid or the Contract Documents.

IB.37 Arbitration (SPP Rule 34)

Any dispute that is not amicably resolved shall be finally settled, unless otherwise specified in the Contract, under the Arbitration Act 1940 updated from time to time and would be held anywhere in the Province of Sindh at the discretion of procuring agency.

BIDDING DATA

Bidding Data

Instructions to Bidders

Clause Reference

- 1.1 Name and address of the Procuring Agency:
Director, Infrastructure & Planning
Sindh Mass Transit Authority,
Government of Sindh,
Office D-43/1, Shahra-e-Ghalib, Block 2, Clifton,
near Bilawal Chowrangi, Karachi,
Phone: 021-99332207-8
Fax: 021-
Email:

- 1.2 Name of the Project and Summary of the works:

Name of Project:

MAINTENANCE OF BRTS GREEN AND ORANGE LINES
“MISCELLANEOUS REPAIR/REPLACEMENT/MAINTENANCE WORKS OF
ROAD, BUILDINGS, ELECTRICAL, HVAC AND MEP WORKS AT BRT GREEN
& ORANGE LINE CORRIDORS, KARACHI”

The identification number of the Contract is:

CONTRACT PACKAGE: SMTA/GL&OL/MAINTENANCE/CP-01

Scope of Work:

Miscellaneous Repair/Replacement/Maintenance Works of Road, Buildings, Electrical, HVAC and MEP Works at BRT Green & Orange Line Corridors. The bidders are required to fill the rates only in Priced Bid in PKR.

- 1.2 The successful bidder will be expected to complete the works within the time specified in Special Stipulations (Appendix-A).

- 2.1 Name of the Funding Source;
Government of Sindh

- 3.2 Add following IB Clause 3.2

Qualification of Bidder

To be qualified for award of the Contract, bidders shall provide evidence satisfactory to the Procuring Agency of their capability and adequacy of resources to carry out the Contract effectively. Bids shall include the following documentation and information on the relevant Forms provided in Appendix L to Bid.

- (a) copies of original documents defining the constitution or legal status, place of registration and principal place of business; written power of attorney of the signatory of the Bid to commit the bidder;

- (b) total annual turnover in the civil works construction business expressed as total of payment certificates for work performed in each of the last Five(05) years;
- (c) Average Networth for the last Five(05) years;
- (d) Average Net working Capital for the last Five(05) years;
- (e) performance as prime contractor, management contractor, or proportionately as member of a joint venture or subcontractor, on works of a similar nature and complexity over the last five(05) years, and details of other work in hand and contractual commitments;
- (f) major items of Contractor's Equipment proposed for carrying out the Contract;
- (g) the qualifications and experience of key personnel proposed for administration and execution of the Contract, both on and off site;
- (h) any proposals for subcontracting elements of the Works such that the total of subcontracting should not be more than 30 percent of the Bid Price;
- (i) reports on the financial standing of the bidder including profit and loss statements, balance sheets and auditor's reports for the past three years;
- (j) authority to seek references from the bidder's bankers;
- (k) information regarding any litigation or arbitration resulting from contracts executed by the bidder in the last five(05) years or currently under execution. The information shall include the names of the parties concerned, the disputed amount, cause of litigation, and matter in dispute;
- (l) information regarding black listing of the bidder by government, semi government, autonomous bodies, private parties; and
- (m) proposal of work methods and program, in sufficient detail to demonstrate the adequacy of the bidder's proposals to meet the technical specifications and the completion time referred to in Appendix A to bid.

Bids submitted by a joint venture of two or more firms as partners shall comply with the following requirements:

- (a) the Bid shall include all the information listed in Sub-Clauses 3.2 (a) to (e) and (g) to (k) above for each joint venture partner and 3.2 (f) and (l) for the joint venture;
- (b) the Bid, and in case of a successful Bid, the Form of Agreement, shall be signed so as to be legally binding on all partners;
- (c) one of the partners shall be nominated as being in charge, and this authorization shall be evidenced by submitting a power of attorney signed by legally authorized signatories of all the partners;
- (d) the partner in charge shall be authorized to incur liabilities and receive instructions for and on behalf of any and all partners of the joint venture, and the entire execution of the Contract, including payment, shall be done exclusively with the partner in charge;
- (e) all partners of the joint venture shall be liable jointly and severally for the execution of the Contract in accordance with the Contract terms, and a statement to this effect shall be included in the authorization mentioned under

(c) above, as well as in the Form of Bid and in the Form of Agreement (in case of a successful Bid); and

- (f) a copy of the Joint Venture Agreement entered into by all partners shall be submitted with the bid. Alternatively, a Letter of Intent to execute a Joint Venture Agreement in the event of a successful bid shall be signed by all partners and submitted with the bid, clearly mentioning share of each JV member, together with a copy of the proposed Agreement.

For the purposes of this particular Contract, bidders shall meet the minimum qualifying criteria set forth at the end of Bidding Data.

The figures for each of the partners of a joint venture shall be added together to determine the bidder's compliance with the minimum qualifying criteria set out in this Sub-Clause 3.2 above and in Evaluation & Qualification Criteria

The qualifications, capacity, and resources of proposed subcontractors will not be taken into account in assessing those of individual or joint venture bidders, unless they are named specialist subcontractors and the scope of their specialized participation in the Works is clearly defined in the bid.

Refer Evaluation & Qualification Criteria provided at the end of Bidding Data, to establish its qualifications to perform the Contract in accordance with Evaluation and Qualification Criteria the Bidder shall provide the information requested in the corresponding information forms included in Appendix L along with information required in this Sub-Clause 3.2.8.1

Time limit for clarification:

The written clarification should reach the addressee of the NIT on any working day but not later than 7 working days prior to last date of bid submission.

6.1 Site Visit

Delete the text and substitute:

The Bidder or his authorized representative shall visit and inspect the Site of Works including the areas and surroundings to be used for Contractor's Camp, on his own responsibility and at his own expense, and obtain all the information from his own sources which may be necessary for the purpose of preparing the bid. The Employer may assist but will not take any responsibility for the supply or correctness of the information.

The Bidder shall, before submitting his bid, satisfy himself in all respects including the following:

- a. The existing facilities in the vicinity of the Site of Work, the hydrological and climatological conditions, the form and nature of the Site of Work.
- b. The quantities and nature of the work and materials necessary for completion of the Works.
- c. The means of access to the Site of Work and exit from the Site.
- d. The available accommodation on land for Contractor's Camp within or outside the Site of Work.
- e. All necessary information as to risks, contingencies and other circumstances, which may influence or affect the bid.

- f. The existing condition at Site.
- g. Traffic Management during construction
- h. etc

Each Bidder shall also enquire and satisfy himself as to the source, the quantity of supply, the sufficiency of and the means of obtaining and transporting all plant, material, labour, fuel, water, electricity, and other matters or things required for or in connection with the Works.

In preparing the bid, Bidder shall also consider his obligation to adequately store all materials and maintain existing facilities and all Temporary Works during the period of their usage.

The Bidder must make local inquiries as to the physical conditions prevailing at the Site and obtain his own information on all matters and things that may in any way influence him in making a bid and fixing the rates in the Bill of Quantities. He must also satisfy himself as to the risks, obligations and responsibilities to be undertaken in accordance to the Contract to be entered into by him should his bid be accepted.

The Bidder shall make his own investigations, enquiries and assessments, on all matters, of all conditions of existing constructions at the site and its vicinity, to his satisfaction before submitting his bid

8 **Clarification of Bidding Documents**

Time Limit for Clarifications is 07 days instead of 28 days prior to the deadline for submission of bid.

10.1 Bid language:

Bid language is English

11.1 Delete whole Clause 11.1 and replace with following:

The Bid shall comprise two envelopes submitted simultaneously, one called the Technical Bid containing the documents listed in Clause 11.1a and the other the Price Bid containing the documents listed in Clause 11.1b, both envelopes enclosed together in an outer single envelope.

11.1(a) The Technical Bid shall comprise the following:

- Forms of Technical Bid with required attachments;
- Appendices to Bid except Appendix D
- Original Bid Security in accordance with Clause 15;
- Alternative bids, if permissible, in accordance with Clause 16;
- Written confirmation authorizing the signatory of the Bid to commit the Bidder, in accordance with Clause 18;
- Documentary evidence in accordance with Clause 3.2 establishing the Bidder's qualifications to perform the contract;
- The Bidder shall furnish, as part of the Technical Bid, a Technical Proposal including a statement of work methods, equipment, personnel, schedule and any other information as stipulated in Appendices, in

sufficient detail to demonstrate the adequacy of the Bidders' proposal to meet the work requirements and the completion.

Furnish a technical proposal taking into account the various Appendices to Bid specially the following:

Appendix-E to Bid: Proposed Construction Schedule

Appendix-F to Bid: Method of Performing the Work

Appendix-G to Bid: List of Major Equipment

Appendix-H to Bid: Construction Camp and Housing Facilities

Appendix-I to Bid: List of Subcontractors

Appendix-K to Bid: Organization Chart for Supervisory Staff

Appendix-L to Bid: Forms of Eligibility

Appendix-M to Bid: Integrity Pact

and other pertinent information such as mobilization programme etc;

11.1(b) The Price Bid shall comprise the following:

- Form of Price Bid;
- completed Price Bill of Quantities (Appendix D), in accordance with Clause 11.1c and Clause 12;

11.1(c) The Forms of Technical Bid and Price Bid, and all documents listed under Clause 11.1a and 11.1b, shall be prepared using the relevant forms furnished at the end of Bidding Data and in Appendix D to L. The forms must be completed without any alterations to the text, and no substitutes shall be accepted. All blank spaces shall be filled in with the information requested.

In case any original document is in other language, translation in bid language should be provided which must be attested by the consulate of the country of the foreign bidder. The document in bid language shall prevail in case of any discrepancy

12.3 Add following paragraphs:

- a) The Bidder, by the act of submitting a bid, acknowledges that he has inspected the Site of Works and determined the general characteristics and conditions. The Employer will not assume any responsibility for information, interpretations and deductions the bidder may make from the information furnished by the Employer or the Engineer. No verbal agreement or conversation with any officer, employee or agent of the Employer or the Engineer before, during or after the execution of the Contract, shall affect or modify any of the terms or obligations contained in the Contract.
- b) The attention of the Bidder is drawn to the fact that local regulations require special formalities to be complied with in connection with the ordering, purchasing and importing of materials from outside Pakistan. Bidder will be deemed to have obtained full information about all such matters and to have allowed in his bid for all delays, additional costs and financing charges that may arise directly or indirectly there from.
- c) Any neglect or failure on the part of the Bidder to obtain reliable information on the spot or elsewhere upon the foregoing or any other matters affecting the execution and completion of the Works, the rates and the Contract shall not relieve the Bidder whose bid is accepted from any risks or liabilities or from the responsibility of completing and handing over the works.

- d) The bidder is to fill only the rates in price bid. The premium/rebate if set down by the Bidder against each bill in the Bill of Quantities are to be the full inclusive value of the finished work described there under and shall be deemed to include all costs of performing the Works including all taxes and duties, profits and costs of accepting the general risks, liabilities and obligations of every kind set forth or implied in the Contract

13.1 Bidders to quote entirely in Pak. Rupee

The currency of Bid is Pakistan Rupee (PKR). All payment will be made in PKR only

14.1 Period of Bid Validity:

Period of Bid Validity shall be 90 days

15.1 Amount of Bid Security:

Refer Notice Inviting Tender (NIT).

15.2 Bid Security:

Delete Clause 15.2 and replace with following

The Bid Security shall be in shape of Pay Order or irrevocable Bank Guarantee issued by a Scheduled Bank in Pakistan in favour of the Employer named in IB Clause 1.1 above Add following at the end of IB-15.2.

The bid Security (original) should be submitted with the Technical Bid and the copy (ies) should be submitted with Price Bid as per IB Clause 11.

16.1 Alternate Proposals/Bid

Alternative bids is not permitted

Alternative times for completion is not permitted.

Alternative technical solutions is not permitted for any part of the Works

17.1 Venu, time, and date of the pre-Bid Meeting:

Refer NIT

17.2 Add at the end of the Para following

Errors, Omissions & Queries

The Bidder shall notify “the Employer” of any inconsistencies, errors and omissions found in the Bid Documents, prior to the Bid opening date. Withholding of any such information which will later materially affect the contract price during construction may be considered as sufficient grounds for rejection of Bid. All queries shall be directed to:

**Director, Infrastructure & Planning
Sindh Mass Transit Authority,
Government of Sindh,
Office D-43/1, Shahra-e-Ghalib, Block 2, Clifton,
near Bilawal Chowrangi, Karachi,
Phone: 021-99332207-8
Fax: 021-
Email:**

The Employer is not responsible for any verbal communications or instructions to the Bidders

Delete Sub-Clause 18.4 and 18.5 and replace with following

18.4 Number of copies of the bid to be completed and returned:

Original + Two Copies

The Bidder shall prepare one original of the Technical Bid and one original of the Price Bid comprising the Bid as described in IB Clause 11 and clearly mark it “ORIGINAL - TECHNICAL BID” and “ORIGINAL - PRICE BID”. Similarly, the Bidder shall prepare two copies of the Technical and Financial Bids.

18.5 The original and all copies of the Bid shall be typed or written in indelible ink and shall be signed by a person duly authorized to sign on behalf of the Bidder. This authorization shall consist of a written confirmation as specified below and shall be attached to the bid. The name and position held by each person signing the authorization must be typed or printed below the signature. All pages of the Bid, except for un-amended printed literature, shall be signed or initialed by the person signing the bid.

The written confirmation of authorization to sign on behalf of the Bidder shall consist of:

(a) Power of Attorney on Judicial Paper duly attested by Notary Public; and

Bids submitted by an existing or intended JV shall include an undertaking signed by all parties (i) stating that all parties shall be jointly and severally liable, and (ii) nominating a Representative who shall have the authority to conduct all business for and on behalf of any and all the parties of the JV during the bidding process and, in the event the JV is awarded the Contract, during contract execution.

18.6 Delete the text and substitute:

The bid shall contain no alterations, omissions or additions, except to comply with instructions issued by the Employer, or as are necessary to correct errors made by the Bidder, in which case such corrections shall be initialed by the person or persons signing the bid. Each correction shall be separately signed and stamped. Over-writing, erasures, use of whitening fluid, correction tape for making corrections is not permitted. Non-compliance of these instructions may be construed as sufficient ground to render the bid non-responsive.

18.7 At the end of this para, add the following:

Bids shall be prepared and submitted on the forms of “Technical Bid” and “Price Bid” provided. All blank spaces must be filled in and completed form must be without interlineations or alteration of the original wording. Bids with incomplete and/or unsigned Form of Bids may be rejected /considered Non-Responsive. The Bidder shall stamp and sign each page of Bid Documents for the purpose of identification and acknowledgement of acceptance thereof.

The Bids must conform in all respects to the Bid Documents.

19.1 Sealing & Marking of Bids:

Delete Sub-Clause 19.1 and replace with following:

Bidders may always submit their bids by mail or by hand. Procedures for submission, sealing and marking are as follows:

Bidders submitting bids by mail or by hand shall enclose the original of the Technical Bid, the original of the Price Bid, and each copy of the Technical Bid and

each copy of the Price Bid, in separate sealed envelopes, duly marking the envelopes as “ORIGINAL - TECHNICAL BID”, “ORIGINAL - PRICE BID” and “COPY NO... - TECHNICAL BID” and “COPY NO.... - PRICE BID.” These envelopes, the first containing the originals and the others containing copies, shall then be enclosed in one single envelope per set.

- 19.2 (a) Procuring Agency's address for the purpose of bid submission:

Same as given in Clause IB 1.1 above

- (b) Name and Identification Number of the Contract:

**“MISCELLANEOUS REPAIR/REPLACEMENT/MAINTENANCE
WORKS OF ROAD, BUILDINGS, ELECTRICAL, HVAC AND MEP
WORKS AT BRT GREEN & ORANGE LINE CORRIDORS, KARACHI”**

The identification number of the Contract is:

CONTRACT PACKAGE: SMTA/GL&OL/MAINTENANCE/CP-01

- 20.1 (a) Deadline for submission of bids:

Refer NIT

- (b) Venue, time, and date of bid opening:

Refer NIT

Delete Sub-Clause 23.1 and replace with following:

- 23.1 The Procuring Agency shall open the Technical Bids in public at the address, date and time specified in the Invitation for bids in the presence of Bidders' designated representatives and anyone who choose to attend. The Price Bids will remain unopened and will be held in custody of the Procuring Agency until the specified time of their opening.

Delete Sub-Clause 23.3 and replace with following

- 23.3 All other envelopes holding the Technical Bids shall be opened one at a time, and the following read out and recorded:

- (a) the name of the Bidder;
- (b) whether there is a modification or substitution;
- (c) the presence of an Original Bid Security;
- (d) any other details as the Procuring Agency may consider appropriate.

Only Technical Bids and alternative Technical Bids read out and recorded at bid opening shall be considered for evaluation. No Bid shall be rejected at the opening of Technical Bids except for late bids, in accordance with Clause IB 21.

Delete Sub-Clause 23.4 add replace with following:

- 23.4 At the end of the evaluation of the Technical Bids, the Procuring Agency will invite bidders who have submitted substantially responsive Technical Bids and who have been determined as being qualified for award to attend the opening of the Price Bids. The date, time, and location of the opening of Price Bids will be advised in writing by the Procuring Agency. Bidders shall be given reasonable notice for the opening of Price Bids.

And following Sub-Clauses 23.5 to 23.8

- 23.5 The Procuring Agency will notify Bidders in writing who have been rejected on the grounds of their Technical Bids being substantially non-responsive to the requirements of the Bidding Document and return their Price Bids unopened.
- 23.6 The Procuring Agency shall conduct the opening of Price Bids of all Bidders who submitted substantially responsive Technical Bids, in the presence of Bidders' representatives who choose to attend at the address, date and time specified by the Procuring Agency. The Bidder's representatives who are present shall be requested to sign a register evidencing their attendance.
- 23.7 All envelopes containing Price Bids shall be opened one at a time and the following read out and recorded:
- (a) the name of the Bidder;
 - (b) whether there is a modification or substitution;
 - (c) the Bid Prices, including any discounts and alternative offers if permitted; and
 - (d) any other details as the Procuring Agency may consider appropriate.

Only Price Bids, discounts, and alternative offers read out and recorded during the opening of Price Bids shall be considered for evaluation. No Bid shall be rejected at the opening of Price Bids.

- 23.8 The Procuring Agency shall prepare a record of the opening of Price Bids that shall include, as a minimum: the name of the Bidder, the Bid Price, any discounts, and alternative offers. The Bidders' representatives who are present shall be requested to sign the record.

Add following paragraph at the end of Sub Clause 26.1

The Procuring Agency shall examine the Technical Bid to confirm that all documents and technical documentation requested in Clause 11 have been provided, and to determine the completeness of each document submitted.

The Procuring Agency shall confirm that the following documents and information have been provided in the Technical Bid. If any of these documents or information is missing, the offer shall be rejected.

- Form of Bid;
- written confirmation of authorization to commit the Bidder;
- Bid Security, if applicable; and
- Technical Proposal in accordance with IB 11

26.1 ***Examination of Bids and Determination of Responsiveness***

Add following paragraph at the end of Sub Clause 26.1

The Employer shall examine the Technical Bid to confirm that all documents and technical documentation requested in Clause 11 have been provided, and to determine the completeness of each document submitted.

The Employer shall confirm that the following documents and information have been provided in the Technical Bid. If any of these documents or information is missing, the offer shall be rejected.

- i. Letter of Technical Bid;
- ii. written confirmation of authorization to commit the Bidder;
- iii. Bid Security, if applicable; and
- iv. Technical Proposal in accordance with IB 11

26.2 Examination of Bids and Determination of Responsiveness

Add following text at the end of Sub-Clause 26.2

The Employer's determination of a Bid's responsiveness is to be based on the contents of the bid itself, as defined in IB 11.

A substantially responsive Technical Bid is one that meets the requirements of the Bidding Document without material deviation.

The Employer shall examine the technical aspects of the Bid submitted in accordance with IB 11, Technical Proposal, in particular, to confirm that all requirements of Works and Bidding Documents have been met without any material deviation. Provided that a bid is substantially responsive, the Procuring Agency may waive any non-conformity in the Bid that does not constitute a material deviation, reservation or omission. Provided that a Technical Bid is substantially responsive, the Employer may request that the Bidder submit the necessary information or documentation, within a reasonable period of time, to rectify nonmaterial nonconformities in the Technical Bid related to documentation requirements. Requesting information or documentation on such nonconformities shall not be related to any aspect of the Price Bid. Failure of the Bidder to comply with the request may result in the rejection of its Bid.

Provided that a Technical Bid is substantially responsive, the Employer shall rectify nonmaterial nonconformities related to the Bid Price. To this effect, the Bid Price shall be adjusted, for comparison purposes only, to reflect the price of a missing or non-conforming item or component. The adjustment shall be made using the method indicated in Evaluation and Qualification Criteria.

The Employer shall determine to its satisfaction during the evaluation of Technical Bids whether Bidders meet the qualifying criteria specified in Evaluation and Qualification Criteria.

The determination shall be based upon an examination of the documentary evidence of the Bidder's qualifications submitted by the Bidder, pursuant to Sub Clause 3.2.

An affirmative determination shall be a prerequisite for the opening and evaluation of a Bidder's Price Bid. A negative determination shall result into the disqualification of the Bid, in which event the Employer shall return the unopened Price Bid to the Bidder

Add following at the end of SubClause 26.4

Provided that a bid is substantially responsive, the Procuring Agency may waive any non-conformity in the Bid that does not constitute a material deviation, reservation or omission.

Provided that a Technical Bid is substantially responsive, the Procuring Agency may request that the Bidder submit the necessary information or documentation, within a reasonable period of time, to rectify nonmaterial nonconformities in the Technical Bid related to documentation requirements. Requesting information or documentation on such nonconformities shall not be related to any aspect of the Price Bid. Failure of the Bidder to comply with the request may result in the rejection of its Bid.

Provided that a Technical Bid is substantially responsive, the Procuring Agency shall rectify nonmaterial nonconformities related to the Bid Price. To this effect, the Bid Price shall be adjusted, for comparison purposes only, to reflect the price of a missing or non-conforming item or component. The adjustment shall be made using the method indicated in Evaluation and Qualification Criteria.

The Procuring Agency shall determine to its satisfaction during the evaluation of Technical Bids whether Bidders meet the qualifying criteria specified in Evaluation and Qualification Criteria.

The determination shall be based upon an examination of the documentary evidence of the Bidder's qualifications submitted by the Bidder, pursuant to Sub Clause 3.2.

An affirmative determination shall be a prerequisite for the opening and evaluation of a Bidder's Price Bid. A negative determination shall result into the disqualification of the Bid, in which event the Procuring Agency shall return the unopened Price Bid to the Bidder.

- 28.4 If the successful bidder failed to submit Performance Security of increased amount within twentyeight (28) days of demand by the PA, its bid shall be cancelled and his bid security shall be forfeited.**

Add following at the end of IB Clause 28.4

“In case of in-appropriate discount/rebate, the successful bidder shall be required to provide additional Performance Security of the percentage equal to the percentage of discount/rebate”

29.2 Award of Contract

Add the following sub-para:

The Employer does not bind himself to award the Contract to the lowest or to any Bidder but will take into careful consideration the bidders premium/rebate and such other factors as are deemed applicable.

32.1 Performance Security:

The Performance Security shall be of an amount 05% of the Contract Price stated in the Letter of Acceptance. Such Security shall be in the form of irrevocable, unconditional bank guarantee acceptable to the Employer from any scheduled Bank of Pakistan or from a bank located outside Pakistan duly counter-guaranteed by a Scheduled Bank of Pakistan, in favour of Employer. valid for a period 28 days after the issue of taking over/completion certificate.

32.3 Validity of performance security

The Performance Security shall be valid for a period 28 days after the issue of taking over/completion certificate.

33.4 Stamp duty

The formal Agreement between the Employer and the successful bidder shall be duly stamped at rate of 0.35 % of bid price (updated from time to time by the Government of Sindh)) stated in Letter of Acceptance. The successful bidder shall bear the cost of stamp duty.

[0.35% may vary depending upon the rules applicable at the time of signing the Contract]

Amend Clause IB-36

36 Instructions to Bidders and Bidding Data are part of the Contract Documents

QUALIFICATION CRITERIA

GENERAL

Qualification will be based on all the criteria given in succeeding paras regarding the applicant's general and particular experience, personnel and equipment capabilities, and financial position, as demonstrated by the applicant's responses in the forms provided. The Employer reserves the right to waive minor deviations if these do not materially affect the capability of an applicant to perform the contract.

The Employer reserves the right to verify or seek clarification/substantiation of the information furnished by the applicants. The Employer may reject any application for any misrepresentation knowingly made by any applicant in, or pursuant to, their application or for any statement furnished in connection therewith, and intended to be relied upon by the Employer, which is incorrect in any respect.

PRELIMINARY EXAMINATION

All applications / documents submitted shall be checked for the following items:

- i. Has the Letter of Application been signed?
- ii. Has all information asked for in Form 1 to 15 been provided?
- iii. Have all Affidavits required been provided and duly signed by the authorized person?
 - Affidavit that firm has never been blacklisted;
 - Affidavit for veracity of documents;
 - Affidavit that firm has never been bankrupt
- iv. Registered with FBR for Income Tax
- v. Registered with Sindh Revenue Board for Sales Tax
- vi. List of litigation (if any) their nature and status / outcomes;
- vii. Financial statements for last 5 years duly audited by Reputable Chartered Firm.

INITIAL SCRUTINY

All the applicants shall be subjected to initial scrutiny using the following criteria:

Valid Registration with Pakistan Engineering Council in relevant category and discipline **C-3** and discipline **CE01, CE-10** JV Member: PEC Category C4 and Lead should be C-3.

At least One project related to building maintenance (including Electrical, MEP, HVAC), road works having minimum cost 300 Million completed during last five years;

OR

At least Two project related to building maintenance (including Electrical, MEP, HVAC), road works having minimum cost 150 Million completed during last five years;

Note:-

Taking Over/Completion Certificate, Maintenance/Defects Liability Certificate is mandatory.

DETAILED EVALUATION

After the initial screening of all applicants, a detailed evaluation of the constructors shall be undertaken using the following criteria based on the scoring system as follows:

Category	Points	
	Maximum	Minimum Acceptable
Financial	35	25
Experience	35	25
Personnel	15	10
Equipment	15	10

To qualify, applicants must receive not less than the specified minimum acceptable points for each category and aggregate of **minimum 70 points**. In case of JV the score shall be determined on a cumulative basis.

CRITERIA FOR DETAILED EVALUATION

FINANCIAL CAPABILITY

Financial Capability of an applicant will be taken as follows:

- The applicant shall demonstrate that he has access to, or have available liquid assets, un-encumbered real assets, lines of credit and other financial means sufficient to meet the cash flow for the execution of works.
- The Audited Balance Sheets and Annual Turn Over for the **last five years** from reputable Chartered firm must be submitted and should demonstrate the soundness of the applicant's financial position, showing long term profitability.

Where necessary, the Employer will make inquiries with the applicant's bankers.

Points shall be awarded under this category based on the following criteria:

Sr. No.	Description	Max Points Assigned	Criteria for Points Obtained
a)	Average Annual Turnover in last 5 years	15	• 10 points will be given if the Annual Average Turnover is between 300 and 350 Million. • Full Points will be given in case of Average Annual Turnover for the last five years is more than Rs. 350 Million.
b)	Average working capital in last 5 years.	15	• 12 points will be given if the average working capital is equal to 300 Million.

C)	Income Tax Return for last five years	5	- Full points will be given if the average working capital is more than 300 Million. - Full points will be given if the income tax return for last five years is submitted. - No points will be given if the income tax certificate is not attached for last five years.
Total Max assigned Points		35	

EXPERIENCE

Experience for Project Completed will be evaluated on the basis of the following points:

(Information regarding general civil works completed projects shall be supported by documents such as **Taking Over/Completion Certificate, Maintenance / Defects Liability Certificate** is mandatory.

Experience	Points
At least One project related to building maintenance (including Electrical, MEP, HVAC), road works having minimum cost 300 Million completed during last five years; or At least Two project related to building maintenance (including Electrical, MEP, HVAC), road works having minimum cost 150 Million completed during last five years;	25
Experience of maintenance of any Metro (BRT) project.	05
5 additional point will be given for each project of worth more than Rs. 300 Million during last five years.	05
Maximum Points	35

Personnel will be evaluated on the basis of following points:
Submission of detailed CV is mandatory.

Key Personnel	Points (maximum)
i. Project Manager B.E.(Civil)	4
ii. Structure Engineer (Civil)	4
iii. MEP Engineer B.E.(Mechanical / Electrical)	4
iv. PHE Engineer (Civil)	3
Maximum Points	15

(Information regarding education qualification, total work experience and specific work experience is to be supported by documents such as copy of education qualification certificate/degree and CVs of concerned personnel proposed for the above position duly signed and any other relevant documents. Engineers should have valid PEC Certificate). Points for personnel will be given on the basis of the following criteria:

PROJECT MANAGER**(must be a University Degree holder in Civil Engineering)**

Qualification	Points
Total work Experience (years)	
More than 15	2.0
10 ⁺ -15	1.5
7 ⁺ - 10	1.0
05 ⁺ -7	0.5
05 or less	0.0
Maximum Points	2.0
Specific Experience (years).	
More than 10	2.0
07 ⁺ -10	1.5
05 ⁺ -07	1.0
03 ⁺ - 05	0.5
03 or less	0.0
Maximum Points	2.0
Total Points (maximum)	4.0

Specific experience means experience as a Project Manager/Program Manager/ Resident Engineer or similar post.

STRUCTURE ENGINEER (CIVIL)**(must be a University Degree holder in Civil Engineering)**

	Points
Total work Experience (years)	
More than 15	2.0
10 ⁺ -15	1.5
07 ⁺ -10	1.0
05 ⁺ -07	0.5
05 or less	0.0
Maximum Points	2.0
Specific Experience (years) as site engineer or relevant post	
More than 08	2.0
05 ⁺ -08	1.0
03 ⁺ -05	0.5
03 or less	0.0
Maximum Points	2.0
Total Points (maximum)	4.0

Specific experience means as a Site Engineer/Project Engineer/Assistant Resident Engineer or similar post

•

MEP ENGINEER (Mechanical / Electrical)
Must be a University Degree holder in B.E. (Mechanical / Electrical)

	Points
Total work Experience (years)	
More than 15	2.0
10 ⁺ -15	1.5
07 ⁺ -10	1.0
05 ⁺ -07	0.5
05 or less	0.0
Maximum Points	2.0
Specific Experience (years) as site engineer or relevant post	
More than 08	2.0
05 ⁺ -08	1.0
03 ⁺ -05	0.5
03 or less	0.0
Maximum Points	2.0
Total Points (maximum)	4.0

PHE ENGINEER (CIVIL)
(must be a Degree holder in Civil Engineering)

	Points
Total work Experience (years)	
More than 10	1.5
05 ⁺ -10	1.0
03 ⁺ -05	0.5
03 or less	0.0
Maximum Points	1.5
Specific Experience (years)	
More than 07	1.5
03 ⁺ -07	1.0
03 or less	0.0
Maximum Points	1.5
Total Points (maximum)	3.0

EQUIPMENT CAPABILITY

The applicant shall own, or have assured access to (through rental, lease, purchase agreement or other means), the following key equipment (limited to only major items of equipment) in full working order, and must demonstrate that, based on known commitments, these will be available for deployment on the proposed contract or works. The applicant may also list alternative equipment which he would propose for the contract together with an explanation of the alternate proposal.

Sr. NO.	Description of Equipment	Capacity & Horsepower	Minimum Number	Points
1	Motor Grader	140 HP	2	2
2	Vibratory Roller	10 - 12 Ton	2	1
3	Pneumatic Roller	18 - 21 Ton	2	1
4	Dump Truck	10 Ton	6	2
5	Excavator	105 HP	2	1
6	Asphalt Paver	145 HP (3-6m	2	2
7	Concrete Transit Mixer	6 Cum	2	1
8	Concrete Pump		2	2
9	Crane	25 Ton	3	2
10	Cable Pulling/Laying Winch		2	1

It is mandatory to submit ownership documents/rental agreement/lease documents for the equipment.

- a) Appendix-E to Bid: Proposed Construction Schedule
 - b) Appendix-F to Bid: Method of Performing the Work
 - c) Appendix-G to Bid: List of Major Equipment
 - d) Appendix-H to Bid: Construction Camp and Housing Facilities
 - e) Appendix-I to Bid: List of Subcontractors
 - f) Appendix-K to Bid: Organization Chart for Supervisory Staff
 - g) Appendix-L to Bid: Forms of eligibility
 - h) Appendix-M to Bid: Integrity Pact
- and other pertinent information such as mobilization programme etc;

**FORM OF BID
AND
APPENDICES TO BID**

FORM OF TECHNICAL BID
(on company letter head)

Bid Reference No. _____
(Name of Contract/Work)

To:

1. Having examined the bidding documents including Instructions to Bidders, Bidding Data, and Conditions of Contract, Specifications, Drawings and Bill of Quantities and Addenda Nos. _____ for the execution of the above-named work, we/I, the undersigned, offer to execute and complete the work and remedy any defects therein in conformity with the Conditions of Contract, Specifications, Drawings, Bill of Quantities and Addenda.
2. We/I understand that all the Appendices attached hereto form part of this bid.
3. Our bid consisting of the Technical Bid and the Priced Bid shall be valid for a period of **12 months** based from the date fixed for the bid submission deadline in accordance with the Bidding Documents, and it shall remain binding upon us and may be accepted at any time before the expiration of that period. As security for due performance of the undertakings and obligations of this bid, we/I submit herewith a bid security in the amount of Rupees _____ (Rs. _____) drawn in your favour or made payable to procuring agency.
4. We/I undertake, if our bid is accepted, to commence the works and to complete the whole of the works comprised in the contract within the time stated in Appendix-A to Bid.
5. We/I agree to abide by this bid for the period of **365** days from the date fixed for opening 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 do hereby declare that the bid is made without any collusion, comparison of figures or arrangement with any other bidder for the works.
8. We understand that you are not bound to accept the lowest or any bid you may receive.
9. We undertake, if our/my bid is accepted, to execute the Performance Security referred to in Clause 4.2 of Conditions of Contract for the due performance of the Contract.
10. We confirm, if our bid is accepted, that all partners of the joint venture shall be liable jointly and severally for the execution of the Contract and the composition or the constitution of the joint venture shall not be altered without the prior consent of the procuring agency. (Please delete this in case of Bid form a single bidder)

in the capacity of _____duly authorized to sign Bids for and on behalf of
_____Dated _____ this _____ day
of _____ 2026 _____

Signature: _____

(Name of Bidder in Block Capitals)
(Seal)

CNIC: _____

Address: _____

Witness 1:

Signature: _____

Name: _____

CNIC: _____

Address: _____

Occupation: _____

Witness 2:

Signature: _____

Name: _____

CNIC: _____

Address: _____

Occupation: _____

SPECIAL STIPULATIONS
Particular Conditions of Contract- Part A

	Description	General Conditions Clauses	Stipulations
1	Employer's name and address	1.1.2.2 & 1.3	Director, Infrastructure & Planning Sindh Mass Transit Authority, Government of Sindh, Office D-43/1, Shahra-e-Ghalib, Block 2, Clifton, near Bilawal Chowrangi, Karachi, Phone: 021-99332207-8. Employer's Representative, To be notified
2	Engineer's name and address	1.1.2.4 & 1.3	To be notified
3	Sections	1.1.5.6	Not Applicable
4	Electronic transmission systems	1.3	Scanned copy via e-mail and facsimile are acceptable, if the original is received within three days.
5	Governing Law	1.4	The Laws of Islamic Republic of Pakistan.
6	Ruling language	1.4	English
7	Language for communications	1.4	English
8	Time for access to the Site	2.1	Within seven (07) days after Commencement Date
9	Engineer representing Consulting Firm hired by the procuring agency to issue variation in case of emergency	3.1	Up to 0.25% of the contract price stated in the Letter of Acceptance.
10	Amount of Performance Security	4.2	The performance security shall be in the form of a "unconditional, irrevocable and acceptable bank guarantee" in the amount of 05% (Five percent) of the contract price stated in the Letter of Acceptance. Amount of Performance Security shall increase or decrease as per approved variation order.
11	Subcontract	4.4	The aggregate amount of the Works subcontracted shall not exceed 30% of the Contract Price.(Subject to the mutual consent of the employer i.e. SMTA)
12	Normal working hours	6.5	8 hrs a day and 6 days a week.
13	Time for Commencement	8.1	Immediately from the date of receipt of Engineer's Notice to Commence, this shall be issued within seven (07) days after signing of Contract Agreement.
14	Time for Completion	8.2	12 months from the date of receipt of Engineer's Notice to Commence.

15	Time for Furnishing Programme	8.3	Not Applicable.
16	Revised Programme	8.3	Not Applicable
17	Delay damages for the Works	8.7 & 14.15(b)	Not Applicable
18	Maximum amount of delay damages	8.7& 14.15(b)	Not Applicable
19	Defects Liability Period	11.1	Applicable. With replaceable items of 2.5% amount shall be withheld of the said item.
20	Provisional Sums	13.5.(b)(ii)	5% + Tax
21	Adjustments for Changes in Cost	13.8	Refer Part B
22	Advance payment	14.2	10% of Contract Price stated in the Letter of Acceptance against a Mobilization Advance Guarantee for the full amount of the Advance in the specified from a Scheduled Bank in Pakistan. First Installment: 50% of total Advance Payment shall be made after fulfilling all the requirements provided in Conditions of the Contract. Second Installment: Remaining 50%, on mobilization of Plant, equipment and other resources at site by the Contractor to the satisfaction of the Engineer.
23	Repayment amortization rate of advance payment	14.2(b) 14.3	Proportanately from each monthly statement starting from second month after commencement and must be recovered in '6 equal instalments.
24	Percentage of Retention	14.3	05 % of the amount of Interim/ Running Payment Certificate. Amount of Retenion Money shall increase or decreas as per variation order issued.
25	Limit of Retention Money	14.3	5 % of Contract Price stated in the Letter of Acceptance.
26	Plant and Materials	14.5	Not Applicable
27	Minimum Amount of Interim Payment Certificates	14.6	Rs. 300,000/-
28	Payment	14.7	For IPC, 28 days. For FPC, 56 days
29	Maximum total liability of the Contractor to the Employer	17.6	The product of two (02) times the Accepted Contract Amount

30	Periods for submission of insurance: a. evidence of insurance. b. relevant policies.	18.1	14 days 28 days
31	Maximum amount of deductibles for insurance of the Employer's risks	18.2(d)	10% of the Accepted Contract Amount
32	Minimum amount of Insurance Cover	18.1, 18.2, 18.3 and 18.4	Type of cover The Works Amount of cover The sum stated in the Letter of Acceptance plus fifteen percent (15%) Type of cover Contractor 's Equipment: Amount of cover Full replacement cost plus fifteen percent (15%) Type of cover Third Party-injury to persons and damage to property The Third-Party Compensation Policy must contain following conditions of indemnification per occurrence with the number of occurrence unlimited: i) in case of death, Pak Rs. 1,000,000/= per person ii) in case of major injury, Pak Rs. 500,000/= per person iii) in case of minor injury, Pak Rs. 100,000/= per person iv) in case of damage to property, full amount of repair/replacement as the case may be. Workers: i) in case of death, Pak Rs. 1,000,000/= per person ii) in case of major injury, Pak Rs. 500,000/= per person iii) in case of minor injury, Pak Rs. 100,000/= per person Other cover: Contractor's All Risk Policy

			(In each case name of insured is Contractor and Procuring Agency)
33	Date by which the Dispute Board (DB) shall be appointed	20.2	28 days after the Commencement date
34	The DB shall be comprised of	20.2	Three Members The Adjudicator with name, address, hourly fee and biographical data will be provided after Commencement of Work.
35	List of potential DB sole members	20.2	None
36	Appointment (if not agreed) to be made by	20.3	Pakistan Engineering Council
37	Rules of arbitration	20.6(a)	Rules and Provisions of Arbitration Act 1940 of Islamic Republic of Pakistan enforced for the time being. The Place of Arbitration shall be Karachi.

FOREIGN CURRENCY REQUIREMENTS

1. The bidder may indicate herein below his requirements of foreign currency (if any), with reference to various inputs to the works.
2. Foreign Currency Requirement as percentage of the bid price excluding Provisional Sums _____%.
3. Table of Exchange Rates

Unit of Currency	Equivalent in Pak. Rupees
Australian Dollar	-----
Euro	-----
Japanese Yen	-----
U.K. Pound	-----
U.S. Dollars	-----
-----	-----
-----	-----

**PRICE ADJUSTMENT UNDER CLAUSE 13.8
OF CONDITIONS OF CONTRACT**

"Not Applicable"

BILL OF QUANTITIES

(Refer to Price Bid)

PROPOSED CONSTRUCTION SCHEDULE

Pursuant to Sub-Clause 8.2 of the General Conditions of Contract, the works shall be completed on or before the date stated in Appendix-A to Bid. The bidder shall provide as Appendix-E to Bid, the Construction Schedule in the bar chart (CPM) showing the sequence of work items and the period of time during which he proposes to complete each work item in such a manner that his proposed programme for completion of the whole of the works may meet procuring agency's completion targets in days noted below and counted from the date of receipt of Engineer's Notice to Commence (Attach sheets as required for the specified form of Construction Schedule):

Description

Whole Work

Time for Completion

As stated in Appendix-A

METHOD OF PERFORMING THE WORK

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

1. Organization Chart indicating head office and field office personnel involved in management and supervision, engineering, equipment maintenance and purchasing.
2. Mobilization at site, the type of facilities including personnel accommodation, office accommodation, provision for maintenance and for storage, communications, security and other services to be used.
3. The method of executing the works, the procedures for installation of equipment and machinery and transportation of equipment and materials to the site.

Safety Plan

The Bidder is required to submit an outline Construction Safety and Health Plan for this particular Project. The outline Safety and Health Plan shall be in accordance with the requirements of relevant decrees and/or bye laws governing Occupational Safety and Health Programme in the construction industry being implemented in the Islamic Republic of Pakistan including Sindh Occupational Safety and Health Act, 2017 and shall cover the following topics:

1. Organizational structure for handling all Safety and Health Matters
2. Composition of the Contractor's Construction Safety and Health Committee
3. Specific Safety Policies which the Contractor will undertake to observe and maintain
4. Provision of Protective Equipment
5. Safety Personnel
6. Emergency Occupational Health Personnel and Facilities
7. Worker's Welfare Facilities
8. Emergency Procedures
9. Accident Prevention and Reporting Procedures

(For further details and requirements, refer to Clause 4.8 of the Conditions of Contract, and SP-1)

Award of the Contract to the Bidder shall not be deemed to mean that the outline Construction Safety and Health Plan is considered acceptable, and the Engineer shall be at liberty to instruct the Contractor to implement such safety and health procedures as he may deem necessary. Sindh Occupational Safety and Health Act, 2017 will be the main benchmark and overreaching document guiding/setting the OHS regime.

LIST OF MAJOR EQUIPMENT – RELATED ITEMS

[The bidder will provide on Sheet 2 of this Appendix a list of all major equipment and related items, under separate heading for items owned, to be purchased or to be arranged on lease by him to mobilize at site to carry out the works. The information shall include make, type, capacity, and anticipated period of utilization for all equipment which shall be in sufficient detail to demonstrate fully that the equipment will meet all requirements of the Specifications.]

Sr. NO.	Description of Equipment	Capacity & Horsepower	Minimum Number	Points
1	Motor Grader	140 HP	2	2
2	Vibratory Roller	10 - 12 Ton	2	1
3	Pneumatic Roller	18 - 21 Ton	2	1
4	Dump Truck	10 Ton	6	2
5	Excavator	105 HP	2	1
6	Asphalt Paver	145 HP (3-6m	2	2
7	Concrete Transit Mixer	6 Cum	2	1
8	Concrete Pump		2	2
9	Crane	25 Ton	3	2
10	Cable Pulling/Laying Winch		2	1

LIST OF MAJOR EQUIPMENT (SAMPLE)

Owned Purchased or Leased	Description of Unit (Make, Model, Year)	Capacity HP Rating	Condition	Present Location or Source	Date of Delivery at Site	Period of Work on Project
1	2	3	4	5	6	7
a. Owned						
b. To be Purchased						
c. To be arranged on Lease						

CONSTRUCTION CAMP AND HOUSING FACILITIES

The Contractor in accordance with Clause 6 of the Conditions of Contract shall provide description of his construction camp's facilities and staff housing requirements.

The contractor shall be responsible for pumps, electrical power, water and electrical distribution systems, and sewerage system including all fittings, pipes and other items necessary for servicing the contractor's construction camp.

The bidder shall list or explain his plans for providing these facilities for the service of the contract as follows:

1. Site Preparation (clearing, land preparation, etc.).
2. Provision of Services.
 - a) Power (expected power load, etc.).
 - b) Water (required amount and system proposed).
 - c) Sanitation (sewage disposal system, etc.).
3. Construction of Facilities
 - a) Contractor's Office. Workshop and Work Areas (areas required and proposed layout, type of construction of buildings, etc.).
 - b) Warehouses and Storage Areas (area required, type of construction and layout).
 - c) Housing and Staff Facilities (Plans for housing for proposed staff, layout, type of construction, etc.).
4. Construction Equipment Assembly and Preparation (detailed plans for carrying out this activity).
5. Other Items Proposed (Security services, etc.).

LIST OF SUBCONTRACTORS

I/We intend to subcontract the following parts of the work to subcontractors. In my/our opinion, the subcontractors named hereunder are reliable and competent to perform that part of the work for which each is listed.

Enclosed are documentation outlining experience of subcontractors, the curriculum vitae and experience of their key personnel who will be assigned to the contract, equipment to be supplied by them, size, location and type of contracts carried out in the past.

Part of Works (Give Details)	Subcontractor (With Complete Address)
1	2

ESTIMATED PROGRESS PAYMENTS (SAMPLE)

"Not Applicable"

**ORGANIZATION CHART
FOR THE
SUPERVISORY STAFF AND LABOUR**

(To be filled in by the bidder)

PROPOSED STAFF

(Detailed CVs of following Key staff shall be provided, it is mandatory. PEC registration Certificate and qualification certificates/degrees etc. shall also be provided. It will be mandatory for successful bidder to mobilize same staff as proposed below after the approval of the Engineer. The proposed staff must be employee of the bidder)

Key Personnel	Points (maximum)
i. Project Manager B.E.(Civil)	4
ii. Structure Engineer (Civil)	4
iii. MEP Engineer B.E.(Mechanical / Electrical)	4
iv. PHE Engineer (Civil)	3
Maximum Points	15

FORMS OF ELIGIBILITY/QUALIFICATION

(All forms should be filled and submitted on Company letter head in original by each Bidder or each member of a JV)

Form 1: Bidder Information Form

Company Profile

All individual firms and each partner of a joint venture submitting bid are requested to complete the information in this form.

1.	Name of firm (legal): (In case of Joint Venture (JV), legal name of each member)	
2.	Nature of Business: (Whether the firm is a Corporation, Partnership, Trust etc.) (In case of Consortium; whether the Lead Consortium Member is a Corporation, Partnership, Trust etc.)	
3.	Head Office address:	
4.	Telephone : Fax Number: E-mail address:	
5.	Place of Incorporation/Registration: Year of Incorporation/Registration:	
6.	Applicant's authorized representative: Telephone Fax numbers: E-mail address:	
7.	NATIONALITY OF OWNERS	
	Name:	Country:

Form 2: Blacklisting

Blacklisting
☐ Bidder shall not be blacklisted by government/semi government/autonomous/private organizations.

Form 3: Litigation History

Pending Litigation			
☐ No pending litigation (A fully settled dispute or litigation is one that has been resolved in accordance with the Dispute Resolution Mechanism under the respective contract and where all appeal instances available to the Bidder have been exhausted)			
☐ Pending litigation (All pending litigation shall in total not represent more than 50% of the Bidder's net worth and shall be treated as resolved against the Bidder)			
Year	Outcome as Percent of Total Assets	Outcome as Percent of Total Assets	Total Contract Amount (PKR)
		Contract Identification: Name of Employer: Address of Employer: Matter in dispute:	

Form 4: Not Declared Ineligible by any Client/Entity

Ineligibility

☐ Bidder shall not be declared ineligible by any Client/Entity

Form 5: Bid Security Declaration

Bid Security Declaration

☐ Bidder shall not be under execution of a Bid-Securing Declaration

Form 6: History of Court/Arbitral Award

History of Court/Arbitral Award

☐ Bidder shall not have the consistent history of court/arbitral award decision against bidder.

Form 7: History of Suspension/Termination

Declare any civil work contracts that have been suspended or terminated and/or performance security called by an employer for breach contractual obligations

☐ Previous Contracts of the Bidder shall not be suspended or terminated and/or performance security called by an employer for breach of contractual obligations

Form 8: Financial Situation*Each Bidder or each member of a JV must fill in this form***Financial Data for Previous 5 Years****Information from Balance Sheet**

	Year 2025-26	Year 2024-25	Year 2023-24	Year 2022-23	Year 2021-22
Total Assets					
Total Liabilities					
Current Assets					
Current Liabilities					

Information from Income Statement

Total Revenues of Construction					
Profits Before Taxes					
Profits After Taxes					

- ☐ Attached are copies of financial statements (balance sheets including all related notes, and income statements) for the last five(05) years, as indicated above, complying with the following conditions.
- All such documents reflect the financial situation of the Bidder or partner to a JV, and not sister or parent companies.
 - Historic financial statements must be audited by a certified accountant.
 - Historic financial statements must be complete, including all notes to the financial statements.
 - Historic financial statements must correspond to accounting periods already completed and audited (no statements for partial periods shall be requested or accepted).
 - NTN certificate must be attached
 - Foreign firms if participating in the bidding process should submit NTN Certificate of their country duly attested by Consulate of their country

Form 9: Average Annual Construction Turnover

Each Bidder or each member of a JV must fill in this form

Annual Turnover Data for the Last 5 Years (Construction only)	
Year	Amount (PKR)
2025-26	
2024-25	
2023-24	
2022-23	
2021-22	

Average Annual Construction Turnover

The information supplied should be the Annual Turnover (Construction only) of the Bidder or each member of a JV in terms of the amounts billed to clients for each year for work in progress or completed.

Form 10: Financial Resources

Specify proposed sources of financing, such as liquid assets, unencumbered real assets, lines of credit, and other financial means, net of current commitments, available to meet the total construction cash flow demands of the subject contract as indicated in the Qualification Criteria

Financial Resources		
No.	Source of financing	Amount (PKR)
1		
2		
3		

Form 11: Current Contract Commitments / Works in Progress

Bidders and each member to a JV should provide information on their current commitments on all contracts that have been awarded, or for which a letter of intent or acceptance has been received, or for contracts approaching completion, but for which an unqualified, full completion certificate has yet to be issued.

Current Contract Commitments					
No.	Name of Contract	Employer's Contact Address, Tel, Fax	Value of Outstanding Work [PKR]	Estimated Completion Date	Average Monthly Invoicing Over Last Six Months [PKR/month]
1					
2					
3					
4					
5					

Form 12: Details of Contracts of Similar Nature and Complexity completed over the last 5 years

Sr. No.	1	2	3	4	5
Name of Contractor:					
Country:					
Name of Procuring Agency with Address, Tele, Fax.					
Nature of works and special features relevant to the contract for which applied:					
Contract Role (Mention: Sole, Sub Contactor or Partner in a Joint Venture).					
Value of the total contract in Pak/Rs:					
Date of Award:					
Date of Completion:					
Cost per day Index					

Form 13: Personnel Capabilities

Bidder should provide the names of suitably qualified personnel to meet the specified requirements stated in Evaluation and Qualification Criteria

Sr. No.	Title of Position	Name
1		
2		
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Form 14: Curriculum Vitae (CV) for Proposed Experts**1. Proposed Position:**

2. Name of Expert & PEC Registration

No: _____

3. Name of Firm:

4. Current Residential address:

Telephone No: _____ Fax No:

E-Mail Address:

5. Date of Birth: _____ **Citizenship:** _____

6. Qualification:

7. Work Experience: Summarize professional experience in reverse chronological order.

Indicate particular technical and managerial experience relevant to the project.

From	To	Company/Project/Position/Relevant technical and management experience

Form 15: Plant & Equipment

Bidder shall provide adequate information to demonstrate clearly that it has the capability to meet the requirements for the key equipment whether owned/ leased/ rented listed Evaluation and Qualification Criteria.

A. Equipment Capabilities (owned by the contractor/firm)

Sr. No	Name of Equipment	Name of Manufacturer	Model and power rating	Capacity	Year of Manufacture	Current Location

Note: Provide copies of ownership of equipment.

B. Equipment Capabilities (leased/rented by the contractor/firm)

Sr. No	Name of Equipment	Mention whether leased or rented	Name of Owner	Address of owner	Contact name and title with Telephone Fax & Email of the owner	Agreements Details of rental/ lease/ manufacture agreements specific to the project

Note: Provide copies of Lease Agreement/ Rent Agreement

(INTEGRITY PACT)

Refer to Price Bid

FORMS

**BID SECURITY
PERFORMANCE SECURITY
CONTRACT AGREEMENT
MOBILIZATION ADVANCE GUARANTEE
INDENTURE BOND FOR SECURED ADVANCE**

BID SECURITY
(Bank Guarantee)

Security _____ Executed _____ on _____

(Date)

Name of Surety (Bank) with Address: _____

(Scheduled Bank in Pakistan)

Name _____ of _____ Principal _____ (Bidder) _____ with _____ Address _____

Penal Sum of Security Rupees. _____ (Rs. _____)

Bid Reference No. _____

KNOW ALL MEN BY THESE PRESENTS, that in pursuance of the terms of the bid and at the request of the said Principal (Bidder) we, the Surety above named, are held and firmly bound unto _____

(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 Bidder has submitted the accompanying bid dated _____ for Bid No. _____ for _____ (Particulars of Bid) to the said Procuring Agency; and

WHEREAS, the Procuring Agency has required as a condition for considering said bid that the **bidder** furnishes a bid security in the above said sum from a Scheduled Bank in Pakistan or from a foreign bank duly counter-guaranteed by a Scheduled Bank in Pakistan, to the procuring agency, conditioned as under:

- (1) that the bid security shall remain in force up to and including the date 28 days after the deadline for validity of bids as stated in the Instructions to bidders or as it may be extended by the procuring agency, notice of which extension(s) to the Surety is hereby waived;
- (2) that the bid security of unsuccessful bidders will be returned by the procuring agency after expiry of its validity or upon signing of the Contract Agreement; and
- (3) that in the event of failure of the successful bidder to execute the proposed Contract Agreement for such work and furnish the required Performance Security, the entire said sum be paid immediately to the said procuring agency pursuant to Clause 15.6 of the Instruction to bidders 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 with the said procuring agency in accordance with his bid as accepted and furnish within twenty eight (28) days of his being requested to do so, 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 for its validity then this obligation shall be void and of no effect, but otherwise to remain in full force and effect.

PROVIDED THAT the Surety shall forthwith pay the procuring agency, the said sum 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 Surety at its address given above.

PROVIDED ALSO THAT the procuring agency shall be the sole and final judge for deciding whether the Principal (Bidder) 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 Surety shall pay without objection the said sum upon demand from the procuring agency forthwith and without any reference to the Principal (Bidder) or any other person.

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

SURETY (Bank)

WITNESS:

Signature _____

1. _____

Name _____

Title _____

Corporate Secretary (Seal)

Corporate Guarantor (Seal)

2. _____

Name, Title & Address

**FORM OF PERFORMANCE SECURITY
(Bank Guarantee)**

Guarantee No. _____

Executed on _____

Expiry date _____

[Letter by the Guarantor to the Procuring Agency]

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

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 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 11, Defects Liability, 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 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 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-bounden 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:		
1. _____		Signature _____
		Name _____
_____		Title _____
Corporate Secretary (Seal)		
2. _____		
_____		_____ Corporate Guarantor (Seal)
Name, Title & Address		

FORM OF CONTRACT AGREEMENT

THIS CONTRACT AGREEMENT (hereinafter called the “Agreement”) made on the _____ day of _____ (month), 2026 between _____ (hereafter called the “Procuring Agency”) of the one part and _____ (hereafter 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 Contract Agreement (if completed),
 - (b) the Letter of Acceptance,
 - (c) the completed Letters of Technical and Price Bids
 - (d) the Particular Conditions – Part A, (Appendix A)
 - (e) the Particular Conditions – Part B
 - (f) the General Conditions
 - (g) The completed Appendices to Bid (E to M);
 - (g) the Drawings,
 - (h) Special Provisions
 - (i) Specification,
 - (j) the Appendix D, Bill of Quantities and
 - (k) and any other documents forming part of the Contract
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 with the provisions of the contract.
4. 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.

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

Signature of the Contactor

(Seal)

Signature of Procuring Agency

(Seal)

Signed, Sealed and Delivered in the presence of:

Witness:

(Name, Title and Address)

Witness:

(Name, Title and Address)

MOBILIZATION ADVANCE GUARANTEE

Bank _____ Guarantee _____ No. _____ Date _____

WHEREAS _____ (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 Rupees _____ (Rs _____) 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 mobilization advance for the performance of his obligations under the said Contract.

AND WHEREAS, _____
(Scheduled Bank in Pakistan)
(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 fulfilment 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, 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.

This Guarantee shall remain in force until the advance is fully adjusted against payments from the Interim Payment Certificates of the Contractor or until _____ whichever is earlier.

(Date)

The Guarantor's liability under this Guarantee shall not in any case exceed the sum of Rupees _____ (Rs _____).

This Guarantee shall remain valid up to the aforesaid date and shall be null and void after the aforesaid date or earlier if the advance made to the Contractor is fully adjusted against payments from Interim Payment Certificates of the Contractor provided that the Guarantor agrees that the aforesaid period of validity shall be deemed to be extended if on the above mentioned date the advance payment is not fully adjusted.

GUARANTOR

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

WITNESS

1. _____

Corporate Secretary (Seal)

2. _____

(Name Title & Address)

Corporate Guarantor (Seal)

Condition of Contract

Federation International des Ingenieurs-Conseils, or FIDIC)

- (a) **Part I - General Conditions of Contract**
- (b) **Part II - Particular Conditions of Contract**

Notes on the Conditions of Contract

The Conditions of Contract comprise two parts:

(a) Part I - General Conditions of Contract

(b) Part II – Particular Conditions of Contract

Over the years, a number of “model” General Conditions of Contract have evolved. The one used in these Standard Bidding Documents was prepared by the International Federation of Consulting Engineers (Federation Internationale des Ingenieurs-Conseils, or FIDIC), and is commonly known as the FIDIC Conditions of Contract. (The used version is the harmonized Edition March 2006).

The FIDIC Conditions of Contract have been prepared for an ad measurement (unit price or unit rate) type of contract, and cannot be used without major modifications for other types of contract, such as lump sum, turnkey, or target cost contracts.

The standard text of the General Conditions of Contract chosen must be retained intact to facilitate its reading and interpretation by bidders and its review by the procuring agency. Any amendments and additions to the General Conditions, specific to the contract in hand, should be introduced in the Particular Conditions of Contract.

The use of standard conditions of contract for all civil works will ensure comprehensiveness of coverage, better balance of rights or obligations between procuring agency and Contractor, general acceptability of its provisions, and savings in time and cost for bid preparation and review, leading to more economic prices.

The FIDIC Conditions of Contract are copyrighted and may not be copied, faxed, or reproduced. Without taking any responsibility of its being accurate, Pakistan Engineering Council with prior consent of FIDIC Secretariat, has reproduced herein the FIDIC General Conditions of Contract for reference purpose only which cannot be used by the users for preparing their bidding documents. The bidding document may include a purchased copy, the cost of which can be retrieved as part of the selling price of the bidding document. Alternatively, the FIDIC Conditions of Contract can be referred to in the bidding documents, and the bidders are advised to obtain copies directly from FIDIC

Copies of the FIDIC Conditions of Contract can be obtained from:

FIDIC CASE POSTALE, CH-1215 Switzerland;

Tel. +41 22 799 49 00;

Fax; +41 22 799 49 01

E-mail: fidic@fidic.org.

PART B - PARTICULAR CONDITIONS OF CONTRACT

1.1	Definitions
1.1.1.4	“Form of Bid” is synonymous with “Letter of Tender”.
1.1.1.5	“Bid” is synonymous with “Tender”.
1.1.1.8	“The word ‘Tender’ is synonymous with ‘Bid’, and the words ‘Bidding’ with ‘Tendering’ and the words ‘Appendix to Tender’ with ‘Appendix to Bid’ and words ‘Tender Documents’ with ‘Bid Documents’”.
1.1.1.11	Insert this Sub Clause “Programme” means the programme to be submitted by the contractor in accordance with Sub-Clause 8.3 and any approved revisions thereto.
1.1.2.2	“Employer” is synonymous with “Procuring Agency” Employer’s Representative, To be notified
1.1.2.4	The Engineer is: Muhammad Siddiq Sulemani
1.1.2.9	“DB” is synonymous with “Committee”
1.1.2.11	Deleted
1.1.2.12	Deleted
1.1.3.7	“Defects Notification Period is synonymous with Defects Liability Period”
1.1.5.4	Add following as new para It is mandfatory on the Contractor to start jungle cutting in Sector 16 and 87 simultaneously with Infrastructure Development Work at Sector 61. The Jungle Cutting is required to be completed within 15days after issuance of Comencement Notice. Subject to approval of SMTA.
	Add following definations
Sub-Clause 1.15 Inspections and Audit by the Bank	Deleted
Sub-Clause 1.5 Priority of Documents	<i>Replace sequence of priority of documents with the following:</i> (l) the Contract Agreement (if completed), (m) the Letter of Acceptance, (n) the completed Letters of Technical and Price Bids (o) the Particular Conditions – Part A, (Appendix A) (p) the Particular Conditions – Part B (q) the General Conditions (g) The completed Appendices to Bid (E to M); (r) the Drawings, (s) Special Provisions (t) Specification, (u) the Appendix D, Bill of Quantities and (v) and any other documents forming part of the Contract.
Sub-Clause 1.6 Contract Agreement	<i>Replace the word “Employer” with “Contractor” in last line</i>
Sub-Clause 2.4	This Sub-Clause is deleted entirely.

Employer's Financial Arrangements	
Sub-Clause 3.1 Engineer's Duties and Authority	<i>The following paragraph is added after duties:</i> Procuring agency shall ensure that the Engineer's Representative/Staff is a professional engineer as defined in the Pakistan Engineering Council Act 1975 (V of 1976) <i>Replace part of Clause after the sentence "The following provisions shall apply" with following:</i> The Engineer shall obtain the specific approval of the Employer before taking action under the following Sub Clauses of these conditions: a) Sub-Clauses 1.9, 2.1, 4.7, 4.12, 4.24, 7.4, 8.4, 8.5, 8.9, 10.3, 13.7, and 19.4: Agreeing or determining an extension of time and / or additional cost. b) Approving subletting of any part of the Works under Clause 4.4. c) Sub-Clause 8.8: Instructing suspension of Works; d) Sub-Clause 10.1: Issuing Taking Over Certificate e) Sub-Clause 10.2: Issuing Taking Over Certificates f) Sub-Clause 11.9: Issuing Performance Certificate(s) g) Sub Clause 13.1: Instructing a Variation, except; i) in an emergency situation as determined by the Engineer, or ii) if such Variation would increase the Accepted Contract Amount not more than 1% cumulatively of such Amount. h) Sub-Clause 13.3: Approving a proposal for Variation submitted by the Contractor in accordance with Sub Clause 13.1 or 13.2. i) Sub Clause 13.4: Specifying the amount payable in each of the applicable currencies j) Sub-Clause 13.7: Before Adjustment for Changes in Legislation k) Sub-Clause 13.8: Before Adjustment for Changes in Cost l) Sub-Clause 20.1: Approving Claims of the Contractor (Time / Financial) under Clause 20.1 and accepting principles of the Claims Notwithstanding the obligation, as set out above, to obtain approval, if, in the opinion of the Engineer, an emergency occurs affecting the safety of life or of Works or adjoining property, he may, without relieving the Contractor of any of his duties and responsibility under the Contract, instruct the Contractor to execute all such work or to do all such things as may, in the opinion of the Engineer, be necessary to abate or reduce the risk. The Contractor shall forthwith comply, despite the absence of approval of the Employer, with any such instruction of the Engineer. The Engineer shall determine an addition to the

	Contract Price, in respect of such instruction, in accordance with Clause 13 and shall notify the Contractor accordingly, with a copy to the Employer.
Sub-Clause 3.6 Management Meetings	<i>Insert this Sub Clause at the end of Clause 3</i> “The Engineer or the Contractor’s Representative may require the other to attend a management meeting in order to review the progress with reference to the agreed program and arrangements for future works. The Engineer shall record the business of management meetings and supply copies of the record to those attending the meeting and to the Employer. In the record, responsibilities for any actions to be taken shall be in accordance with the Contract”.
Sub-Clause 4.3 Contractor’s Representative	<i>Insert additional paragraph at the end of Sub-Clause 4.3</i> The Contractor’s authorized representative and his other professional engineers working at site shall register themselves with the Pakistan Engineering Council.
Sub-Clause 4.4 Subcontractors	<i>Replace first line with the following:</i> The Contractor may subcontract the Works for the maximum value equal to 30% of the Accepted Contract Amount.
Sub-Clause 4.8 Safety Procedures	<i>Insert additional paragraphs at the end of Sub-Clause 4.8</i> In order to provide for the safety, health and welfare of persons, and for prevention of damage of any kind, all operations for the purposes of or in connection with the Contract shall be carried out in compliance with the Safety Requirements of the Government of Pakistan with such modifications thereto as the Engineer may authorise or direct and the Contractor shall take or cause to be taken such further measures and comply with such further requirements as the Engineer may determine to be reasonably necessary for such purpose. The Contractor shall make, maintain and submit reports to the Engineer concerning safety, health and welfare of persons and damage to property, as the Engineer may from time to time prescribe. The Contractor shall have on his staff at the site an officer dealing only with questions regarding the safety and protection against accidents of all staff and labour. This officer shall be qualified for this work and shall have the authority to issue instructions and shall take protective measures to prevent accidents. Adequate number of Site Safety Inspectors shall be deployed by Contractor to assist Accident Prevention Officer and ensure safety of workers in the hazardous work areas. The Contractor shall within 24 hours of the occurrence of any accident at or about the site or in connection with the execution of the Works report such accident to the Engineer with copy to the Employer. In case of any fatality or serious accident the Contractor shall in addition notify the Engineer immediately by the quickest available means. In case of fatal accident, the Engineer may suspend the Work till

	the Contractor enhances proper safety arrangements. Such suspension shall be at the Cost of the Contractor and no time extension shall be considered for such suspension. In the event of work being carried out at night, the Contractor shall at his own cost, provide and maintain such good and sufficient light as will enable the work to proceed satisfactorily and without danger. The approaches to the Site and the Works where the night-work is being carried out shall be sufficiently lighted. All arrangement adopted for such lighting shall be to the satisfaction of the Engineer.
Sub-Clause 4.18 Protection of the Environment	<i>Final paragraph to be added to after second paragraph</i> The Contractor shall exercise care to protect the natural landscape and shall conduct his construction operation so as to prevent any unnecessary destruction, scarring or defacing of the natural surroundings in the vicinity of the Works, except where clearing is required for permanent works, approved temporary works and for excavation operations. All trees and native vegetation shall be preserved and shall be protected from damage, which may be caused, by the Contractor's construction operations and equipment. On completion of the Works, all work areas shall be smoothed and graded in a manner to scarring damage or defacing may occur as a result of the Contractor's operations, it shall be repaired, replanted or otherwise corrected as directed by the Engineer at Contractor's expense. Borrow areas shall be located and operated so as not to detract from the future usefulness or value of the sites. Upon completion of operations, borrow areas shall be left in a safe and sightly conditions. No borrow areas shall be located within 500 meters from the right of way. During the performance of the work required under the Contract, the Contractor shall carryout proper and efficient measures as often as necessary to reduce the dust nuisance, and to prevent dust originating from his operations. For wastewater disposal, the provision of septic tank alone for worker's camp etc. will not be sufficient and may have to be supplemented with secondary treatment in form of gravel drains / constructed wetland depending on the laboratory results of effluent from the septic tank. The Contractor shall take all necessary measures to prevent water from the Site causing a nuisance on or, in any neighbouring land or property either by causing flooding or by depositing sediment on the surface of the ground or in drains or watercourses. Wherever necessary to prevent this, the Contractor shall construct temporary drainage channels, layer sumps and traps (in addition to those shown on the Contract) discharging into existing drain, ditches or watercourses. The Contractor snail removes over all sediment, which may accumulate on any land or in any drains, ditches or watercourses or in any other property as a result of his operations. All works including those below sub-soil standing water level

	shall be carried out in the dry unless specified otherwise. The Contractor's arrangements for controlling the inflow of water into the parts of the excavation being worked and during the placing of concrete and other works therein and for the collection and disposal of water shall be to the Engineer's Approval. Such arrangements may include interalia temporary cofferdams, well-point systems, pumps, drains trenches, flumes and other recognized means. All Costs and charges in dealing with water in any way whatsoever and the effects thereof will be deemed to be included in the Contract Price and in the unit rates or prices of the Contractor for excavations. Water flowing into excavations shall be carried by trenches, drainage layers or open jointed drains to sumps from which it shall be pumped. Such trenches drains or sands shall generally be clear of the Permanent Works unless approved otherwise by the Engineer. If, with the said Approval of the Engineer trenches drains or sumps are excavated under or immediately adjacent the Permanent Works, these shall comprise open-jointed pipes with gravel mounds. When no longer required and when approved by the Engineer they shall be filled with a cement /sand grout injected under pressure so as to fill the pipe and all voids completely. The Contractor shall keep all surfaces upon or against which concrete is to be deposited free from running water and no concrete shall be placed until such surfaces are properly drained. Suitable precautions shall be taken to prevent running water from washing out cement or concrete while it is setting or from injuring the Works in any other way. Notwithstanding the Approval by the Engineer of the Contractor's methods of dealing with water, the Contractor shall be responsible for and accept all the risks and liabilities of dealing with water from whatever source and of all effects thereof. The Contractor shall throughout the execution and completion of the Works and the remedying of any defects therein, comply with all applicable Environment Protection Laws and Regulations of the Country. For other details regarding Environment, Helath and Safety refer to Appendix L and M, SP-10 and SP-11, which are the integral part of the Contract Documents.
Sub-Clause 4.21 Progress Reports	<i>Add following paragraphs after paragraph (h)</i> (i) An updated construction schedule indicating the progress in percentage; and (j) Description of all works carried out since the last report; and (k) An updated Progress Curve/Projected Cash flow indicating the planned and actual progress; and (l) An updated Critical Resource Usage Chart showing comparison of planned and actual values; and (m) An updated material procurement plan showing

	comparison of planned and actual values; and (n) An updated schedule of shop drawings comparison of planned and actual values; and (o) Description of the Works planned for the next 28 days sufficiently detailed to enable the Engineer to determine his programme of inspection and testing; and (p) Summary of all submission; and (q) Information about problems and areas of concern and proposal to overcome the same.
Sub-Clause 6.5 Working Hours	<i>Add the following paragraph at the end of Sub-Clause 6.5:</i> The Contractor shall pay overtime payment to the Engineer's Support Staff/Personnel who were required by the Contractor to perform their respective work assignment beyond the normal working hours stated in Part A – Particular Conditions (Appendix A).
Sub-Clause 6.10 Records of Contractor's Personnel and Equipment	<i>The following paragraphs added:</i> The Contractor shall, upon request by the Engineer at any time in relation to any time of hired Contractor's Equipment, forthwith notify the Engineer in writing the name and address of the Owner of the equipment and shall certify that the agreement for the hire thereof contains a provision in accordance with the requirements set forth above.
Sub-Clause 6.20 Prohibition of Forced or Compulsary Labor	<i>Delete Text of Sub-Clause 6.20 and replace with following:</i> The Contractor, including its Subcontractors, shall not employ or engage forced labor. Forced labor consists of any work or service, not voluntarily performed, that is exacted from an individual under threat of force or penalty, and includes any kind of involuntary or compulsory labor, such as indentured labor, bonded labor or similar labor-contracting arrangements. No persons shall be employed or engaged who have been subject to trafficking. Trafficking in persons is defined as the recruitment, transportation, transfer, harboring or receipt of persons by means of the threat or use of force or other forms of coercion, abduction, fraud, deception, abuse of power, or of a position of vulnerability, or of the giving or receiving of payments or benefits to achieve the consent of a person having control over another person, for the purposes of exploitation
Sub-Clause 6.21 Prohibition of Harmful Child Labor	<i>Delete Text of Sub-Clause 6.21 and replace with following:</i> The Contractor, including its Subcontractors, shall not employ or engage a child under the age of 14 unless the national law specifies a higher age (the minimum age). The Contractor, including its Subcontractors, shall not employ or engage a child between the minimum age and the age of 18 in a manner that is likely to be hazardous, or to interfere with, the child's education, or to be harmful to the child's health or physical, mental, spiritual, moral, or social development. The Contractor including its Subcontractors, shall only employ or engage children between the minimum age and the age of 18 after an appropriate risk assessment has been conducted by the

	Contractor with the Engineer's approval. The Contractor shall be subject to regular monitoring by the Engineer that includes monitoring of health, working conditions and hours of work. Work considered hazardous for children is work that, by its nature or the circumstances in which it is carried out, is likely to jeopardize the health, safety, or morals of children. Such work activities prohibited for children include work: (a) with exposure to physical, psychological or sexual abuse; (b) underground, underwater, working at heights or in confined spaces; (c) with dangerous machinery, equipment or tools, or involving handling or (d) transport of heavy loads; (e) in unhealthy environments exposing children to hazardous substances, agents, or processes, or to temperatures, noise or vibration damaging to health; or (f) under difficult conditions such as work for long hours, during the night or in confinement on the premises of the employer
Sub-Clause 6.23 Workers' Organizations	<i>Insert sub-clause after Sub-Clause 6.22:</i> In countries where the relevant labor laws recognize workers' rights to form and to join workers' organizations of their choosing and to bargain collectively without interference, the Contractor shall comply with such laws. In such circumstances, the role of legally established workers' organizations and legitimate workers' representatives will be respected, and they will be provided with information needed for meaningful negotiation in a timely manner. Where the relevant labor laws substantially restrict workers' organizations, the Contractor shall enable alternative means for the Contractor's Personnel to express their grievances and protect their rights regarding working conditions and terms of employment. The Contractor shall not seek to influence or control these alternative means. The Contractor shall not discriminate or retaliate against the Contractor's Personnel who participate, or seek to participate, in such organizations and collective bargaining or alternative mechanisms. Workers' organizations are expected to fairly represent the workers in the workforce
Sub-Clause 6.24 Non-Discrimination and Equal Opportunity	<i>Insert sub-clause after Sub-Clause 6.23:</i> The Contractor shall not make decisions relating to the employment or treatment of Contractor's Personnel on the basis of personal characteristics unrelated to inherent job requirements. The Contractor shall base the employment of Contractor's Personnel on the principle of equal opportunity and fair treatment and shall not discriminate with respect to any aspects of the employment relationship, including recruitment and hiring, compensation (including wages and benefits), working conditions

	and terms of employment, access to training, job assignment, promotion, termination of employment or retirement, and disciplinary practices. Special measures of protection or assistance to remedy past discrimination or selection for a particular job based on the inherent requirements of the job shall not be deemed discrimination. The Contractor shall provide protection and assistance as necessary to ensure non-discrimination and equal opportunity, including for specific groups such as women, people with disabilities, migrant workers and children (of working age in accordance with Sub-Clause 6.24)
Sub-Clause 6.25 Epidemics	<i>Insert sub-clauses after Sub-Clause 6.24:</i> In the event of any outbreak of illness of an epidemic nature, the Contractor shall comply with and carry out such regulations, orders and requirements as may be made by the Government or the local medical or sanitary authorities, for the purpose of dealing with and overcoming the same.
Sub-Clause 7.9 Use of Pakistani Materials and Services	<i>Insert additional sub-clauses after Sub-Clause 7.8</i> The contractor shall, so far as may be consistent with the contract, make the maximum use of materials, supplies, plant and equipment indigenous to or produced or fabricated in Pakistan and services, available in Pakistan provided such materials, supplies, plant, equipment and services shall be of required standard.
Sub-Clause 8.1 Commencement of Works	<i>Delete paragraph (b) entirely and substituted with the following.</i> The contractor shall commence the works on site within the period named in Appendix-A to Bid from the date of receipt by him from the Engineer of a written Notice to Commence. Thereafter, the contractor shall proceed with the works with due expedition and without delay
Sub-Clause 8.2 Time for Completion	<i>Add following at the end of Clause</i> Jungle Cutting (subject to the approval of SMTA) in Sector 16 and 87 shall be completed by the Contractor within 15 days from the date of Commencement
Sub-Clause 8.3 Programme	Not Applicable
Sub-Clause 8.7 Delay Damages	Not Applicable
Sub-Clause 10.1 Taking Over of the Works and Sections	<i>Insert following as 3rd paragraph after 2nd paragraph</i> Within 07 days of the date of receipt of Contractor's notice for issuance of Taking Over Certificate the Employer shall on the written request of the Engineer constitute a committee comprising of Engineer/Engineer's Representative, Employer's and Contractor's Representatives. The Committee shall conduct a detailed inspection of the works completed by the Contractor to ascertain the completion or the extent of completion to decide about the issuance of Taking Over Certificate. The Engineer shall take further action on the Contractor's application in pursuance to the recommendations of the

	committee.
Sub-Clause 11.9 Performance Certificate	<i>Insert following as 2nd paragraph after 1st paragraph</i> At the completion of the Defects Notification Period the Employer shall constitute a committee comprising of Engineer / Engineer's Representative, Employer's and Contractor's Representatives. The Committee shall conduct a detailed inspection of the works to ascertain the issuance of Performance Certificate or otherwise.
Sub-Clause 13.1 Right to Vary	In the last line of Para, after the word "Variation", the word "in writing" is added.
Sub-Clause 13.3 Variation Procedure	In the tenth line, after the words "as soon as practicable" following is added: "and within a period not exceeding one-eighth of the completion time"
Sub-Clause 13.8 Adjustments for Changes in Cost	Delete Sub-Clause 13.8 and replace with following: Price Adjustment Formula: $P_n = 0.40 + 0.6 \frac{C_{Wn}}{C_{Wo}}$ "P_n" is the adjustment multiplier to be applied to the estimated contract value in Pakistan Rupees (PKR) of the work carried out in period "n", this period being a month. "C_{Wn}" is the current cost index for the period/month "n" (to which the particular Payment Certificate relates); and "C_{Wo}" is the base cost index applicable on the date 14 days prior to the bid submission date. The source for determining the base cost and current cost will be the official monthly cost index for CP "Construction Input Items" published by the Pakistan Bureau of Statistics (PBS) through the "Monthly Review of Price Indices". Depending on the location of construction site, either the index of "construction input items" under the CPI (urban) or CPI (rural) should be selected. All the historical publications are available at https://www.pbs.gov.pk/content/price-statistics.
Sub-Clause 14.1 The Contract Price	<i>Renumber subparagraphs (c) and (d) as (f) and (g) and delete subparagraph (e).</i> <i>Insert following paragraphs (c), (d) and (e):</i> (c) The Contract Price shall include all taxes (sales tax as well), duties and other charges imposed outside the Country on the production, manufacture, sale and transport of the Contractor's Equipment. Plant, Materials and supplies to be used on or furnished under the Contract, and on the services to be performed under the Contract. (d) The Contractor's staff and labour will be liable to pay personal income taxes in the Country in respect of such of their salaries and wages as are chargeable under the Laws for the time being in force, and the Contractor shall perform

	such duties in regard to such deductions thereof as may be imposed on him by such laws. (e) Notwithstanding the provisions of subparagraph (b), Contractor's Equipment, including essential spare parts therefore, imported by the Contractor for the sole purpose of executing the Contract shall be temporarily exempt from the payment of import duties and taxes upon initial importation, provided the Contractor shall post with the customs authorities at the port of entry an approved export bond or bank guarantee, valid until the Time for Completion plus six months, in an amount equal to the full import duties and taxes which would be payable on the assessed imported value of such Contractor's Equipment and spare parts, and callable in the event the Contractor's Equipment is not exported from the Country on completion of the Contract. A copy of the bond or bank guarantee endorsed by the customs authorities shall be provided by the Contractor to the Employer upon the importation of individual items of Contractor's Equipment and spare parts. Upon export of individual items of Contractor's Equipment or spare parts, or upon the completion of the Contract, the Contractor shall prepare, for approval by the customs authorities, an assessment of the residual value of the Contractor's Equipment and spare part to be exported, based on the depreciation scale(s and other criteria used by the customs authorities for such purposes under the provisions of the applicable Laws. Import duties and taxes shall be due and payable to the customs authorities by the Contractor on (a) the difference between the initial imported value and the residual value of the Contractor's Equipment and spare parts to exported; and (b) on the initial imported value that Contractor's Equipment and spare parts remaining in the Country after completion of the Contract. Upon payment of such dues within 28 days of being invoiced, the bond or bank guarantee shall be reduced or released accordingly; otherwise the security shall be called in the full amount remaining.
Sub-Clause 14.2 Advance Payment	<i>Delete the Clause in entirety and replace with following:</i> The Employer if requested by the Contractor shall make an interest free advance payment for mobilisation and cash flow support, when the Contractor submits a guarantee in accordance with this Sub-Clause. The total advance payment, the number and timing of instalments (if more than one) shall be as stated in the Appendix A. The Advance Payment (if required) shall be paid in two equal instalments after the following conditions have been fulfilled. Installment-1: 50% of the total amount of the Advance Payment • That the Contract Agreement has been signed by the Parties. • The Contractor has submitted bank guarantee for the full amount of the advance payment in the form of irrevocable

	without recourse bank guarantee. • The Contractor has submitted the Performance Security in the form as prescribed in Sub-Clause 4.2. Installmentt-2: Remaining 50% of the total amount of the Advance Payment shall be paid on mobilization of Plant, Equipment and other resources at site by the Contractor to the satisfaction of the Engineer. Unless and until the Employer receives this guarantee, or if the total advance payment is not stated in the Part-A (Appendix A), this Sub-Clause shall not apply. The Engineer shall deliver to the Employer and to the Contractor an Interim Payment Certificate for the advance payment or its first instalment after receiving a Statement (under Sub-Clause 14.3 [Application for Interim Payment Certificates]) and after the Employer receives (i) the Performance Security in accordance with Sub-Clause 4.2 [Performance Security] and (ii) a guarantee in amount equal to the advance payment. This guarantee shall be issued by an entity and from within a country (or other jurisdiction) approved by the Employer and shall be in the form annexed to the Particular Conditions or in another form approved by the Employer. The Contractor shall ensure that the guarantee is valid and enforceable until the advance payment has been repaid, but its amount shall be progressively reduced by the amount repaid by the Contractor as indicated in the Payment Certificates. If the terms of the guarantee specify its expiry date, and the advance payment has not been repaid by the date 28 days prior to the expiry date, the Contractor shall extend the validity of the guarantee until the advance payment has been repaid. At any time, the bank guarantee shall be valid for an amount not less than the amount of the original Advance Payment less any partial repayment of that Advance Payment which may have been affected. The Contractor shall inform the guaranteeing bank, by letter, counter signed by the Employer, of the required amount of the guarantee from time to time. Reduction of the amount shall not be made without such authorizing letter. Unless stated otherwise in the Appendix A, the advance payment shall be recovered proportionately from each monthly statement starting from second month after commencement and must be recovered in 6 equal instalments. If the advance payment has not been repaid prior to the issue of the Taking-Over Certificate for the Works or prior to termination under Clause 15 [Termination by Employer], Clause 16 [Suspension and Termination by Contractor] or Clause 19 [Force Majeure] (as the case may be), the whole of the balance then outstanding shall immediately become due and in case of termination under Clause 15 [Termination by Employer] and Sub-Clause 19.6 [Optional Termination, Payment and Release], payable by the Contractor to the Employer. In the event that the amount of money certified and due to the
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	Contractor under the contract at any time is less than the total of due repayments of Advance Payment, the balance of the due repayments shall be paid to the Employer by the Contractor within seven days of demand by the Employer. If the balance is not so paid, the Employer shall be empowered to call in sufficient of the Advance payment bank guarantee to cover the said balance. The Employer shall be empowered to call in the guarantee in whole or in part(s) if the Contractor defaults in the repayment(s) for any reason(s).
Sub-Clause 14.5 Plant and Materials intended for the Works	Deleted
Sub-Clause 14.8 Delayed Payment	<i>Second Para is replaced with following text:</i> In the event of the failure of the Procuring Agency to make the payment within the time stated, the procuring agency shall pay to the contractor the compensation at rate of 8% per annum (simple interest) in local currency, upon all sums to be paid from the date of which the same would have been paid.
Sub-Clause 14.15 Currencies of Payment	Currency of Payment is Pakistan Rupee (PKR).
Sub-Clause 15.6 Corrupt and Fraudulent Practices	<i>The following text is to be added as 3rd paragraph:</i> <i>Successful Contractor has to provide Integrity Pact (for contracts worth Rs.10.0 million and above).</i> If the Contractor or any of his Subcontractors, agents or servants is found to have violated or involved in violation of the Integrity Pact signed by the Contractor as Appendix-L to his Bid, then the procuring agency shall be entitled to: - 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 Subcontractors, agents or servants; - terminate the Contract; and - 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 Subcontractors, agents or servants. The termination under sub-para (b) of this Sub-Clause shall proceed in the manner prescribed under sub-clauses 15.2 & 15.5 and the payment under Sub-Clause 15.4 shall be made after having deducted the amounts due to the procuring agency under Sub-Para (a) and (c) of this Sub-Clause.
Sub-Clause 16.1 Contractor's Entitlement to Suspend Work	<i>Delete words "... Sub-Clause 2.4 [Employer's Financial Arrangements] or ..." from first paragraph</i> Delete paragraph 2 in entirety (i.e. from words "Notwithstanding" to "notification from the bank").
Sub-Clause 16.2 Termination by Contractor	<i>Delete paragraph (a) in entirety.</i>
Sub-Clause 17.3	Delete paragraph (a) in entirety.

Employer's Risks	
Sub-Clause 18.1 General Requirements for Insurance	<i>Add following text</i> The contractor shall be obliged to place all insurances relating to the contract (including, but not limited to, the insurances referred to in Clauses 18.1,18.2,18.3,18.4) with Insurance Company having at least AA rating from PACRA/JCR in favour of the Employer valid for a period 28 days after the expiry of Defects Liability Period. Costs of such insurances shall be borne by the contractor.
Sub-Clause 19.6 Optional Termination, Payment and release by the Employer	Delete paragraph (c), (d) and (e) in entirety.
Sub-Clause 20.1 Contractor's Claims	<i>Insert following at the end of Sub-Clause 20.1</i> The Contractor shall not be entitled for any extension of Time for Completion and/or additional payment in respect of the claim(s) if the Contractor fails to comply with the requirements or any of the requirement of Sub-Clause 20.1 within the time period stipulated there in the Clause above mentioned and or fails in keeping and producing necessary records whenever demanded by the Engineer.
Sub-Clause 20.6 Arbitration	<i>Delete the Clause in entirety and replace with following</i> Any dispute in respect of which: <i>the decision of the Dispute Board has not become final and binding pursuant to sub-clause 20.2, and</i> <i>amicable settlement has not been reached within the period stated in sub-clause 20.5, shall be finally settled, under the provisions of the Arbitration Act, 1940 as amended or any statutory modification/Rules of Conciliation and Arbitration PEC Islamabad or re-enactment thereof for the time being in force.</i> The place of arbitration shall be Karachi. The arbitrators shall have full power to open up, review and revise any certificate, determination, instruction, opinion or valuation of the Engineer, and any decision of the DB, relevant to the dispute. Nothing shall disqualify representatives of the Parties and the Engineer from being called as a witness and giving evidence before the arbitrators on any matter whatsoever relevant to the dispute. Neither Party shall be limited in the proceedings before the arbitrators to the evidence or arguments previously put before the DB to obtain its decision, or to the reasons for dissatisfaction given in its notice of dissatisfaction. Any decision of the DB shall be admissible in evidence in the arbitration. Arbitration shall be commenced after completion of the Works. The obligations of the Parties, the Engineer and the DB shall not be altered by reason of any arbitration.

APPENDIX: DISPUTE BOARD

General Conditions of Dispute Board Agreement

1. Definitions

Each “Dispute Board Agreement” is a tripartite agreement by and between:

- (a) the “Employer”;
- (b) the “Contractor”; and
- (c) the “Member” who is defined in the Dispute Board Agreement as being:
 - (i) the sole member of the "DB" and, where this is the case, all references to the “Other Members” do not apply, or
 - (ii) one of the three persons who are jointly called the “DB” (or “Dispute Board”) and, where this is the case, the other two persons are called the “Other Members.”

The Employer and the Contractor have entered (or intend to enter) into a contract, which is called the "Contract" and is defined in the Dispute Board Agreement, which incorporates this Appendix. In the Dispute Board Agreement, words and expressions which are not otherwise defined shall have the meanings assigned to them in the Contract.

2. General Provisions

Unless otherwise stated in the Dispute Board Agreement, it shall take effect on the latest of the following dates:

- (a) the Commencement Date defined in the Contract,
- (b) when the Employer, the Contractor and the Member have each signed the Dispute Board Agreement, or
- (c) when the Employer, the Contractor and each of the Other Members (if any) have respectively each signed a dispute board agreement.

This employment of the Member is a personal appointment. At any time, the Member may give not less than 70 days’ notice of resignation to the Employer and to the Contractor, and the Dispute Agreement shall terminate upon the expiry of this period.

3. Warranties

The Member warrants and agrees that he/she is and shall be impartial and independent of the Employer, the Contractor and the Engineer. The Member shall promptly disclose, to each of them and to the Other Members (if any), any fact or circumstance which might appear inconsistent with his/her warranty and agreement of impartiality and independence.

When appointing the Member, the Employer and the Contractor relied upon the Member's representations that he/she is:

- (a) experienced in the work which the Contractor is to carry out under the Contract,
- (b) experienced in the interpretation of contract documentation, and
- (c) fluent in the language for communications defined in the Contract.

4. General Obligations of the Member

The Member shall:

- (a) have no interest financial or otherwise in the Employer, the Contractor or Engineer, nor any financial interest in the Contract except for payment under the Dispute Board Agreement;
- (b) not previously have been employed as a consultant or otherwise by the Employer, the Contractor or the Engineer, except in such circumstances as were disclosed in writing to the Employer and the Contractor before they signed the Dispute Board Agreement;
- (c) have disclosed in writing to the Employer, the Contractor and the Other Members (if any), before entering into the Dispute Board Agreement and to his/her best knowledge and recollection, any professional or personal relationships with any director, officer or employee of the Employer, the Contractor or the Engineer, and any previous involvement in the overall project of which the Contract forms part;
- (d) not, for the duration of the Dispute Board Agreement, be employed as a consultant or otherwise by the Employer, the Contractor or the Engineer, except as may be agreed in writing by the Employer, the Contractor and the Other Members (if any);
- (e) comply with the annexed procedural rules and with Sub-Clause 20.4 of the Conditions of Contract;
- (f) not give advice to the Employer, the Contractor, the Employer's Personnel or the Contractor's Personnel concerning the conduct of the Contract, other than in accordance with the annexed procedural rules;
- (g) not while a Member enter into discussions or make any agreement with the Employer, the Contractor or the Engineer regarding employment by any of them, whether as a consultant or otherwise, after ceasing to act under the Dispute Board Agreement;
- (h) ensure his/her availability for all site visits and hearings as

are necessary;

- (i) become conversant with the Contract and with the progress of the Works (and of any other parts of the project of which the Contract forms part) by studying all documents received which shall be maintained in a current working file;
- (j) treat the details of the Contract and all the DB's activities and hearings as private and confidential, and not publish or disclose them without the prior written consent of the Employer, the Contractor and the Other Members (if any); and
- (k) be available to give advice and opinions, on any matter relevant to the Contract when requested by both the Employer and the Contractor, subject to the agreement of the Other Members (if any).

5. General Obligations of the Employer and the Contractor

The Employer, the Contractor, the Employer's Personnel and the Contractor's Personnel shall not request advice from or consultation with the Member regarding the Contract, otherwise than in the normal course of the DB's activities under the Contract and the Dispute Board Agreement. The Employer and the Contractor shall be responsible for compliance with this provision, by the Employer's Personnel and the Contractor's Personnel respectively.

The Employer and the Contractor undertake to each other and to the Member that the Member shall not, except as otherwise agreed in writing by the Employer, the Contractor, the Member and the Other Members (if any):

- (a) be appointed as an arbitrator in any arbitration under the Contract;
- (b) be called as a witness to give evidence concerning any dispute before arbitrator(s) appointed for any arbitration under the Contract; or
- (c) be liable for any claims for anything done or omitted in the discharge or purported discharge of the Member's functions, unless the act or omission is shown to have been in bad faith.

The Employer and the Contractor hereby jointly and severally indemnify and hold the Member harmless against and from claims from which he is relieved from liability under the preceding paragraph.

Whenever the Employer or the Contractor refers a dispute to the DB under Sub-Clause 20.4 of the Conditions of Contract, which will require the Member to make a site visit and attend a hearing, the Employer or the Contractor shall provide appropriate security for a sum equivalent to the reasonable expenses to be incurred by the Member. No account shall be taken of any other

payments due or paid to the Member.

6. Payment

The Member shall be paid as follows, in the currency named in the Dispute Board Agreement:

- (a) a retainer fee per calendar month, which shall be considered as payment in full for:
 - (i) being available on 28 days' notice for all site visits and hearings;
 - (ii) becoming and remaining conversant with all project developments and maintaining relevant files;
 - (iii) all office and overhead expenses including secretarial services, photocopying and office supplies incurred in connection with his duties; and
 - (iv) all services performed hereunder except those referred to in sub-paragraphs (b) and (c) of this Clause.

The retainer fee shall be paid with effect from the last day of the calendar month in which the Dispute Board Agreement becomes effective; until the last day of the calendar month in which the Taking-Over Certificate is issued for the whole of the Works.

With effect from the first day of the calendar month following the month in which the Taking-Over Certificate is issued for the whole of the Works, the retainer fee shall be reduced by one third. This reduced fee shall be paid until the first day of the calendar month in which the Member resigns or the Dispute Board Agreement is otherwise terminated.

- (b) a daily fee which shall be considered as payment in full for:
 - (i) each day or part of a day up to a maximum of two days' travel time in each direction for the journey between the Member's home and the site, or another location of a meeting with the Other Members (if any);
 - (ii) each working day on Site visits, hearings or preparing decisions; and
 - (iii) each day spent reading submissions in preparation for a hearing.
- (c) all reasonable expenses including necessary travel expenses (air fare in less than first class, hotel and subsistence and other direct travel expenses) incurred in connection with the Member's duties, as well as the cost of telephone calls, courier charges, faxes and telexes: a receipt shall be required for each item in excess of five percent of the daily fee referred to in sub-paragraph (b) of this Clause;
- (d) any taxes properly levied in the Country on payments made to the Member (unless a national or permanent resident of the Country) under this Clause 6.

The retainer and daily fees shall be as specified in the Dispute Board Agreement. Unless it specifies otherwise, these fees shall remain fixed for the first 24 calendar months, and shall thereafter be adjusted by agreement between the Employer, the Contractor and the Member, at each anniversary of the date on which the Dispute Board Agreement became effective.

If the parties fail to agree on the retainer fee or the daily fee, the appointing entity or official named in the Contract Data shall determine the amount of the fees to be used.

The Member shall submit invoices for payment of the monthly retainer and air fares quarterly in advance. Invoices for other expenses and for daily fees shall be submitted following the conclusion of a site visit or hearing. All invoices shall be accompanied by a brief description of activities performed during the relevant period and shall be addressed to the Contractor.

The Contractor shall pay each of the Member's invoices in full within 56 calendar days after receiving each invoice and shall apply to the Employer (in the Statements under the Contract) for reimbursement of one-half of the amounts of these invoices. The Employer shall then pay the Contractor in accordance with the Contract.

If the Contractor fails to pay to the Member the amount to which he/she is entitled under the Dispute Board Agreement, the Employer shall pay the amount due to the Member and any other amount which may be required to maintain the operation of the DB; and without prejudice to the Employer's rights or remedies. In addition to all other rights arising from this default, the Employer shall be entitled to reimbursement of all sums paid in excess of one-half of these payments, plus all costs of recovering these sums and financing charges calculated at the rate specified in Sub-Clause 14.8 of the Conditions of Contract.

If the Member does not receive payment of the amount due within 70 days after submitting a valid invoice, the Member may (i) suspend his/her services (without notice) until the payment is received, and/or (ii) resign his/her appointment by giving notice under Clause 7.

7. Termination

At any time: (i) the Employer and the Contractor may jointly terminate the Dispute Board Agreement by giving 42 days' notice to the Member; or (ii) the Member may resign as provided for in Clause 2.

If the Member fails to comply with the Dispute Board Agreement, the Employer and the Contractor may, without prejudice to their other rights, terminate it by notice to the Member. The notice shall take effect when received by the Member.

If the Employer or the Contractor fails to comply with the Dispute Board Agreement, the Member may, without prejudice to his other rights, terminate it by notice to the Employer and the Contractor. The notice shall take effect when received by them both.

Any such notice, resignation and termination shall be final and binding on the Employer, the Contractor and the Member. However, a notice by the Employer or the Contractor, but not by both, shall be of no effect.

8. Default of the Member

If the Member fails to comply with any of his obligations under Clause 4 (a) - (d) above, he shall not be entitled to any fees or expenses hereunder and shall, without prejudice to their other rights, reimburse each of the Employer and the Contractor for any fees and expenses received by the Member and the Other Members (if any), for proceedings or decisions (if any) of the DB which are rendered void or ineffective by the said failure to comply.

If the Member fails to comply with any of his obligations under Clause 4 (e) - (k) above, he shall not be entitled to any fees or expenses hereunder from the date and to the extent of the non-compliance and shall, without prejudice to their other rights, reimburse each of the Employer and the Contractor for any fees and expenses already received by the Member, for proceedings or decisions (if any) of the DB which are rendered void or ineffective by the said failure to comply.

9. Disputes

Any dispute or claim arising out of or in connection with this Dispute Board Agreement, or the breach, termination or invalidity thereof, shall be finally settled by institutional arbitration. If no other arbitration institute is agreed, the arbitration shall be conducted under the Rules of Arbitration of the International Chamber of Commerce by one arbitrator appointed in accordance with these Rules of Arbitration.

Annex: Procedural Rules

Unless otherwise agreed by the Employer and the Contractor, the DB shall visit the site at intervals of not more than 140 days, including times of critical construction events, at the request of either the Employer or the Contractor. Unless otherwise agreed by the Employer, the Contractor and the DB, the period between consecutive visits shall not be less than 70 days, except as required to convene a hearing as described below.

The timing of and agenda for each site visit shall be as agreed jointly by the DB, the Employer and the Contractor, or in the absence of agreement, shall be decided by the DB. The purpose of site visits is to enable the DB to become and remain acquainted with the progress of the Works and of any actual or potential problems or claims, and, as far as reasonable, to endeavour to prevent potential problems or claims from becoming disputes.

Site visits shall be attended by the Employer, the Contractor and the Engineer and shall be co-ordinated by the Employer in co-operation with the Contractor. The Employer shall ensure the provision of appropriate conference facilities and secretarial and copying services. At the conclusion of each site visit and before leaving the site, the DB shall prepare a report on its activities during the visit and shall send copies to the Employer and the Contractor.

The Employer and the Contractor shall furnish to the DB one copy of all documents which the DB may request, including Contract documents, progress reports, variation instructions, certificates and other documents pertinent to the performance of the Contract. All communications between the DB and the Employer or the Contractor shall be copied to the other Party. If the DB comprises three persons, the Employer and the Contractor shall send copies of these requested documents and these communications to each of these persons.

If any dispute is referred to the DB in accordance with Sub-Clause 20.4 of the Conditions of Contract, the DB shall proceed in accordance with Sub-Clause 20.4 and these Rules. Subject to the time allowed to give notice of a decision and other relevant factors, the DB shall:

- (a) act fairly and impartially as between the Employer and the Contractor, giving each of them a reasonable opportunity of putting his case and responding to the other's case, and
- (b) adopt procedures suitable to the dispute, avoiding unnecessary delay or expense.

The DB may conduct a hearing on the dispute, in which event it will decide on the date and place for the hearing and may request that written documentation and arguments from the Employer and the Contractor be presented to it prior to or at the hearing.

Except as otherwise agreed in writing by the Employer and the Contractor, the DB shall have power to adopt an inquisitorial procedure, to refuse admission to hearings or audience at hearings to any persons other than representatives of the Employer, the Contractor and the Engineer, and to proceed in the absence of any party who the DB is satisfied received notice of the hearing; but shall have discretion to decide whether and to what extent this power may be exercised.

The Employer and the Contractor empower the DB, among other things, to:

- (a) establish the procedure to be applied in deciding a dispute,

- (b) decide upon the DB's own jurisdiction, and as to the scope of any dispute referred to it,
- (c) conduct any hearing as it thinks fit, not being bound by any rules or procedures other than those contained in the Contract and these Rules,
- (d) take the initiative in ascertaining the facts and matters required for a decision,
- (e) make use of its own specialist knowledge, if any,
- (f) decide upon the payment of financing charges in accordance with the Contract,
- (g) decide upon any provisional relief such as interim or conservatory measures, and
- (h) open up, review and revise any certificate, decision, determination, instruction, opinion or valuation of the Engineer, relevant to the dispute.

The DB shall not express any opinions during any hearing concerning the merits of any arguments advanced by the Parties. Thereafter, the DB shall make and give its decision in accordance with Sub-Clause 20.4, or as otherwise agreed by the Employer and the Contractor in writing. If the DB comprises three persons:

- (a) it shall convene in private after a hearing, in order to have discussions and prepare its decision;
- (b) it shall endeavour to reach a unanimous decision: if this proves impossible the applicable decision shall be made by a majority of the Members, who may require the minority Member to prepare a written report for submission to the Employer and the Contractor; and
- (c) if a Member fails to attend a meeting or hearing, or to fulfil any required function, the other two Members may nevertheless proceed to make a decision, unless:
 - (i) either the Employer or the Contractor does not agree that they do so, or
 - (ii) the absent Member is the chairman and he/she instructs the other Members not to make a decision.

SP-10 PROTECTION OF THE ENVIRONMENT

10.1 GENERAL

The Contractor shall take all necessary measures and precautions and otherwise ensure that the execution of the works and all associated operations on-site are carried out in conformity with statutory and regulatory environmental requirements of Federal & Provincial Environmental Protection Agencies (EPA's) including those prescribed elsewhere in this document.

The Contractor shall take all the measures and precautions to avoid any nuisance or disturbance arising from the execution of the works. This shall wherever possible be achieved by suppression of the nuisance at source rather than abatement of the nuisance once generated. The provision of this SP shall, however, be disregarded in respect of emergency work required for saving life or the safety of the works. However, after completing such works of emergent nature, suitable environmental mitigation measures will be adopted by the contractor with the approval of Engineer.

In the event of any spoil or debris or silt from the sites being deposited on adjacent land, the Contractor shall immediately remove such spoils, debris or silt and restore the affected areas to its original state to the satisfaction of both the Engineer and the landowner.

Surplus excavation materials and topsoil shall, wherever possible, be used to reinstate quarries or borrow pits or other areas as may be approved by the Engineer. Such materials should be spread in such a manner as to limit subsequent erosion and the site shall be re-vegetated as existing ground cover dictates.

10.2 *Borrow-Pits for Embankment Construction*

Borrow-pits shall not be dug in the right of way of the road. However, even outside the ROW, depending upon type of soil strata, depth of water table, ground topography and prevalent vegetation state etc, a minimum distance for such borrow areas will be pre-specified by the Engineer. The main ruling factors for determining such distances will be the highway safety from capillary action where pore pressure may damage the pavement and the water stagnation, becoming a source of disease vector.

10.3 *Quarry Operations*

The Contractor shall obtain materials from licensed and government approved quarries only. The quarry operation shall be undertaken within the purview of the rules and regulations in force.

10.4 *Soil Erosion and Sedimentation Control*

The Contractor shall carry out the works in such a manner that soil erosion is fully controlled, and sedimentation and pollution of natural watercourses, ponds, tanks and reservoirs is avoided. At suitable places sedimentation basin with impervious linings will be constructed for containing, stopping and

trapping any silt run off for premature siltation of downstream watercourses and reservoirs.

10.5 Conservation of Fauna and Flora

The Contractor shall adopt all measures and take necessary precautions to avoid disturbance to fauna and flora, as far as possible. Felling of trees and removal of vegetation for fuel or other uses will not be practiced.

10.6 Fuel and Chemical Storage

All fuel and chemical storage shall be sited on an impervious base within an embanked area and secured by fencing. The storage area shall be located away from any watercourse or wetland. The base and walls of the embankment shall be impermeable and of sufficient capacity to contain 110% of the volume of tanks.

Filling and refueling shall be strictly controlled and subjected to formal procedures. All valves and trigger guns shall be resistant to unauthorized interference and vandalism and be turned off and securely locked when not in use. The contents of any tank or drum shall be clearly marked. Measures shall be taken to ensure that no contamination happens, or discharges enter any drain or water courses.

10.7 Water Quality

The Contractor shall prevent any interference with the supply to or abstraction from polluted water sources (including underground percolating water) as a result of execution of the works.

Areas where water is regularly or repetitively used for dust suppression purposes shall be laid to fall to specially constructed settlement tanks to permit sedimentation of particulate matter. After resettlement, the water may be re-used for dust suppression.

All water and liquid waste products arising on the sites shall be collected and disposed of at location outside or off site and in a manner that shall not cause nuisance or pollution.

The Contractor shall not discharge or deposit any matter arising from the execution of the works into any place except with the permission of the Engineer and the regulatory authorities concerned.

The Contractor shall protect all watercourses, water ways, ditches, canals, drains, lakes and the like from pollution, silting flooding or erosion as a result of the execution of the works.

The Contractor shall submit the details of his temporary drainage works system (including all surface channels, sediment traps, washing basins and discharge-pits) to the Engineer for approval prior to commencing work on its construction.

10.8 *Air Quality*

The Contractor shall devise and arrange methods of working to minimize dust, gaseous or other air borne emissions and carry out the works in such a manner as to minimize adverse impacts on air quality.

Bituminous hot-mix plants and concrete batching plants shall be located sufficiently away from habitation, agricultural operations or industrial establishments.

The Contractor shall utilize effective after sprays during the delivery and handling of materials when dust is generated and dampen stored material during dry weather.

Stockpiles of materials should be sited in sheltered areas or within hoarding, away from sensitive areas. Stockpiles of friable materials shall be covered with clean tarpaulins with application of sprayed water during dry and windy weather. Stockpiles of debris shall be dampened prior to their movement, except where this is contrary to the specifications.

Any vehicle with an open load carrying area used for transport of potentially dust producing materials shall have properly fitting side and tailboards. Materials having potential to produce dust shall not be loaded to a level higher than the side and tail boards and shall be covered with clean tarpaulin in good condition. The tarpaulin should be properly secured and extended to at least 300 mm over the edges of the sideboard and tailboard.

During high wind, no dust generating operations shall be permitted within 200 m of residential areas having regard to the prevailing direction of the wind.

Construction vehicles and machinery shall be kept in good working order and engine turned off when not in use. Appropriate measures shall be taken to limit exhaust emissions from construction vehicles, machinery and plant and the Contractor shall include details of such proposed measures in the mitigation and monitoring plan to be submitted to the Engineer.

In residential areas or other sensitive areas, such as nurseries, schools, hospitals, etc. advance warning shall be given to potentially affected persons so that some measures can be taken by them before commencement of the works.

Any open vehicle carrying a load of freshly mixed asphalt concrete for transportation and laying the pavement must have a full cover of tarpaulin sheet. In this manner its toxic fumes will be reduced against any atmospheric contamination.

10.9 *Noise*

The Contractor shall consider noise as an environmental concern in his planning and during execution of the works.

The Contractor shall use plant and equipment conforming to international standards and directives on noise, vibrations and emissions shall include the

details of measures for abating noise at source in the mitigation and the monitoring plan to be submitted to the Engineer.

10.10 TRANSMISSION OF DISEASES

Contractor shall take all necessary measures to prevent transmission of diseases between inhabitants and the labourers engaged for the works, especially with regard to sexually transmitted diseases. The Contractor shall install the necessary medical facilities for this purpose.

The Contractor shall verify that checkup for detecting the occurrence of sexually transmitted diseases amongst the labourers engaged for the works are actually being carried out and submit a certificate to that effect to the Engineer.

10.11 PRESERVATION OF ARCHAEOLOGICAL, CULTURAL, RELIGIOUS ASSETS/HERITAGE VALUE AND ANTIQUITIES

The Contractor shall take all necessary measures to protect any archaeological finds or antiquities as required.

Where antiquities are shown on the drawing or otherwise identified during the course of the works, these shall be protected by means of suitable fencing and barriers to the satisfaction of the Engineer. The Contractor shall provide and maintain access at all time for persons wishing to stop and pay their respects.

10.12 ENVIRONMENT ENHANCEMENT

All existing highways and roads used by vehicle of the Contractor or any of his sub-contractors or suppliers of materials or plant, and similarly any new roads which are part of the works and which are being used by traffic, shall be kept clean and clear of all dust/mud or other extraneous materials dropped by the said vehicles or their tyres. Similarly, all dust/mud or other extraneous materials from the works spreading on these highways shall be immediately cleared by the Contractor.

Clearance shall be affected immediately by manual sweeping and removal of debris, or, if so, directed by the Engineer, by mechanical sweeping and clearing equipment, and all dust, mud and other debris shall be removed entirely from the road surface. Additionally, if so, directed by the Engineer, the road surface shall be hosed or watered using suitable equipment.

Any structural damage caused to the existing roads by the Contractor's construction equipment shall be made good without any extra cost.

On completion of the works, the Contractor shall reinstate all areas with proper vegetation to the satisfaction of the Engineer.

The Contractor shall remove all old tyres and internal rubes from within the limits of right of way and subject to the agreement of adjacent landowners for additional areas of 75 m on either side of the road centerline. The Contractor shall dispose of all materials in a manner approved by the Engineer.

Where directed by the Engineer, the Contractor shall improve and reinstate the land on which informal roadside service area has been established, by removing all debris and contaminated soils, regarding to natural ground levels and reestablishing the original vegetation where appropriate. All debris and contaminated materials shall be disposed of on site as approved by the Engineer.

10.13 MEASUREMENT AND PAYMENT

The work under clause SP-10 (Protection of the Environment) shall neither be measured nor be paid separately. The cost incurred in this respect shall be deemed to have been included in other items of work.

In case of failure of the contractor to comply with all or any provision(s) of this clause the damage(s) caused shall be attributable towards the Contractor, and the Engineer shall assess the amount of such damage(s) which shall be deducted from the monies due or to become due to the Contractor. However, the said amount may be reimbursed to the Contractor on rectification of all damage caused and subsequent certification by the Engineer that the said damage has been rectified by the Contractor at his own cost as per the requirements specified herein above.

Where directed by the Engineer, the Contractor shall improve and reinstate the land on which informal roadside service area has been established, by removing all debris and contaminated soils, regarding to natural ground levels and reestablishing the original vegetation where appropriate. All debris and contaminated materials shall be disposed of on site as approved by the Engineer.

However, for third party monitoring of protection of environment and Environment Mitigation Measures, the Employer is planning to hire the services of third party whose fees will be paid through the Contractor for which Provisional Sum will be provided in the BOQ.

SP-11 HEALTH, SAFETY & ENVIRONMENTAL (HSE)

11.1 GENERAL HSE REQUIREMENTS

11.1.1 Compliance to Laws/Regulations/Company Requirements

The Contractor shall comply with all applicable Health, Safety and Environmental (HSE) laws and regulations including fire and security, which are applicable to the location where the works are being carried out.

The Contractor shall indemnify the Employer against all legal costs, fines and compounds imposed and claims and damages incurred as a result of breach or non-compliance with relevant laws and regulations. Contractor shall comply at all times with the requirements as set forth by the Employer in this contract. These requirements are intended to supplement any known or ought to be known laws and regulations applicable at the location where the works are being carried out.

The Contractor shall take all necessary HSE precautions related to or arising out of the performance of the Contract in order to protect the work, the personnel and property of the Employer, the Engineer, the Contractor, Subcontractor, all third parties and public from the hazards associated with the work.

The Contractor shall implement permits/permission based system for all hazardous activities.

11.1.2 Contractor Written Policy/Organization

The Contractor shall acknowledge the Employer's strong commitment to HSE and affirm that it has a written HSE policy which is a standard comparable to international standards and which has been signed and is actively supported and endorsed by the Contractor's management.

The Contractor shall further affirm that its HSE policy is widely disseminated and understood among the Contractor and Subcontractor's employees.

The work's policy should allow workers to refuse work for non safe work practices or if they feel that their safety is being jeopardized.

11.1.3 Protection of Employees, Public, Assets and Environment

The Contractor shall protect the safety and health of workers and people living or working near the construction activity from potential hazards created by that activity. The Contractor, without cost to the Employer, must take all necessary precautions to protect the public and minimise disturbance and inconvenience to the public resulting from performance of the work.

Throughout performance of the work, the Contractor shall conduct all operations in such a way as to minimize any impact upon the natural environment including compliance with all laws, regulations and rules applicable to the site. The Contractor agrees to indemnify the Employer and the Engineer and their staff for all claims, damage costs and penalties relating to any environmental damage or loss or non-compliance with any laws or regulations arising out of the Contractor and / or Subcontractor performance of works.

11.1.4 Right to Stop Work

The Engineer or his designated representatives shall have the right to prohibit commencement of works or to stop any works in progress if the equipment, machinery, personnel or work conditions are considered to be unsafe or not to be in compliance with any applicable rules, regulations and procedures.

Stoppage of the work shall be at the Contractor's expense until the Contractor has satisfactorily rectified such unsafe acts and condition. In the event of serious or repeated infringements, the Employer may terminate the contract without compensation.

11.1.5 Maintain Equipment and Machinery in a Safe Condition

The Contractor shall ensure that all Contractor's machinery, plant & equipment, facilities and other items in any way associated with or utilised in the work are fit for use and maintained in a safe and good working condition.

11.1.6 Risk Management and Hazards Identification

The Contractor shall make an initial assessment of the HSE risks involved in the execution of the works. The focus of the assessment should be to evaluate the inherent hazards in conducting the work and the potential adverse consequence of an accident to the workforce, the public and the environment, company assets and reputation.

The Contractor shall take appropriate measures to prevent incidents from occurring and to minimise the consequence of an event should it occur.

The Contractor shall conduct HSE inspections and audits to ensure that such preventive measures are carried out. The Contractor shall promptly conform to all recommendations made pursuant to the said inspections and audits.

11.1.7 Competent Personnel

The Contractor shall ensure that competent personnel are fully trained and certified to carry out the task of operating all machinery, equipment, and tools. The Contractor shall provide an adequate level of technical and HSE related training conducted by a recognized training institution for all relevant personnel in connection with the work. All Contractor's supervisory personnel shall attend relevant HSE training and be competent in hazard identification.

The Contractor shall ensure that all Contractor and Subcontractors personnel engaged in the works are healthy and fit, and possess the experience and skill required to perform the works.

11.1.8 HSE Awareness

The Contractor shall be responsible for maintaining and enhancing the HSE awareness among its personnel and subcontractor's personnel, including arranging safety induction, toolbox, regular HSE meetings and emergency drills.

Findings of hazard identification including Job Safety Analysis shall be communicated to the Contractor's personnel. Copies of minutes of the Contractor's safety meetings shall be submitted to the Engineer.

11.1.9. Incident Reporting

The Contractor shall report to the Engineer immediately of the occurrence of any incident or accident including near misses. The Contractor shall also alert

fire brigade, police and /or other authorities relevant to the incidents or accidents. The Contractor shall be responsible for reporting accidents and incidents to relevant Government Agencies.

All incidents or accidents that result in or have the potential to cause serious injury or property damage must be suitably investigated by the Contractor and reported to the Engineer.

The Contractor shall maintain accurate incident and injury reports and shall comply with the Engineer's requests for information relating to accidents, injury or illnesses.

11.1.10. Housekeeping

The Contractor shall ensure that good housekeeping is maintained continuously throughout the duration of the work. Due regard being paid to proper disposal of scrap material, tidiness, and clear access ways and emergency exits.

Access and egress of all exits, fire and safety equipment, and work areas must be kept clear of obstructions at all times. Special attention must be given to maintaining clear walkways, removal of slippery and tripping hazards, securing or removing of loose materials at height, and proper storage of materials. Oily or chemical soaked rags must be disposed of in a proper manner. All housekeeping shall be at The Contractor's cost.

11.2. SPECIFIC HSE REQUIREMENTS

11.2.1. Site SHO/Safety Supervisor

The Contractor shall, at Contractor's cost, provide such numbers of qualified Safety and Health Officers (SHO) or supervisors who will be responsible to provide guidance and advice pertaining to Health, Safety and Environment (HSE) requirements of works. He shall guide Contractor's management on hazard assessment and measures, with equal diligence being paid to fulfillment of the contractual technical specifications.

In addition to the ongoing monitoring of the site, the Contractor's SHO or supervisors shall also perform a formal inspection of the site at least once every week to identify and correct any hazardous conditions noted. A written record of all inspections and their status of action follow-ups shall be given to the Engineer.

Prior to start of works, the Contractor shall submit the CV of the proposed SHO or supervisors for the Engineer's approval.

11.2.2. Project HSE Plan

One week, prior to mobilization, the Contractor shall prepare and submit a project specific HSE plan to the Engineer which, as a minimum, describes the followings:

- Prevailing laws and regulations
- Contractor's HSE policy
- Contractor's organization including position for HSE manager
- HSE responsibilities of key personnel
- Hazards review including control and mitigating measures
- Description and schedule of HSE activities

- Accident/incident reporting
- Emergency response plan
- Internal Audit mechanism for improving HSE plans.

The Engineer's review or comments on such plan shall not relieve nor shall such review and comments to be construed as limiting in any manner the Contractor's obligations to undertake any action which may be necessary to establish and maintain safe working conditions at the location where the works are being carried out.

11.2.3. Equipment Safety Inspections

Prior to start of works, the Contractor is required to inspect the equipment and machinery required in connection with the works including but not limited to cranes, bulldozers, trucks, tractors, rigs, dumpers, etc., to ensure that works will be performed under safe condition.

In addition, the Contractor shall maintain and perform continuous safety inspection throughout the works and shall promptly implement all recommendations made pursuant to the said inspection.

The Engineer shall have the right to conduct its own safety audit or inspection at worksite. The Contractor shall comply with all recommendations arising from such audit or inspection.

The Contractor shall ensure that all fuel powered and electrical equipment working in the vicinity of flammable vapors is equipped with proper ignition protective devices. The Contractor shall ensure that only permitted personnel by way of previous technical training and familiarization are allowed to operate and/or maintain equipment and machinery.

11.2.4. Personal Protective Equipment (PPE)

The Contractor shall at its own cost, supply its personnel and subcontractor's personnel required in connection with the works with adequate PPE and maintain enforcement on the use of such PPE.

The Contractor shall purchase PPE in accordance with the following specification - PPE STANDARDS & TECHNICAL SPECIFICATIONS.

1	Safety Glasses	Frame: Wide vision, clear plastic eye shield with side protection which can be worn over spectacles Lenses: Clear polycarbonate affording BS2092 Grade 2 impact protection Marking: all eye shields shall be appropriately and distinctly stamped with the authentic trademarks of the Manufacturer's monogram and standards. Accessories: Neck strap only Certificate: Manufacture's Certificate of compliance to standards. ANSI Z 87.1-1979 ANSI ZZ 87.1-1979 AS 1337-1981 BS 2092, BS1542, BS679,
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		DIN 4646/58211
2	Safety Shoes for general use	Hazard control: Crush from heavy objects (steel toe), Cuts and Puncture, Slip (oil resistant sole), Trip & Fall and Electrocution. ANSI Z 41.1-1967 AS 2210 EN 345
	For chemical use	Hazard control: Crush from heavy objects(steel toe), Slip(oil resistant sole), Trip & Fall and Chemical contact BS 1870/3 , DIN 4843
3.	Coverall	One-piece coverall, Long Sleeve. Flame/fire retardant material Nomex III A (DuPont Product) Weight : min 150 gm/m ² Colour : Dark Green
4	Hand Protection Cotton Glove Leather Cotton Glove PVC Glove	All types of gloves, cotton, leather or PVC conforming to BS 1651 are acceptable. Knitted Cuffs, palm, thumb and forefinger with anti-slip, PVC Dots. Overall length 250mm Cotton drill knitted cuffs with chrome leather palm. Overall length 250mm PVC over knit cotton interlock standard weight and smooth surface. Length 400 mm.
5	Hearing Protection Ear muff Ear muff on helmet Ear plug/insert	Adjustable all-purpose headbands BS 6344, ANSI S 3.19 Adjustable BS 6344, ANSI S 3.19 Expandable Foam, Non -toxic and Nonirritant ANSI Z 24.22 ANSI s 3.19-74 BS 5108, ISO 4869
6	Head Protection	Peak type, Chemical resistance complete with hot press branding adjustable headband, Clip and Elastic chin straps Material: ABS (Acrylic Butadiene Styrene Added with Nitrile) ANSI Z 89.2-71, ANSI Z 89.1-86 class B, AS 1808-81, BS 5240, DIN 4840
7	Eye/face Protection Chemical splash goggle Face shield	Goggles with hooded ventilation - 2 (face shield (9) in combination with safety glasses - 4, 5) ANSI Z87.1-68 Goggles or Safety glasses - 1,3, 4, 5 (for severe exposure face shield – 9)

	Welding goggles	ANSI Z 89.1 Welding goggles with tinted lenses 6, 7, 8 (for severe exposure face shield - 9) ANSI Z 87.1-68, ANSI Z 87.1-79
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8	Safety Harness/lifebelt	The harnesses shall be constructed of shock-absorbing material e.g. Webbing manufactured from synthetic fiber. Similar, safety lanyards shall also be of synthetic fibers e.g. Polyamide, nylon or polyester. To reduce possible injuries to the users from decelerating forces, safety harnesses, the leg and shoulder load-carrying straps at least 38mm (1.5 inches) wide. Each safety harness must be provided with one or more D-rings suitably positioned for attachment to a safety lanyard. They shall withstand a 5000 lb (2300 kg) force without breaking or cracking. Buckles should be of a universal-friction type. Harnesses with load-bearing single-insertion type buckles are not permitted. Snap hooks for safety lanyards shall be of the self-closing type and shall be designed so that disengagement of each of the latches requires a deliberate action. All harnesses and safety lanyards shall carry test certificates or certificates of compliance to the standards to which they are manufactured. Two types of safety harnesses are recommended, and they are classified according to their intended use:- Chest Harness - Class II Body Harness - Class III AS1891, BS1397, MS707, LS 954-lanyard
9	Personal floatation Devices(PFD's) Life Jacket Work Vest	It is intended as an aid to turn an unconscious person in the water from a face down position to a vertical and slightly backward position which greatly increases the chance of survival. Type 1 PFD USGC(US Coast Guard) It is intended as an aid to floatation should the wearer fall into the water. Type V PFD USGC(US Coast Guard)
10	Breathing Apparatus	BS 4667, NIOSH
11	Self-contained Breathing Apparatus	NIOSH, ANSI, AS, BS
12	Other Respirator for protection from dust,	BS 2091, NIOSH, EN 149

	vapors, etc.	
13	Fire Fighting Suits	NFPA 1971, NBSIR 75, US OSHA CFR 1010 VOL 45

11.2.5. Mechanical Equipment Operation

The Contractor shall upon arrival at the worksite, inspect all mechanical construction equipment that is to be utilized in the work.

The equipment will include but may not be limited to the following:

- Cranes
- Dozers
- Graders
- Rollers
- Excavators
- Forklifts
- Dumpers
- Semi-Trailers and Prime Movers
- Compressors
- Temporary Electrical Distribution Boards
- Scaffolding equipment
- Rigging equipment
- Man-cages/Personal Baskets
- Aerial Work Platforms
- Etc

All equipment inspected that requires remedial work (or replacement) shall be carried out at the Contractor's cost.

All equipment inspected and accepted for use on the work shall be clearly identified by a tagging system.

11.2.6. Occupational Health

The Contractor shall ensure that all its employees and subcontractor employees engaged in the work are medically fit and healthy. Any medical diseases or disabilities which the Contractor may consider will not adversely influence the employee's ability to perform his role in the work, should be reported to the Engineer prior to start of the work.

The Contractor shall at no cost to the Employer be responsible for the medical welfare of its own and subcontractor employees and shall take care of arrangements for medical attendance, treatment or hospitalization if and when necessary and will arrange suitable insurance coverage for such contingencies.

The Contractor shall at its own expense have a fully equipped first aid station on site and make arrangement for availability of an ambulance. This station will be manned during all working hours.

The Contractor shall ensure that its personnel and subcontractor's personnel shall maintain a high standard of hygiene in connection with the performance of the work.

The Contractor shall provide where necessary sufficient hygienic drinking fluids and toilet facilities to meet health regulations and all other legislated requirements.

11.2.7. Confined Space

The Contractor shall take precautions which include gas/oxygen tests, PPE requirement, respiratory equipment, isolation of connections to confined space, provide ventilation and making confine space free from fumes, place person on standby, ensure availability of rescue equipment and team.

The Contractor's SHO or supervisor shall ensure that all necessary precautions and protective measures are implemented.

The person(s) shall be certified medically fit before they are allowed to work in confined space.

11.2.8. Emergency Response Preparedness

The Contractor, at its own cost, shall ensure adequate provision for emergency response at site for all hazardous and risky works, which as a minimum, includes the following;

- fire fighting
- fire prevention
- accidents or incidents
- epidemic spread
- first aid medical facilities
- any other hazardous/risky activity identified during execution

The Contractor personnel shall be trained and competent in the use of firefighting equipment effectively.

The Contractor shall also ensure its first aiders are trained and competent to render such services effectively.

11.2.9. Tools and Equipment

The Contractor shall ensure that all Contractor's machinery, tools and equipment, facilities, and other items associated with the works whether purchased or rented are maintained in a safe condition and to be operated by competent operators. Tools shall only be used for the job they were designed to perform. All guards must be fitted and shall be in good condition at all times. All grinding discs must be checked for correct size and speed prior to fitting. Electrically powered tools shall meet the hazardous zones requirement where applicable. All electric cables shall be industrial type. Use of domestic electric cables is prohibited. The Contractor shall repair or replace defective tools and equipment at its own cost. Appropriate personal protective equipment must be worn at all times when using any tool or equipment.

11.2.10. Compressed Gas Cylinders

The Contractor shall ensure that:

- ✓ Mineral and Industrial Gases Safety Rules, 2010 should be followed.

- ✓ Compressed gas cylinders are stored, transported or used shall be in an upright position and secured to some substantial object or structure by a chain or other suitable means capable of supporting the weight of the cylinder. This applies to all cylinders, whether empty or full.
- ✓ Cylinder valves shall be closed, and hoses depressurized when cylinders are not in use.
- ✓ Cylinders shall have protective valve caps in place while they are being transported/stored.
- ✓ Cylinders shall be returned promptly to a suitable storage area after use. They shall not be left at any worksite. Cylinder storage areas should be kept away from general traffic paths and must not be adjacent to vehicle paths.
- ✓ Flammable gases and oxygen cylinders must not be stored in close proximity unless separated by a non-combustible wall.
- ✓ Cylinders may only be hoisted when enclosed in an approved box or cradle within which they are securely fastened.
- ✓ Cylinders must be identified by a colour code in accordance with Malaysian or respective national standards.
- ✓ Gas welding cylinders shall have hose check valve (non-return valves), which allow gases to the blowpipe, but not back from it. Flashback arrestors shall be installed to quench flashback flames and cut off the gas flow automatically, in both oxygen and fuel gas outlet lines.

11.2.11. Welding and Cutting

The Contractor shall ensure only competent, authorized workers be allowed to use welding equipment. Hard hats are not required to be worn by welders during actual process of welding if there is no immediate potential for head injury.

The Contractor shall ensure suitable precautions against exposure of welding hazards such as excessive ultraviolet radiation, fire, or dusts.

Welding, and/or flame cutting in the vicinity of flammable or combustible items shall only done under the control of qualified persons.

The Contractor shall provide adequate number of suitable fire extinguishers at a welding site. Welders must be competent in the use of these extinguishers.

The Contractor shall carried out all welding and cutting works following WB EHS General Guidelines, OSHA regulations, AWS/ASME/BS/CEN/ISO relevant standards.

11.2.12. Grit Blasting

The Contractor shall take permit prior to grit blasting. The Contractor shall provide the blaster with an approved air mask and oil free air supply. Associated workers and any other personnel within the blasting area must wear approved respiratory protection. The blasting gun must have a 'dead man' safety device operated by the blaster. Under no circumstances the device be tied back.

The Contractor shall made efforts to minimize the exposure of the blasting grit to the surrounding environment. Protective shield shall be erected, and notice board shall be posted in order to prevent exposure of the blasting grit.

11.2.13. Chemicals

The Contractor shall ensure all requirements for storage, handling and personal protection outlined in the material safety data sheet are followed.

Solvents, cleaners and cleaning agents must not be stored or used in unventilated areas or in immediate proximity to any sources of ignition. Quantities of such materials greater than needed for one day's work must be stored outside the work area in a proper storage facility. Smoking is not permitted while using or in the vicinity of any such chemical.

11.2.14. Driving/Vehicle Safety

The Contractor's personnel travelling to and from worksite shall use proper means of transport. Such transport shall comply with the Pakistan Statutory Rules made under the Road Traffic. Transportation of personnel in open trucks is prohibited unless fitted with seats and certified to carry passengers. The Contractor shall be responsible to provide safe access and egress to the worksite. The Contractor shall set allowable speed limit and place suitable road signs at the worksite.

The Contractor shall maintain and enhance the awareness of safe driving among its employees and its subcontractors. This includes wearing of seat belt, observing speed limit, maintain good vehicle condition, driving defensively and possess valid driving license.

11.2.15. Electrical Safety/Power Source

No part of any lifting device or any equipment operated around power lines is closer than below:

150-750 V	2.0 m
750- 50k V	3.0m
50k-250k V	4.5m
250kV	6.0m

For High Tension Lines 9.0m

The above clearance applies in all directions. All overhead lines shall be identified with a highly visible sign placed 7m from both sides of the lines, 1.8m above ground. A restriction guard pole connected with ropes shall be installed to restrict clearance close to power lines.

It is mandatory to follow NEPRA Power Safety Code 2014 for all electrical works

11.2.16. Excavation

The Contractor shall ensure that all excavation works shall meet the following requirements as a minimum:

- ✓ Prior to embarking excavation work, proper design and plan shall be drawn up taking into account the soil type and the weather conditions and proximity to facilities.
- ✓ Walkways between trenches should be kept clear of obstruction.

- ✓ A competent person must inspect all excavations, shafts, tunnels and earthworks of any description each day when persons are working.
- ✓ A standby person shall be made available at all times equipped with all necessary safety equipment.
- ✓ All excavation exceeding 1.5 meters shall be shored. For excavation exceeding 2 meters deep, a confined space permit shall be secured.
- ✓ No mechanical excavation within 1 meter of the existing service is allowed. All underground services must be hand exposed and identified.
- ✓ All excavation operations should be carried out following WB EHS General Guidelines., ISO 93.02, ILO standards, OSHA standards.

11.2.17. Barricade, Platforms and Guardrails.

The Contractor shall provide adequate barricades, covers, guardrails, signal flag persons or other appropriate warning devices to protect personnel near any hazardous operations or overhead work. Temporary covers for floor openings shall be firmly fastened and clearly identified by warning signs.

All elevated work areas, walkways, platforms etc. whether permanent or temporary, shall be protected by an approved guardrail (consisting of an upper and intermediate rail and toe board) and shall provide a sturdy working space. The Contractor shall provide all the necessary signs, barriers, flag persons, etc. to protect the general public from exposure to injury from the work.

11.2.18. Scaffold

A safe means of access must be provided for any work to be carried out at a height greater than 2 meters above ground. If a suitable permanent access is not available, a well-designed, erected, inspected and maintained scaffold will provide a safe means of access and safe working areas. Additionally, safe access to scaffold work platforms by ladder must be provided. All scaffoldings shall be constructed in accordance with B.S 5973 Code of Practice for Access and Working Scaffolds and Special Scaffold Structures in Steel or its equivalent.

All scaffolding materials and components shall be as follows:

a. Scaffold tubes

All tubes must be galvanized steel 48.3mm OD and wall thickness 4mm comply to BS 1139 Part 1, 1982 and free from cracks, splits or excessive corrosion and straight. Black steel or aluminum scaffold not allowed in offshore.

b. Coupling and fittings

They must be of sound construction, comply with BS 1139, Part 2. Do not mix tubular and fittings of different standards.

c. Board or decking

All timber scaffold boards shall meet the international standards.

d. Ladders (If Applicable)

Ladders shall meet BS 1129:1982.

e. Frame or tubular scaffold

Only proprietary steel frame or tubular scaffold of sound design and construction are allowed as per manufacturer specification.

f. Inspection (If Applicable)

A scaffold inspector shall inspect all scaffold material. Any scaffold above 40 meters must be designed and endorsed by a professional structural and forward to DOSH.

g. Erection

Scaffolds must only be erected, altered or dismantled by competent scaffolder under supervision of a chargeh and scaffolder. All inspection of any scaffold shall be done by a scaffold inspector.

11.2.19. Camp Site

The Contractor shall construct and operate the camp in accordance to the following requirements:

- Air-condition rooms
- Electrical equipment and wiring to safety standard
- Smoking in bedrooms prohibited
- All fuel lines are properly connected
- Smoke detectors in rooms
- Fire extinguishers at strategic locations
- Evacuation procedures posted

11.2.20. Office

The Contractor shall maintain comfortable working condition in office as follows:

- Temp 20-26 deg C
- Humidity 40-60%
- Adequate ventilation
- No smoking policy
- Photocopy placed away from personnel workstations
- Adequate lighting comfortable to the eyes at 400 lux
- Recommend white ceiling
- Colorful posters/picture on walls
- Office space at 6.25 sq. m per workstation
- Welfare facilities e.g. toilet, eating area
- Cleaning daily
- Clear passageways, remove tripping hazards
- Emergency plans for evacuation
- Ensure car park well-lit and control of vehicle movement
- Office chairs with 5 wheels and adjustable seat height and back rest
- Reduce VDU screen glare
- Frequent breaks for key board operator
- Gentle stretching exercise before work and after lunch

- Keep first aid box

11.2.21. Storage/Warehouse

The Contractor shall ensure an acceptable means for storing of material, chemical and fuel on sites. The requirements for storing of materials shall also include the following:

- Construction material shall be stored at the designated on site location
- Written procedures on handling and disposal for all material must be made available
- Good housekeeping must be practiced at all storage sites
- Storage areas must be located away from vehicular traffic at areas
- Storage floors and bins shall be labeled and constructed to safely support the loads that are to be imposed upon them with a posted appropriate maximum safe load limits provided
- Storage buildings and warehouses must be provided with an approved lighting, well ventilated and constructed with a fire resistance or explosion proof facilities where appropriate for the chemicals or fuel stored.
- Welding, cutting or any other operations that create sparks must be prohibited inside a warehouse or near the flammable/combustible material storage yards
- Adequate number of fire extinguishers of appropriate type shall be made available at all storage areas and warehouses.
- All personnel shall wear approved hard hats while in storage areas.
- Flammable and combustible liquids shall be stored separately preferably in storage buildings.
- Storage rooms shall be constructed to meet the required fire-resistant rating for their use
- Approved safety cans/cabinets shall be used to store and transfer flammable and combustible liquids, with the name of the material clearly stamped
- “No Smoking” signs shall be posted at storage areas involving flammable and combustible liquids

11.2.22. Explosives

The Contractor shall ensure that every reasonable precaution will be taken to ensure that Contractor’s personnel dealing with the explosives observe recognized industry regulations in the correct transportation, storage and usage of explosives. Similar precautions must be exercised when dealing with other potentially hazardous sources e.g. flammable substances.

The Contractor shall obtain all relevant permits and comply with the regulatory requirements for the use of explosives.

11.2.23. Transportation

Whether by land, sea or air, the Contractor is obliged to follow recognized industry guidelines for the safe transport of personnel and equipment.

11.2.24. Lifting

All cranes supplied by the Contractor shall be tested before going into service and witnessed by the Engineer and a competent person. All associated lifting equipment shall be inspected.

The Contractor shall maintain cranes in a safe condition and make repair or replace unsafe crane for works. Should there be any doubt to the safety of the crane, the Contractor may be required to perform load test at the Contractor's cost.

A colour coding shall be used to identify inspected lifting appliance. The Contractor shall seek approval from the Engineer on any heavy lifting of 15 tons and above. The Contractor is responsible for ensuring that a competent, authorised worker operates any lifting device and that a signaler is designated to signal the operator as necessary to properly place and control the loads.

Prior to performing any lift, the operator shall determine the weight of the object being lifted and ensure that cables, lifting device and any slings, wire rope, chains etc used in the lift are of a sufficient strength to support the weight of the load.

No worker shall be allowed under the load. Tag lines must be used to guide and control the load where excessive movement is possible.

A competent worker shall inspect all wire rope, chains, and slings prior to performing any lift. Record of inspection shall be kept for the Engineer's review. During winch or tow, all personnel must be clear of the 'whip area' of cable under tension.

All lifting operations must be carried out using OHSA, ISO and other international standards and regulations.

11.2.25. Heavy Machinery

All Contractor's vehicles on any worksite must have proper insurance, be in safe operating condition.

They must be operated by a competent, properly licensed operator. It shall be operated in a safe manner and a speed suited to the terrain and weather condition.

All cranes, stringing trucks, heavy and tracked equipment and machinery, welding rigs and all vehicles except passenger vehicles must be fitted with reverse alarms. Any vehicle with restricted vision shall not operate in the vicinity of workers, except under the direction of a designated worker who is in a position to see that the way is clear and safe.

11.2.26. Security

The Contractor shall provide adequate number of security personnel and security measures to safeguard the worksite from any threat, damage or theft of properties. The Contractor's security personnel shall be equipped with communication equipment and able to contact police and other emergency units as required.

The Contractor shall provide shelter, facilities and amenities to enable such functions or duties to be performed properly and to the satisfaction of safety officer.

11.2.27. Drugs and Alcohol

The use, sale, dispensing or possession of drugs, narcotics and alcoholic beverages is prohibited on the location and at any place where the work is performed.

The Contractor shall ensure that its personnel do not at any time, during the performance of the work, partake, brought onto the worksite, or be under the influence of any alcoholic liquor, drug or other intoxicating substance. This prohibition also covers all legal or prescription drug which may impair an employee's ability to perform his job safely. Employees who are caught using or in possession of drugs, on the job site shall be discharged. The Employer reserves the right to randomly require the Contractor's employee, to undergo drug test at any time. Drugs test may be used in the event of accident investigation. The Contractor undertakes that each and every person engaged by it or on its behalf to perform any element of the work (including Sub-Contractor) shall be advised of the local laws relating to the importation and/or possession of drugs.

11.2.28. Statistics Board

The Contractor is required to install a Loss Production Scoreboard to highlight achievement/milestone for safe working hours of employees.

The Contractor shall install the above at each site office. The Loss Production Scoreboard shall be of acceptable material and shall contain the following information as a minimum (in English and Urdu):

Name of CONTRACTOR_____

Date Start of Work.

Safety Target without LTA (Manhours, Year)____

Best Record Achieved (Manhours, Year)____

Current Manhours Achieved (Manhours, Year)____

Date of Last Loss Time Accident _____

Total Number of Loss Time Accidents_____

All lettering in the Safety Scoreboard shall be of suitable sizes and shall be visible from at least 10 meters distance.

11.2.29. Safety Induction

The Contractor shall implement a safety induction for the site. The Contractor shall identify its employees who will be required to attend the safety induction program. The induction briefing shall be applicable to all employees and sub-contractor's employees. The participation of all staff is mandatory.

Briefing shall be done at site prior to the commencing of the construction activities.

Each worker who has attended and completed the safety induction program shall be issued with a sticker to indicate that he has completed the safety induction course. The sticker shall be displayed on the safety hat and worn at site.

11.2.30. Toolbox HSE Meeting

The Contractor shall ensure that his appointed works supervisor hold 'toolbox' safety meeting for about 5-10 minutes daily or prior to each shift. Specific topics shall include hazards relevant to current work, review of accidents and near misses and deficiencies and any new equipment or machinery. The Contractor shall maintain records of attendance and submit to the Engineer as and when required.

11.2.31. HSE Meetings

The Contractor shall form a Safety Committee at work site and shall hold regular meetings, minimum monthly to create and maintain an active interest in safety. The meeting shall be attended by the Contractor management and workers representatives and chaired by the Engineer or his representative. Minutes of meeting shall be distributed to all attendees.

11.2.32. Working at Height

When working at height more than 7.5 meters, the Contractor shall provide suitable safety nets, which extends 2.5 meters beyond the edge of work level. The nets shall be sufficiently anchored using steel hooks or shackle. The net shall be inspected daily.

If nets are impractical, the Contractor shall provide to the workers fall protection devices such as belts, harness etc. Fall protection is required when working above 3 meters. Personnel using fall protection shall be instructed on its use.

All works carried out at height should comply with European Directives/BS/OHSA/ILO/ISO standards, regulations and directives

11.2.33. Air hose

Air hose should not be used to clean any part of the body or clothing or use to blow off dirt on the floor.

11.2.34. Safety Inspection/Audits

Prior to commencement of works, the Contractor is required to inspect the worksite and equipment involved to ensure that works will be performed under safe conditions. In addition, the Contractor shall maintain and perform continuous safety inspection throughout the works and shall promptly implement all recommendations made pursuant to the said inspection. The Employer/ Engineer shall have the right to conduct its own safety audit/Inspection at the worksite. The Contractor shall comply with all recommendations arising from such audit/Inspection.

11.2.35. Safety Performance Target

The Contractor shall implement and establish a safety management award program to recognize the achievement and milestone for safe working performance for its employees.

11.2.36. Abrasive Wheels

The Contractor shall ensure that safety protection in the form of goggles and /or shields are provided and utilized by the personnel working with grinding machines and abrasive wheels. When changing discs on a portable grinder it is imperative that a suitable replacement disc is fitted and placed in the correct manner. The Contractor shall ensure only trained and competent personnel are permitted to carry out this task.

11.2.37. Contractor HSE Performance Reports

The Contractor shall compile and maintain HSE performance records pertaining to its work. These records shall be updated and submitted to the Engineer's representative monthly or as and when required.

11.2.38. Contractor Training Records

The Contractor shall provide adequate training to all its personnel to ensure that they have sufficient knowledge and skill to undertake assigned tasks. The Contractor's training records shall be maintained and controlled.

11.2.39. Job Safety Analysis (JSA)

Prior to performance of works, the Contractor shall implement JSA as a safety precaution to eliminate or guard against hazards on a specified job. The JSA methodology shall include the following:

- Study the job and develop basic job steps
- Identify the hazards on each job step
- Identify the safety precautions to be taken against each job step
- Record the JSA and inform all workers of the hazards and precautions to be taken.

11.2.40. Incident Notifications and Investigation

The Contractor shall develop an accident/incident reporting system. Any hazardous incident involving the Employer, the Engineer, the Contractor's or any third-party personnel, plant or equipment, shall be immediately reported to the Engineer, irrespective of whether there is injury to personnel or damage to plant or equipment.

All incidents that result in or have the potential to cause serious injuries or property damage must be suitably investigated by the Contractor and reported to the Engineer. The Contractor shall keep a copy of the report at site. The Contractor is required to investigate and report major accident to the concerned government department in accordance with the regulatory requirements. The investigation and report shall not preclude any similar investigations and reports required by the governmental authority in accordance with any relevant laws and regulations and maybe handled concurrently with them.

Upon completion of the work under the contract and/or on an annual basis, whichever is more frequent, the Contractor shall prepare a summary report of its HSE performance together with an accident statistic.

The Employer and the Engineer should be notified by the Contractor of any incident/accident as per Clause 4.8 of the Conditions of Contract.

11.2.41. Use of Public Road

The Contractor shall keep public roads free from its debris due to vehicle movement to and from site. The Contractor shall provide washing facilities at site to clean vehicle tyres. In the event of spillage onto the road, the Contractor shall undertake the cleaning at its own cost.

11.3. MEASUREMENT AND PAYMENT

The work under this SP-11 (Health & Safety) shall neither be measured nor be paid separately. The cost incurred in this respect shall be deemed to have been included in other items of work.

In case of failure of the contractor to comply with all or any provision(s) of this SP-11, the damage(s) caused shall be attributable towards the Contractor, and the Engineer shall assess the amount of such damage(s) which shall be deducted from the monies due or to become due to the Contractor.



**GOVERNMENT OF SINDH
SINDH MASS TRANSIT AUTHORITY
TRANSPORT & MASS TRANSIT DEPARTMENT**



**Sindh
Mass Transit
Authority**

MAINTENANCE OF BRTS GREEN AND ORANGE LINES

**“MISCELLANEOUS REPAIR/REPLACEMENT/MAINTENANCE
WORKS OF ROAD, BUILDINGS, ELECTRICAL, HVAC AND MEP
WORKS AT BRT GREEN & ORANGE LINE CORRIDORS”**

BID DOCUMENTS VOLUME- II

SPECIFICATION (SINGLE STAGE TWO ENVELOPE)

September 2026

TABLE OF CONTENT

1. Road Work etc., (refer to NHA Specs)
2. Public Health Work
3. Civil Work (Structure & Architecture)
4. Electrical Work
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6. HVAC Work
7. DCC Work

Road Works SPECIFICATIONS

For Road Works Technical Specification, refer to NHA's General Specification 1998. All the bidders should obtained the copy of Specifications from NHA (NHA Specification 1998 is copy right document illegal copy should be avoided)

PUBLIC HEALTH ENGINEERING WORKS

SECTION - 1

1. GENERAL

- 1.1. This General Specification is to be taken as applying to all the works in this Contract. Figured dimensions on the working drawings shall be followed in preference to the scale.
- 1.2. Until and unless specified otherwise, all goods and materials are to be Pakistan manufactured and to be of the best quality, and where not otherwise specified shall be according to latest engineering practice and conforming to Pakistan Standards (P.S) or British Standard Specifications (B.S.S) or Standard of American Society of Testing Materials (ASTM). The Engineer or the Consultants may also supplement such specifications during the progress of work.
- 1.3. All materials and goods used for such and other items shall be subjected to standard testing and if found below the specified standard such as PS or BSS or ASTM or their equivalent shall be removed from the site immediately at Contractor's own expense. All testing of materials finished and unfinished, shall be carried out by the Contractor at his cost, in the presence of Engineer or Engineer or his Representative for which the Contractor shall maintain a reasonably well equipped laboratory of his own, close to the site of work or make any other additional arrangement to the satisfaction and convenience of the Engineer. The Contractor shall include testing charges in his quotations and shall not be entitled to any reimbursement on this account for routine testing.
- 1.4. The Contractor must give early attention to the submission of samples of materials for approval of the Engineer, indicating the names of the manufacturing firms where applicable especially of cement, sand, aggregates, steel, water, tiles, hard-core and all fittings. Whenever practicable, samples shall be submitted at least three weeks before it is proposed to use the materials. Until and unless specified otherwise and whenever materials are ordered to be forwarded to a testing laboratory other than site laboratory for check/ testing, the Contractor will be reimbursed the cost of fees for such tests if proved satisfactory, by the Employer. The Contractor, however, will be required to bear the cost of the fees for tests, which proved unsatisfactory.
- 1.5. The Contractor must take all steps necessary to prevent damage or interference with all supply lines such as water, electric power, fuel, telephones, drains, buried cables and any construction designed for the use of the public, government or semi government authorities or the Employer. The Contractor shall be responsible for any damage caused to such services

or constructions and settle all claims in respect of such damage.

- 1.6. The Contractor shall protect from injury by covering all work, internally and externally needing protection including new concrete, Formwork, surface renderings, floors, etc., to the satisfaction of the Engineer, including the work of his sub-contractors at his own cost.
- 1.7. The whole work shall be carried out in the best manner in accordance with the instructions contained in these documents and those given by the Engineer from time to time during the progress of the work. The work shall be carried out in conformity with the best of the standard construction practices preferably the British Codes of Practices.
- 1.8. The Contractor shall submit to the Engineer for his approval before beginning the work, a complete plan of the proposed sequence and methods of operations for the execution of the works. Detailed drawings showing the location and construction of dumping and working platforms, cranes, building and all other structures in connection with the Contractor's plant and material storage sheds shall also be submitted to the Engineer for his approval before construction.
- 1.9. Orders and directions may be given orally by the Engineer or his Representative, and shall be received and promptly obeyed by the Contractor or his Representative or any superintendent or foreman or any supervisor of the Contractor whosoever may have charge of the particular part or section of work in relation to which the orders or directions are given, and a confirmation in writing of such order or directions will be given to the Contractor by the Engineer, if so requested. The Contractor shall provide and maintain at his own expense during the performance of the work an office in the vicinity of work. Orders or directions, written or oral, from the Engineer or his Representative delivered at such office shall be considered as delivered to the Contractor. The Contractor's office shall be fitted with a telephone connected to the local Telephone Exchange.
- 1.10. The Contractor shall not use the site for any other purpose than that of carrying out this Contract work. The operations of the Contractor shall be confined to the area immediately adjoining the buildings and the works included in this Contract but site clearance shall be kept to the satisfaction of the Engineer to permit carrying out of other works by other Contractors. The Contractor shall not affix advertisements; neither shall he permit advertisements to be displayed without the written consent of the Engineer.
- 1.11. The contract drawings are the working drawings to guide the Contractor generally about the shape and size of all the structures and fittings. Before proceeding to make preparations, fabrication, execution, erection of any such fittings and other details of any temporary works, scaffolds, railings, shuttering, details of doors, windows, partitions, iron mongers work, etc; the

Contractor shall be under obligation to prepare and submit all detailed shop drawings to the satisfaction and the approval of the Engineer, before doing any or all of that described above or as directed. Approval of the contractor's drawings shall not relieve the Contractor for any part of his obligation to meet all the requirements of the specifications or correctness of his drawings.

- 1.12. No cement work shall be permitted during extreme cold weather when unless otherwise authorized by the engineer.

2. PAYMENT

Contractor shall not be entitled to any separate or additional payment on account of all these general requirements and any other arrangement or action Contractor has to undertake under the direction of the Engineer for a proper carrying out of the works and meeting all obligations of the Contract.

SECTION – 2

EXCAVATION, FILLING, BACKFILLING AND DISPOSAL

1. GENERAL EXCAVATION AND BACKFILLING

The work covered by this section of the specifications consists of furnishing all plants, equipment, appliances, labour and materials in performing all operations in connection with excavating, filling and backfilling for all types of construction works including pipelines and other foundations complete in strict accordance with proper gradient, slope with top and bottom of trenches etc. as per specifications and drawings and subject to the terms and conditions of the Contract.

2. EXCAVATION – GENERAL

The Contractor shall remove the whole of the vegetation, top soil, concrete, flagging, paving, and curbing, road metalling and other materials from the site of any excavation and shall keep separately and preserve the same for reuse where applicable. The ground shall be excavated for the permanent and temporary works to the required depths, width and levels so that the dimensions of the permanent works shall not be less than as shown on the drawings or as may be directed by the Engineer.

All rubbish, filth and matter of an offensive nature taken out of any excavation shall be disposed off at once and not left on the surface within the site.

The major works for excavation involved in borrow pits indicated on drawings or otherwise proposed by the Contractor. The Contractor shall carryout the excavation in borrow areas for obtaining earth for construction of embankments. The Contractor shall provide necessary transport for excavated earth from the borrow areas to the site / location of embankment with means approved by the Engineer. The Contractor shall ensure that earth obtained from borrow areas is suitable for construction of embankments and shall not contain excess water. Excess water if any shall be removed by the Contractor through exposure to natural whether or through any other means approved by the Engineer. The borrow pits shall not be measured for accessing the quantity of earth required for excavation.

3. EXCAVATION – PIPELINES / SUMP WELL

- 3.1 The excavation shall be carried out to the required alignment, levels, slopes or gradients as per drawings or described in the specifications and bill of quantities taking into account bedding required below pipes or to such other dimensions and slopes as the Engineer may direct in writing to facilitate laying of pipes. The Contractor shall provide masonry pillars of suitable size and fix temporary benchmarks at intervals to be determined by the Engineer or his

representative. No trench excavations shall be commenced without prior approval of the Engineer. Excavation shall proceed at the same rate of laying, jointing and backfilling.

- 3.2 The quantity of excavation shall be the volume of materials removed from below the original surface of the ground to the limits of excavation specified or shown on the drawings. For soft and unstable soils, the Contractor shall provide adequate side supports. The cost of supply of all material, plant and labour necessary for site clearance, excavation, over break, timbering, sheet piling, shoring, shuttering, refilling, watering and ramming etc. shall be included in the Contract rates for excavation. In case sides or ends of any excavation collapse under self-weight or due to any other reason, the Contractor shall at his own cost remove all disturbed material. Should sides of ends of any excavation give way, the Contractor shall at his own cost remove all disturbed material. Any excavation outside the limits shown shall be treated as excess and shall not be paid for.
- 3.3 Where the Contractor has excavated to depths in excess of the requirements, he shall refill and compact the excess excavation with 1:4:8 cement concrete up to the correct level at his own cost. Any excavation done in excess of specified width due to any reason whatsoever shall not be paid.
- 3.4 For excavation the width of the trench shall be equal to the external diameter of the pipe plus 450 mm up to pipe diameters not exceeding 200 mm.
- 3.5 Additional excavation will be necessary at all valves chambers, sump well and pipe welding joints to facilitate the making of joints. Additional excavation for construction of valve chambers and joint holes shall be of such dimensions as shown in the drawing, so as to give clear working space. The Contractor shall make allowance for the additional excavation required for the sump well and valve chambers in the price tendered for trench excavation. These shall not be separately measured or paid.
- 3.6 The length of the trench shall be measured along the centreline of the trench and the depth shall be measured vertically for original ground level to the average bed level.

4. TIMBERING, SHORING AND BRACING

GENERAL

- 4.1 The Contractor shall provide where required all shoring, supports etc., to the sides of excavation to prevent sliding or any movement. The timbering, shoring and bracing; shall be of adequate strength to withstand the pressure encountered and the Contractor shall be solely responsible for the losses due to collapse or failure of shuttering, bracing, shoring etc.
- 4.2 No payment for side support including shoring, shuttering or bracing or sheet piling shall be made. The Contractor's rate for excavation shall be deemed to

include the cost of providing and removing side supports timbering, strutting and bracing with all connected operations.

- 4.3 The Contractor shall at all times support effectively the sides of the pipe trenches and other excavation by suitable timbering, shuttering etc.
- 4.4 Where required the contractor shall use close timbering in all loose or sandy or unstable strata both above or below ground level, if found necessary by the Engineer and accord approval. It is intended that all timbering and side supports for pipe trenches shall be removed as the work proceeds. The Contractor shall ensure that the removal of timbering and side support is done gradually and carefully to avoid any damage to existing or new structures, roads, pavements or any other private or public property. All timbering, sheeting and their supports shall be of adequate strength and dimension and fully braced and strutted so that no collapse, subsidence or any damage to public or private property shall take place. The Contractor shall be solely responsible for the sufficiency of all timbering and their supports to be used. All damages to persons or property resulting from the improper quality, strength, placing, maintaining or removal of the same shall be payable by him under all circumstances.

5. PUMPING, BAILING AND DEWATERING

- 5.1 The work covered by this section of Specifications consists of furnishing all plants, labour, materials, and equipment appliances for performing all operations for Pumping, Bailing Dewatering and Draining water from the areas, excavated for all works in this contract in accordance with this section of Specifications, and subject to terms and conditions of the contract.
- 5.2 The Contractor shall at all times during the progress of work remove any water from any source which may accumulate, inflow or be found in the trenches and other excavations made under the contract and shall, keep them entirely free from water at all time while excavating.
- 5.3 The Contractor shall keep excavations free from water at all time and provide adequate pumping plant including special dewatering equipment and means of disposing off the pumped water as directed by the Engineer In charge. The Contractor shall ensure to keep away un-desired water from all sump clear of excavation and provide all necessary plant and equipment for dealing with any subsoil condition that may be encountered.
- 5.4 The work covered by this section of Specifications consists of furnishing all plants, labour, materials, equipments and appliances for performing all operations for Pumping, Bailing Dewatering and Draining water from the areas, excavated and all other works in this contract in accordance with this section of Specifications, and subject to terms and conditions of the contract.

- 5.5 If necessary for the construction of the works, the contractor shall lay-sub-drain where directed to convey the water to pumping sumps. The sub-drains shall be laid un-jointed with the invert not less than 300 mm below formation level of the permanent works and shall be covered with gravel to formation level.
- 5.6 Water pumped from the trenches shall be disposed off by the Contractor in a manner that will neither cause injury to the public health nor damage to the existing structures or the works completed or in progress or to the surface of any road or streets, nor cause any interference with the use of the same by the public.
- 5.7 The Contractor shall be held fully and wholly responsible for all damages done to structures or property resulting from his dewatering, pumping and all other connected operations. If he fails to make good or to pay the expenses of making good damages with all practicable dispatch the Engineer shall be at liberty to get the work done by other means or to pay the cost of the said damages by deducting the amount from any money that may be or become due to the Contractor or may recover the same from the Contractor from his dues, as decided and found feasible by Engineer, the decision of Engineer will be final and contractor shall be liable to be bound.

6. FILL, BACKFILLING AND RESTORING OF GROUND TO ORIGINAL CONDITION

- 6.1 Fill where required to raise the sub-grade for concrete slabs shall be clean unadulterated local river sand and shall be free from wood, stones and other debris. Excavated material shall only be used for fill if approved by the Engineer or his representative.
- 6.2 All fill backfilling or earthwork in embankment shall be compacted by mechanical rammer, or other approved equipment in layers not more than 150 mm thick. Each layer shall be uniformly spread and fully compacted and shall have proper moisture content for the required degree of compaction that shall be done by mechanical tampers as approved by Engineer.
- 6.3 Backfill shall not be placed against walls etc., prior to the water proofing treatment if provided and approved by the Engineer. Backfill shall be brought up evenly on each side a wall as far as practicable. Heavy equipment for spreading and compacting backfill shall not be operated closer to tie wall than distance equal to the height of the backfill above the top of base slab footing. No back filling shall be done before the new structure has been cured for at least two weeks.

7. BACKFILLING AND RESTORING OF GROUND TO ORIGINAL CONDITION

- 7.1 The back filling of the trench shall be allowed after the sewer pipe has been laid and jointed over the specified bed, inspected, checked, tested and approved by the Engineer.

7.2 Backfilling of the trenches shall be carried out by filling half pipe level. The filling shall then be thoroughly rammed. More filling shall be carried out and rammed again until the consolidated filling reaches pipe top level. Only selected dry materials free from stones or debris shall be used for backfilling that shall be spread and rammed evenly across the trench. Thereafter, the trench shall be filled in layers not exceeding 150 mm in depth, each layer being properly rammed before the next layer is placed so that 95-100% compaction is obtained as per AASHO Standard.

7.3 On completion of backfilling, the Contractor shall level a grounds disturbed by him in the course of the work, spread t soil where necessary as directed by the Engineer.

7.4 **ROUGH GRADING**

Necessary rough grading if required shall be carried out by the Contractor to establish the finish grade as specified in the drawings or construction requirements of the site, or otherwise indicated shall have uniform levels or slop between points on existing and finished grades. Abrupt changes in slopes shall be rounded.

8. **COMPACTION**

8.1 Fill and/or backfill within the building or structure and for a distance of five (5) feet outside building or structure shall be compacted to a density of not less than 95% of the maximum density at optimum moisture as determined by 110 AASHO T-99.

8.2 Isolated boulders and rubble not exceeding 0.1 cubic meter in volume may be incorporated at the Engineer's discretion.

8.3 If any material after placing reaches a condition such that it cannot be thoroughly compacted the contractor shall either remove all of the material which is in unsuitable condition or improve the condition of the material by mechanical or chemical means.

9. **REMOVAL OF EXCESS AND UNDESIRABLE MATERIALS**

9.1 Excess and undesirable material from excavation not require for fill or backfill shall be disposed off, removed and/or deposited and levelled on the site where directed by the Engineer. Earth suitable and meant for backfill if required shall be stored at site in a manner not to interfere with the progress of construction works in progress.

9.2 The Contractor shall keep all excavated soil sprinkled with water during the excavation work so as to prevent any dust nuisance.

9.3 All surplus soil arising out of the work shall be carried away to approved site within a week, deposited and spread as directed by the Engineer.

- 9.4 The Contractor shall carry out the cutting of existing bituminous road as required for excavation for carrying out the work to the full depth of hard crust of any existing thickness. The stone metal soling etc. shall be separately stacked along the side of excavation for possible reuse.

10. PROTECTION OF UTILITY SERVICES

10.1 DAMAGE TO SURFACE

If carriage ways, verges or footways in roads whether paved or unpaved or gardens, plantations or other surfaces are damaged outside the limits of the excavations due to lack of proper traffic control or moving plant and equipment or other operations of the contractor then such surfaces shall be reinstated by the contractor at his own expenses. The surfaces shall be restored to their original condition using such materials as may be required whether obtained from the excavated materials or not.

10.2 MAINTENANCE OF TRAFFIC

When the excavation is in roads care shall be taken to cause the least inconvenience to traffic. When directed or necessary for the maintenance of traffic, the contractor shall remove from the site all materials as excavated from the trenches and return the same as necessary for refilling after the structures have been completed or the pipes tested and approved.

10.3 CONTROL OF TRAFFIC ON ROADS

The Contractor shall ensure that the flow of traffic over existing roads and access to properties is maintained at all times during the contract. The flow of traffic is to take place at all time over a reasonable surface that is to be segregated as far as possible from areas where work is progress.

11. MEASUREMENT AND PAYMENT

- 11.1 All excavation shall be measured net and perpendicular and no allowance shall be made for any increase in bulk of the excavated material after excavation or for sloping sides, or widened trenches to accommodate formwork, shoring and bracing etc. Similarly the measurements for filling/backfilling shall be thoroughly compacted and measured net and no allowance shall be made for any increase in bulk after excavation. Excavation, filling and Disposal shall include all leads and lifts as specified elsewhere in these specifications.
- 11.2 Payment for all the items under this section shall be made at the rates entered in the Estimates appended to the contract and in accordance with the applicable conditions of the contract.

SECTION – 3**CONCRETE****1. SCOPE OF WORK**

The work covered by this section of the Specifications consists of furnishing all plants, labour equipment appliances and materials and in performing all operations in connection with concrete work complete in strict accordance with the applicable drawings and the Specifications herein and subject to the terms and Condition of the Contract.

2. GENERAL

Full cooperation shall be extended to other trades to install embedded items, and opening etc. Embedded items shall have been inspected and check tests for concrete and other materials or for mechanical operations shall have been completed and approved before concrete is placed.

3. MATERIALS**3.1 PORTLAND CEMENT****1) General Requirements**

- a) Portland Cement shall be indigenous stuff unless otherwise approved by the Engineer.
- b) Unless otherwise permitted, cement from not more than two plants shall be used and in general, the product of only one plant shall be used in any particular section of the work.

2) Specification

These specifications cover five types of Portland cement, as follows:

No.	Applicable Specifications		Application
	ASTM	BS	
a.	C150 (Type I)	BS 12	Ordinary Portland Cement: For use in general concrete construction when the special properties specified for Type II, III, IV and V are not required.
b.	C150 (Type II)	BS 1370	Moderate Heat Portland Cement: For use in general concrete construction exposed to moderate sulfate action, or when moderate heat of hydration is required.
c.	C150 (Type III)	BS 12	Rapid Hardening Portland Cement: For use when high early strength is required.
d.	C150 (Type IV)	BS 1370	Low Heat Portland Cement: For use

			when low heat of hydration is required.
e.	C150 (Type V)	BS 4027	Sulfate Resisting Portland Cement: For use when high sulfate resistance is required.

3) **Packing and Marking**

- a) Cement shall be furnished in sacks or in bulk form, as approved by the Engineer.
- b) Cement in sacks shall be delivered in strong, well made, paper or cloth bags, each plainly marked with the manufacturer's name, brand, type of cement and the weight of cement contained therein, except that, in the case of Type-I cement, the type need not be identified.
- c) A bag shall contain 50 Kg. net.
- d) When the cement is delivered in bulk; this information shall be contained in the shipping invoice, accompanying the shipment.

4) **Inspection**

The Contractor shall facilitate the Engineer, in all respects, for careful sampling and inspection, either at the mill or at the site of work, as may be specified by the Engineer. The following periods, in days, from the time of sampling shall be allowed for completion of testing.

- | | | |
|----|-------------|----|
| a) | 1-day test | 6 |
| b) | 3-day test | 8 |
| c) | 7-day test | 12 |
| d) | 28-day test | 33 |

5) **Rejection**

- a) Cement may be rejected if it fails to meet any of the requirements of these specifications.
- b) Cement remaining in bulk storage at the mill, prior to shipment, for a period greater than six months after completion to the tests, may be tested and may be rejected if it fails to conform to any of the requirements of these specifications.
- c) Packages varying more than 3% from the weight marked thereon may be rejected and if the average weight of packages in any consignment as determined by weighing fifty packages taken at random, is less than that marked on the packages, the entire consignment may be rejected.
- d) Packages received in broken or damaged condition shall be rejected or may be accepted only as fractional packages as determined by the Engineer.

- e) Cement that is found to be adversely affected by moisture, as determined by the Engineer, shall be rejected.

6) **Method of Sampling and Testing**

- a) The sampling and testing of Portland cement shall be in accordance with relevant BS or ASTM standard specifications.
- b) Contractor shall carry out all tests on Portland cement, at his own cost, if required by the Engineer.

7) **Transportation of Cement**

Transportation of the cement from the mill to the site stores and to the point of use shall be accomplished in such a manner that the cement is completely protected from exposure to moisture.

8) **Storage**

- a) Cement shall be stored in dry, weather tight and properly ventilated structures. All storage facilities shall be subject to approval and shall be such as to permit easy access for inspection and identification of each consignment.
- b) The sacks should be stacked closely on a damp proof floor or on timber planks, raised by a minimum of 12" (300 mm), from the ground, with air space below. There should be similar air space between the stacks and walls.
- c) To avoid bursting of bags and setting under pressure, the height of the stacks shall be limited 8 bags.
- d) Adequate storage capacity shall be furnished to provide sufficient cement to meet the peak needs of the project.
- e) Cement storage facilities shall be emptied and cleaned by the Contractor when so directed, however, the interval between required cleaning normally will not be less than four months.

9) **Usage**

- a) The Contractor shall use cement in the approximate chronological order in which it is received at the site. All empty sacks shall be promptly disposed off as approved by the Engineer.
- b) No cement stored through a monsoon, or for a period of more than six months, should be used, unless tests have been applied and cement found up to the requisite standard.
- c) Suitable, accurate scales shall be provided by the Contractor for weighing the cement in stores and elsewhere on the work, if required, and he shall also furnish all necessary test weights.

10) **Delivery and Usage Record**

Accurate records of delivery of cement and its use in the works shall be kept by the Contractor. Copies of these records shall be supplied to the Engineer in such a form as he may require.

3.2 **AGGREGATE**

1) **General Requirements**

- a) Aggregates for normal concrete shall conform to the requirements of ASTM Designation C 33 "Specifications for Concrete Aggregates".
- b) In case the Contractor prefers to use aggregate from a source other than that approved by the Engineer; following tests shall be carried out, at the Contractor's cost, to

determine suitability of the material for the intended use:

- i) Mechanical properties
 - ii) Porosity
 - iii) Organic impurities
 - iv) Clay and Silt Contents
 - v) Abrasion and Soundness Tests
 - vi) Alkali Reactivity Potential
 - vii) Water soluble Chloride Contents
- c) The nominal maximum size of the aggregate shall not be larger than one fifth of the narrowest dimension of the finished wall or slab, or larger than three fourth of the minimum clear spacing between the reinforcing steel and embedment.

2) **Nature of Aggregate**

- a) Fine Aggregate: The use of natural sand or a combination of natural and manufactured sands may be permitted, provided that the fine aggregate meets the applicable requirements of the specifications herein, for particular use intended.
- b) Coarse Aggregate: Except where otherwise specified, coarse aggregate shall consist of crushed natural stone.

3) **Source**

The Contractor shall obtain concrete aggregate from deposits of natural sand and gravel or shall procure crushed aggregate from approved quarries, which produce aggregates meeting with the Specifications contained herein.

4) **Sampling and Testing**

- a) The Contractor shall provide facilities, as may be necessary, for

the ready collection of representative test samples, of the aggregates, to determine compliance with specifications.

- b) The Engineer will obtain and test such samples, at the expense of the Contractor, using appropriate standard test methods, selected by the Engineer.
- c) Testing of concrete aggregates by the Engineer shall not relieve the Contractor of his responsibility to maintain, control and ensure the production, stockpiling and handling of both fine and coarse aggregates, in accordance with these Specifications.

5) **Aggregate Processing**

- a) General: All aggregates, as delivered to the mixer, shall consist of clean, hard, dense and durable and uncoated particles.
- b) Light Weight Elements: Light weight elements, like chalk, clay and organic matter shall be separated by vibro-floatation process. Where required, fines shall be removed from the coarse aggregate by adequate washing.
- c) Soft Particles
 - i) The Contractor in planning his aggregate processing operations shall make necessary provisions, as regards methods and equipment, to ensure effective elimination of soft particles from all aggregates.
 - ii) The percentage of soft particles present in the processed coarse aggregate shall not exceed 3 percent by weight, when determined in accordance with the applicable requirements of ASTM Designation C235 "Standard Method of Test for Scratch Hardness of Coarse Aggregate Particles" or other standard test method, selected by the Engineer.
 - iii) Test Samples shall be representative of the each size group of processed coarse aggregate, as specified in Article 5.6, obtained according to the ASTM Methods D 75.

6) **Grading Requirements**

Compliance with the aggregate grading and uniformity requirements will be determined at the mixer. The aggregates, as delivered to the mixers, shall conform to the following specific grading requirements:

- a) Fine Aggregates

- i. The grading of fine aggregate shall conform to the following requirements:

U.S. Standard Sieve Mesh	Percent Passing
0.375" (9.50 mm)	100
No.4 (4.75 mm)	95-100
No.8 (2.37 mm)	80-100
No.16 (1.18 mm)	50-85
No.30 (0.60 mm)	25-60
No.50 (0.30 mm)	10-30
No.100 (0.15 mm)	2-10

- ii. Fineness modulus shall range between 1.9 and 2.78.
- iii. The sand equivalent value, as determined by ASTM Designation D 2419, "Standard Test Method for Sand Equivalence Value of Soils and Fine Aggregate", shall not be less than 75.

- b) Coarse Aggregate: The grading of the coarse aggregate, within the separated size groups, shall conform to the following requirements:

US Standard Sieve Size (Nominal Size)	Percent by Weight Finer than Each Laboratory Sieve			
	1/4"(6.25 mm) to No. 4 Group	3/4"(19 mm) to No. 4 Group	1"(25 mm) to No. 4 Group	1.5"(37.5 mm) to No. 4 Group
2.00" (50.00 mm)	-	-	-	100
1.50" (37.50 mm)	-	-	100	95-100
1.00" (25.00 mm)	-	100	95-100	-
0.75" (19.00 mm)	100	90-100	-	35-70
0.50" (12.50 mm)	90-100	-	25-60	-
0.375" (9.50 mm)	40-70	20-55	-	10-30
No. 4 (4.75 mm)	0-15	0-10	0-10	0-5
No. 8 (2.37 mm)	0-5	0-5	0-5	-

7) Particle Shape

- a) A flat particle is one having a ratio of width to thickness greater than three. An elongated particle is one having a ratio of length to width greater than three.
- b) The shape of the particles shall generally be spherical or cubical.
- c) The quantity of flat and elongated particles, in the separated size groups of coarse aggregate, as defined and determined by standard tests, approved by the Engineer, shall not exceed 15% by weight in any size group.

8) **Deleterious Substances**

- a) **Fine Aggregate:** The maximum percentages of deleterious substances, in the fine aggregate, as delivered to the mixer, shall not exceed the following values, with sum of the percentages of all deleterious substances not to exceed 5 percent, by weight.

Substances	Percent of Weight
Material passing No. 200 sieve	3
Shale	1
Total of other deleterious substances including mica, chloride, coated grains and soft flaky particles	3

- b) **Coarse Aggregate:** The maximum percentages of deleterious substances, in any size of coarse aggregate, as delivered to the mixer, shall not exceed the following values, with the sum of the percentages of all deleterious substances not to exceed 3 percent by weight.

4. Deleterious Substances	Percent of Weight
Material passing No. 200 sieve	1
Shale	1
Clay lumps	0.5
Other deleterious substances	1

9) **Storage**

- a) Aggregate shall be stored, at the site, in such a manner as to prevent its deterioration or the inclusion of foreign matter.
- b) Aggregate, which has deteriorated or which has been contaminated, shall not be used for concrete.

- c) All methods employed by the Contractor for loading, unloading, handling and stock-piling aggregates shall be subject to the approval of the Engineer, at all times.
- d) Sufficient aggregate shall be maintained at the site, at all times, to assure continuous placement and completion of any lift of concrete started.

10) **Moisture Control**

- a) All fine aggregate and smallest size group of the coarse aggregate shall remain in free draining storage at the site for at least 72 hours, immediately prior to use.
- b) The free moisture content of the fine aggregate and of the smallest size group of coarse aggregate, as delivered to the mixer, shall be controlled so as not to exceed 4% and 1% respectively, expressed as percent by weight, of the dry aggregates; unless higher limits are allowed by the Engineer.
- c) In addition to the limits on the maximum amounts of free moisture in aggregate, the moisture content shall be controlled so that, for each size, the variation in the free moisture will not be more than 0.5 percent, during any one hour of mixing plant operation.
- d) Coarse aggregates, with other sizes, as delivered to the mixers, shall have the least amount and least variation, of the free moisture contents, practicable under the job conditions.
- e) Under no conditions shall the aggregate be delivered to the mixed plant being dripping wet.
- f) The Contractor shall carry out such tests, at his own expense, as the Engineer may deem necessary, to determine the free moisture content of aggregate.

3.3 **WATER**

Water is discussed in water section.

3.4 **CONCRETE STRENGTH**

The minimum compressive strength of concrete required on the basis of test cubes and minimum quantity of cement required for the concrete shall be as under:

Class of Concrete	Min. Qty. of Cement		Cylindrical Strength	
	Lbs. per 100 cft.	Kg. / Cu.m.	At 7 Days	At 28 Days
			Lbs./ Sq. in.	Lbs./ Sq. in.
A	3024	485	3000	4000

B	2520	404	2250	3000
C	2016	323	1875	2500
D	1344	216	900	1200
E	1008	161	600	800

3.5 PROPORTIONING OF CONCRETE MIXES

All concrete shall be proportioned by volume for design of concrete mixes, unless specifically directed by the Engineer to proportion them by weight. The Contractor shall submit to the Engineer before the start of concreting proposed mix designs for concrete to be used based on laboratory tests to determine the proportion of cement, aggregates, and water in the concrete conforming to the quality and strength requirements specified. The source and specific gravity of aggregates and name of laboratory shall be submitted along with mix design. The cost of all such testing and mix design shall be deemed to have been included in the item rates of Contractor.

3.6 MAXIMUM ALLOWABLE WATER CONTENT

All concrete specimens shall be made, cured and tested in accordance with British Standard or ASTM Standard and Water cement ratio shall be varied to achieve the required strength and this ratio shall be got approved by the Engineer before the start of concrete work.

3.7 SLUMP TEST

The slump for concrete, determined in accordance with PS 422:1964 "Slump Test for concrete" should be minimum of 25 mm (1") and a maximum of 75 mm (3") provided the requisite strength is obtained.

3.8 MIXING

Concrete shall be mixed by mechanical mixing with adequate facilities for accurate measurements and control of each material entering the mixer and for changing the proportions to conform to varying conditions of the work. Volumetric batching can be adopted, using cement by weight, according to the following table:

Nominal	Cement		Sand Cft.	Coarse Aggregate Cft.
1:1½:3	110 Lbs	50 Kg.	1 7/8	3 ¾
1:2:4	110 Lbs	50 Kg.	2 ½	5
1:3:6	110 Lbs	50 Kg.	3 ¾	7 ½
1:4:8	110 Lbs	50 Kg.	5	10

Water shall be measured for every batch with due allowance made for water already present in aggregates.

- 1) Mixers shall not be charged in excess of noted capacity nor be operated in excess of noted speed. Excessive mixing shall not be permitted. The entire batch shall be discharged before re-charging.
- 2) Mixing time shall be measured from the instant water is introduced into the mixer drum containing all solids.
- 3) Mixing water shall be introduced before one-fourth of the mixing time has elapsed. Mixing time for mixers of one cubic meter or less shall be 2 minutes.
- 4) No hand mixing shall be permitted. If during concreting the mixing plant fails, the concrete already poured shall be removed, unless otherwise directed by the Engineer or his Representative.
- 5) Test cubes of concrete shall be prepared and stored by the Contractor, in accordance with PS: 560:1965, as and when directed by the Engineer or his Representative. Test cube be tested in laboratory and the Contractor shall bear the charges for the same.

3.9 TRANSPORTING AND PLACING CONCRETE

- 3.9.1 Concrete shall be conveyed and deposited as quickly as possible after mixing and shall proceed so that, as far as possible, a complete section of the work is done in one operation. Concrete that has attained its initial set or has contained its mixing water for more than 30 minutes shall not be allowed to be placed in the works.
- 3.9.2 Transport of concrete shall be in a manner approved by the Engineer or Engineer's Representative and shall be so as to avoid segregation or loss of ingredients of concrete.
- 3.9.3 All foundations and portions of work to be concreted shall be approved by the Engineer's Representative before concrete is poured.
- 3.9.4 All forms and reinforcement shall be completed, cleared, inspected and approved before pouring of concrete. No concrete is to be deposited till the Engineer's Representative has inspected and approved in writing all reinforcement, foundations, forms, details, positioning of all fixtures and materials to be embedded in concrete. The Engineer or his representative shall issue an authorization to start concrete for each day's work in a form to be called pour slip. This pour slip will give the result of checking of form work, reinforcement, and quality of aggregates, cement and mixing & vibrating equipment and date of pouring of concrete. This pour slip shall form the basis for payment to Contractor. No payment will be made for the concrete for which pour slip has not been issued by the Engineer or his representative. The Contractor shall maintain a complete record of concrete pour slips issued by the Engineer or his authorized representative. Laying concrete shall be carried out only in the presence of authorized representative of the Engineer. Dry concrete laid without the presence of Engineer's representative will not be accepted and will not be paid for.
- 3.9.5 All concrete shall be thoroughly compacted and consolidated by means of

Pneumatic or mechanical vibrators or other approved compacting method. Care shall be taken to avoid segregation due to excessive vibration. The Contractor shall maintain on site at all times one or more stand by vibrators. Tapping or other external vibration of forms shall not be allowed, unless so directed by the Engineer's Representative. Compaction shall be done until the whole mass assumes a jelly like appearance and consistency with the water just appearing on the surface. Concrete shall be sufficiently tamped and consolidated around the steel rods, care taken that the vibrator does not touch steel or formwork and is worked into all parts of the moulds in order that no voids or cavities are left. Steel shall not be disturbed during operations of concreting. Concrete shall be brought up in even layers of about 300 mm (12") thickness or as approved by the Engineer and worked against side of forms to give a smooth and uniform surface. No surplus water shall be allowed to come out and lie on the surface of concrete. The concrete must be of such a consistency that after ramming, consolidating and tamping is completed, a thin film of water is just appearing on the surface.

- 3.9.6 Hardened concrete, debris and foreign material shall be removed from interior of forms and from inner surface of mixing and conveying equipments.
- 3.9.7 Runways shall be provided for wheeled concrete handling equipment, and such equipment shall not be wheeled over reinforcement, nor shall runways be supported on reinforcement.
- 3.9.8 Concrete shall not be dropped freely from a height of more than 2.5 m in columns and 1.5 m (5 ft) elsewhere. In case where an excessive drop is inevitable the Contractor shall provide spouts, down pipes, chutes, or side ports to form with pockets that will let concrete flow easily into the form without any risk of segregation. The discharge of the spouts, down pipes or chutes shall be controlled so that the concrete may be effectively compacted into horizontal layers not more than 300 mm (12") thick.
- 3.9.9 When concrete is laid on hard-core, such as sub grade for floor slabs, or other absorbent material, the surface is to be watered, consolidated and, where specified, blinded before the concrete is deposited.
- 3.9.10 Fresh concrete shall not be placed on previously laid concrete or on old concrete surfaces until the latter has been cleaned of dirt, scum and laitance by wire bushes. The clean surface shall then be thoroughly wetted and grouted with cement slurry as approved by the Engineer's Representative.
- 3.9.11 Care shall be taken not to disturb newly placed concrete by vibrator, indirect loading or otherwise. No traffic or loading shall be allowed on the concrete until it has thoroughly set and hardened.
- 3.9.12 No concrete shall be placed during rains or when the sun, heat, winds or other weather conditions prevent proper placing, finishing and curing of concrete or when the temperature is above 43 degree Centigrade and

below 35 degree Fahrenheit or when the concrete is likely to be subjected to freezing temperatures. All fresh concrete shall be suitably protected from rainfall and excessive heat or cold.

- 3.9.13 Should any part of the exposed surface present a rough uneven or imperfect appearance when the shuttering is removed, it shall be picked out to such depth and refilled and properly re-surfaced or entirely redone as per directions of Engineer or his Representative at the cost of the Contractor.
- 3.9.14 On removal of the forms and before the skin has had time to harden, all faces of the concrete inside or outside, to be kept exposed shall be rubbed over with carborundum stone and washed with cement to remove all marks, projections hollows or any other defect. No extra payment shall be made for this work.
- 3.9.15 All exposed surfaces and lines of the concrete work are to be true and fair without cracks, bends, windings and distortions of all kinds without any extra charges by the Contractor

3.10 PROTECTION AND CURING

All exposed concrete shall be cured. Curing shall be accomplished by preventing loss of moisture, rapid temperature change and mechanical injury or injury from rain or flowing water for a period of at least ten days. Curing shall be started as soon as the concrete has hardened sufficiently for the surface not to be marked. Curing shall be done either by continuous sprinkling of water on the surface or by covering with sand, hessian, canvas or other approved fabric mats that shall be kept continually wet. If required and so directed by the Engineer or his Representative, formed surfaces with form in position shall also be cured by keeping all form continually wet.

Minimum period of curing for any concrete shall be ten days or more as directed by the Engineer. All concrete pours and concreted structures shall be clearly marked with non-wash able paints to indicate the date of placing concrete. During hot weather curing shall be done even at nights.

3.11 FORMWORK

3.11.1 GENERAL

The form work shall be inclusive of all labour, material, workmanship and alike. All formwork and supports thereto shall be designed by the Contractor and relevant drawings shall be submitted to the Engineer and his Representative for approval before the work is put in hand. Such approval shall not relieve the contractor from all the obligations of the contract or give rise to any claim.

3.11.2 MAKING FORMS

The formwork for all concrete work to be cast in situ shall be made of sound

and properly seasoned timber or other approved material for all works above ground water table. For all works below ground water table formwork of steel shall be used. These formworks shall be properly jointed and erected with packing material to provide watertight forms. These forms shall be properly cleaned to give a smooth finished surface and shall be rigidly formed and designed by the Contractor to the shapes and forms as per drawings in accordance with the best existing practices so as to be able to withstand, without displacement deflection or deformation movements of any kind, the pressure of the moist concrete and all other loads.

3.11.3 RIGID WITH ALLOWANCE FOR CAMBER AND BULGES

It shall be fabricated and erected in position, perfect in alignment, levels and true to plumb and shape and securely braced so as to enable it to with stand all weights, live and vibrating, to be endured during placing of concrete and its subsequent hardening till the formwork is struck. It shall be sufficiently rigid as not to lose its form or bulge, or deflect and to give the finished concrete the required lines, plumb, size and shape.

3.11.4 MATERIALS AND LABOUR

The Contractor shall supply all materials and labour necessary for a good and speedily erecting formwork such as shuttering, planks, struts, bolts, stays, gangways boards, fillets etc. and shall do all that is essential in executing the job in a workman like manner to the satisfaction of the Engineer.

3.11.5 FORMWORK NOT TO INTERFERE OR INJURE WORK

The formwork shall be so designed and arranged as not to unduly interfere with concrete during its placing and easy to be removed without injuring the finished concrete.

Wedges, clamps, bolts and the rods shall be used when permitted and where practicable in making the formwork rigid and in holding it to true position.

3.11.6 JOINTS IN FORMWORK

All joints in the formwork shall be sufficiently closed to prevent undue leakage of mortar from concrete or show an appearance of leaking mortar on concrete surface.

3.11.7 TREATMENT AND INSPECTION OF FORMS

All rubbish particularly chipping, shavings and saw etc. shall be removed from the interior of the forms immediately before placing concrete. Forms shall be coated with approved mould oil before reinforcement is placed. Surplus oil on forms and any oil on reinforcing steel shall be removed.

3.11.8 REMOVAL OF SHUTTERING

No struts or timbering which serves the purpose of supporting the shuttering or centring shall be struck a removed before the minimum periods for the main classes of work given as under:

Removal of Shuttering	Cold Whether Days	Normal Whether Days
Beams, sides, walls and columns (unloaded)	5	3
Slabs soffits (Props left under)	10	7
Removal of props to slabs	18	14
Beams soffits (props left under)	13	10

Struts or other timbers or supports, the removal of which may cause the transference of load to the finished work shall be kept in place for three weeks after the placing of the concrete.

3.11.9 INJURY OR DAMAGE

The Contractor shall be responsible for any injury to the work and any consequential damages caused by or arising from the removal and striking of forms, centring and supports, and any advice, permission or approval given by the Engineer or his Authorised Representative, related to the removal and striking of forms, centring and support shall not relieve the Contractor from the responsibilities herein defined.

3.11.10 TREATMENT AFTER REMOVAL OF FORMS

Any minor surface honey combing or other irregularities are to be properly made good immediately upon the removal the formwork and the surface made good to the satisfaction of the Engineer and his Representative. Any small voids shall be neatly stopped with cement mortar consisting of one part of cement to two parts of sand and the whole surface rubbed over with carborundum stone and cements wash and bring the whole to a smooth and pleasing finish and uniform colour.

3.11.11 MEASUREMENT AND PAYMENT

Formwork shall not be measured or paid for separately and shall be deemed to be included in the unit price of concrete whether cast-in-situ or pre-cast and subsequently fixed in position.

3.12 CONSTRUCTION JOINTS

Construction joints shall be located as indicated on the drawings and / or as approved or directed by the Engineer or his Representative.

3.13 ANCHOR BOLTS, INSERTS, SLEEVES, CHASES, RECESSES, STEEL FRAMES ETC.

The Contractor shall furnish and place in position accurately shown on drawings, all inserts, sleeves, chases, recesses. etc., supplied by himself or other Contractors, as directed and full cooperation and coordination shall be maintained with other Contractors, Sub-Contractors in this regard.

3.14 CLEANING AND REMOVAL OF RUBBISH

On completion of works herein the Contractor shall remove all concrete debris, rubbish, shuttering materials, scraps etc., from the vicinity of the structures completed. All areas shall be cleaned to the satisfaction and approval of the Engineer.

3.15 PLACING STEEL REINFORCEMENT ON FORM WORK**3.15.1** Clear cover to main reinforcement in concrete members is as follows:

a.	For slabs, projections, chajjas, fins, walls, staircases pre-cast slabs.	19 mm
b.	For beams, Columns, all members of water retaining structures on the side in contact with water	50 mm
c.	For foundations retaining walls and foundation beams	50 mm

3.15.2 All the reinforcing bars are to be properly placed and spaced as shown on the working drawings. Steel chairs and concrete spacer blocks are to be used without any extra cost. Concrete spacer blocks are to be properly cured to avoid their damage during concreting thereby causing displacement of bars. Holes made by bolts etc., introduced for keeping the shuttering in act should be properly treated after striking the shuttering. No such hole shall be allowed in walls of water retaining structures and earth retaining walls.**3.16 WATER PROOF CONCRETE**

All concrete work below ground level shall be executed in SR cement with water proof compound of approved type and shall be mixed in with concrete in strict accordance with the instruction of manufacturer or as directed by the Engineer.

3.17 FINISHING OF FORMED SURFACES

All concrete surfaces exposed to public view or inside of sump or wet well and screening chamber shall be smooth form finish. No plastering will be allowed or paid for. The concrete surfaces not exposed to public view e.g. external surfaces of sump or wet well or screening chamber shall be fairly smooth for application of water proofing treatment. Other surface may be rough form finish.

3.18 BITUMEN COATING ON WALLS

Unless otherwise specified all concrete and masonry work in contact with earth up to plinth level shall be given an application of two coats of Industrial Bitumen paints at the rate of 15 lbs per 100 sq.ft ensuring that no pin holes / patches are left out. Bitumen will be applied after cleaning all dirt, dust and loose material from the surface and ensuring that the concrete or masonry has been cured and dried. Second coat will be applied after the first coat completely dried backfilling of each in foundation up to plinth will only be carried out after the application of bitumen coats and after the final coat completely dried as specified hereinabove or as directed by the Engineer. Bitumen coat shall be measured in square metre of area to be coated and payment for all the items under this section shall be made at the rates entered in the BOQ appended to the contract and in accordance with the applicable conditions of the contract.

3.19 MEASUREMENT AND PAYMENT

Payment for concrete shall be made on the basis of approved tendered rates of the Contractor for all types of concrete work carried out by the Contractor and approved by the Engineer except that no separate payment shall be made for concrete work in valve chambers. This shall be deemed to have included in the lump sum rate for valve chambers quoted by the Contractor.

The rate of concrete quoted by the contractor shall be deemed to include the cost of formwork to produce fair faced concrete.

No payment shall be made for the concrete work that has been laid without the issue of pour slip by the Engineer or his representative.

SECTION – 4**STEEL REINFORCEMENT****1. DESCRIPTION**

Contractor to require in this section is to supplying, cutting, fabricating, bending, placing and installing/binding in position etc., straight or curved hot rolled or cold-worked deformed steel bar reinforcement having minimum yield strength 414 Mpa , including cost of G.I binding wire 18SWG, chairs, wastages, precast c.c. spacers and welding where required by the Engineer, as per ASTM A615 standard. Only those overlaps shall be paid which are according to the approved Bar Bending Schedule/shown on drawings or instructed by the Engineer/as per BSI 4466, complete in all respects as per drawing and specifications for all kind of R.C.C. work. Bars to be cut and placed in position at any level according to the Bar bending schedule prepared by the contractor and approved by the Engineer.

2. SCOPE OF WORK

The work covered by the section of the specification consists of furnishing all materials, tools, labour, equipment & appliances and in performing all operations in connection with the providing, straightening, cutting, bending, binding, fixing, elsewhere with necessary overlaps, wastage including binding wire, chairs, pins, spacer block complete in strict accordance with this section of the Specifications, the applicable drawings, approved bar bending schedule according to BS-4466 and the terms and conditions of the Contract. All steel reinforcement should be placed at locations, to lines and level as shown in the drawings an as the directed by the Engineer.

3. MATERIALS

- 3.1 Reinforcing steel to be new billet stock of mild steel (plain bar), hard grade (deformed bar) and Ribbed Tor steel as specified on the drawings and shall conform to British Standard Specifications or equivalent ASTM or Pakistan Standard.
- 3.2 The Contractor shall furnish to the Engineer's Representative Manufacturers' mills certificate to guarantee that steel meets the standard, specifications requirements and minimum certified yield stresses as follows:-
 - i. Mild Steel plain bars conforming to B.S.S. 4449 or PS-231
 - a) Tensile Strength - 438 to 517 N/Sq.mm (63.5 to 75 Kips/Sq. in).
 - b) Yield Strength - 250 N/Sq. mm (36 Kips/Sq. in)
 - c) Elongation - 16% to 24% (average 20%).

- ii. Hot rolled deformed bars conforming to ASTM A-615 Grade 60 or PS-605
 - a) Tensile Strength - 560 N/Sq. mm (81 Kips/Sq. in).
 - b) Yield Strength - 415 N/Sq. mm (60 Kips/Sq. in).
 - c) Elongation - 11%
- 3.3 All steel to be true to the Standard Specifications with regard to bend ability specially the hard grade deformed bars under 19 mm (3/4") dia. shall be capable of being bent cold through 90 degree round a bar of four times its own diameter without fractures or injury of any kind. In case of deformed bars over 19 mm (3/4") dia. and under 28 mm (1-1/8") dia. round a bar of 6 times its own diameter.
- 3.4 18 gauge galvanized wire shall be used for binding the steel reinforcement.

4. TESTING

Reinforcement shall be obtained only from manufacturers approved by the Engineer or his Representative. All reinforcement shall be tested according to ASTM standard.

If and when required samples shall be tested for above specification in an approved laboratory when required by the Engineer or his Representative and all costs of such tests shall be borne by the Contractor as a minimum three (03) samples will be tested per twenty (20) ton of steel.

5. STORAGE

Reinforcing bars shall be stored on platforms above surface of ground and be free from scales, oil, structural defects prior to placement in works. Rusted or dirty steel bars shall not be used in the works unless brushed and cleaned by proper steel wire brushes and after being approved for use by the Engineer or his Representative.

6. REINFORCEMENT CUTTING AND PLACING

- 6.1 All reinforcement steel shall be cut and bent cold in strict accordance with bar bending schedules approved and drawings supplied by Engineer. The Contractor shall prepare bar bending schedule from approved structural working drawings conform to ACI 318-02 section 12.5. The bending schedules shall be drawn on approved forms and submitted to the Engineer or his Representative for checking and approval. The steel reinforcement shall be cut and bent to sizes as per drawings and approved bending schedules. In case any bars, cut, bent or even fixed in position are found incorrect in dimensions size or shape according to the requirements of the drawings and instructions of Engineer, the Contractor shall replace such steel bars cut bent

or fixed in position by correct sized bars at his own cost and no extra payment shall be made to the Contractor on such account. The system of holding bars in place shall ensure that all steel in top section will support weight of workmen without displacement or distortion. Suitable spacers and chairs as approved by the Engineer or his Representative shall be used for supporting and spacing purposes of bars. In case any bars are bent or displaced they shall be straightened or replaced prior to pouring. All reinforcement bars within the limit of a days pour shall be in place and firmly tied with 18 gauge G.I. wires. Bars with kinks or bends not shown on drawings shall not be used.

- 6.2 Where indicated in the drawings, mesh shall be of the sizes as shown on drawings and conform to British Standard B.S.785. Mesh reinforcement when used in slabs shall be supported at proper elevations by standard accessories. In slabs on ground, pre cast concrete blocks may be substituted for chairs.

7. LAPS AND SPLICES

- 7.1 No splicing of bars shall be allowed at position other than shown on the drawings. All lap lengths shall be of the minimum sizes as indicated on the drawings or in conform to ACI-318-02 section 12.5 and in no case shall lap length be less than 40 times the diameter of the bigger lapping bars for nominal M.S. bars. Hard grade bars and tor steel shall have laps of 50 times the bigger diameter of lapping bars. Splices of adjacent bars shall be staggered unless approved otherwise by the Engineer or his Representative.
- 7.2 All reinforcing steel fixed in position shall be inspected by the Engineers Representative and no concrete shall be poured until steel placement has been approved by the Engineers Representative. For inspection purposes the Contractor shall give to the Engineers Representative reasonable notice before the scheduled pouring time. Clear concrete cover to reinforcement steel shall be as indicated on the drawings/specified.

8. MANUFACTURE

Steel shall be manufactured from prime Pakistan Steel billets.

9. MEASUREMENT AND PAYMENT

- 9.1 The quantity to be paid for shall be the calculated in theoretical number of metric ton of reinforcement steel bars or mesh as determined from the approved bar bending diagrams and incorporated in the concrete and accepted, except when reinforcement is paid for under other items.
- 9.2 The weight of plain or deformed bars will be computed from the theoretical

weight of plain round bars of the same nominal size as shown in the following tabulation:

Size Inch	Weight in		Size Inch	Weight in	
	lbs per ft.	Kg. per ft.		lbs per ft.	Kg per ft.
1/4	0.167	0.076	3/4	1.502	0.681
3/8	0.376	0.170	7/8	2.044	0.927
1/2	0.668	0.303	1	2.672	1.212
5/8`	1.043	0.473	1-1/18	3.382	1.534

- 9.3 Clips, ties, separators, and other material used for positioning and fastening the reinforcement in place, and structural steel, shall not be included in the weight calculated for payment under this item. If bars are substituted upon the Contractor's request and as a result more steel is used than specified only the amount specified shall be included.
- 9.4 When laps are made for splices, other than those shown on the drawings or required by the Engineer and for the convenience of the Contractor, the extra steel shall not be measured nor paid for.
- 9.5 When continuous bars are shown on the drawings, without the splices being shown, the necessary steel in the splices will be paid for on the basis of the individual bars not being shorter than 40 ft (12 m).
- 9.6 The accepted quantity measured as provided above shall be paid for at the contract unit price for the items listed in the Bill of Quantities, which price and payment shall be full compensation for furnishing materials, labour, equipment and incidentals necessary to complete the item.

SECTION – 5**WATER****1. SCOPE:**

The work covered by this section of the Specification consists of furnishing all labour, appliances and in performing all operations in connection with obtaining, conveying and storing water at site of work.

2. QUALITY OF WATER:

The water used for construction the contractor shall supply sufficient water for all purposes, including mixing the concrete, curing and cleaning plants and tools. Where doubt exists as to the suitability of the water, it shall be tested at the cost of the contractor in accordance with BS3148. Where water shall be shown to contain any organic impurities sugar or an excess of acid, alkali or salt, or inorganic impurities in solution or suspension, the engineer shall refuse to permit its use. The suitability of water shall be subject to test when required by the engineer.

3. CHEMICAL REQUIREMENTS

As a guide, water may be used as mixing water if the chemical contents do not exceed the following limits, otherwise control test's to show the suitability have to be made.

<u>Kinds of Ingredient</u>	<u>Permissible Limits</u>
Dissolved Solids	2,000 ppm
Alkali Carbonate and Bicarbonate	1,000 ppm
Chloride*	500 ppm
	1,000 ppm
Sulphate (So ₄)	3,000 ppm
Alkalies (Na ₂ O+0.658 K ₂ O)	600 ppm
PH – Value	4 (minimum)

The maximum concentration of chloride (Cl) in prestressed concrete should not be higher than 500 ppm.

In general, for reinforcement concrete in moist environment, or concrete containing imbedded aluminium structures with dissimilar metals, a maximum concentration of 1000 ppm is acceptable.

If the result of the acceptance tests are within 90% of the permissible limits, the quality control tests for above impurities shall be down each month, of not otherwise directed by the engineer.

If the amounts of each chemical ingredient are lower than specified in the section, and trial mixes show that no harmful effects appear due to the subject tested, the water can be used as mixing water.

4. TEMPORARY STORAGE TANK:

The Contractor shall provide on site at his own cost temporary storage water tank with all necessary G.I. Pipes and fittings as per instructions of the Engineer. No separate payment will be made for tank, pipes and accessories, etc. These tanks shall be removed or dismantled or demolished and the area shall be cleaned and made good on completion of work as per direction of Engineer.

5. PAYMENT:

No separate payment will be made for the work covered under this section, and all costs in connection therewith shall be deemed to be included in the unit rates.

SECTION – 6

BITUMEN COATING

1. SCOPE

The work under this section of the Specifications consists of furnishing all plant, labour, equipment, appliances and materials and in performing all operations for bitumen coating treatment to foundations, complete in strict accordance with this section of this section of the specifications and the applicable drawings and subject to the terms and conditions of the Contract.

2. SUBMITTAL

Samples of all materials proposed for use under this section, shall be submitted to the Engineer for approval.

3. MATERIALS

Bitumen 10/20 grade.

4. DELIVERY STORAGE AND HANDLING

Materials shall be protected from damage during loading shipment delivery and storage Non-staining materials shall be used for blocking and packing.

5. PREPARATORY WORK

All surfaces, to be treated shall be dust free and dry. Application shall not start unless the preparatory work has been inspected and approved by the Engineer.

6. WATER PROOFING TREATMENT IN FOUNDATION / SUB-STRUCTURES

All surfaces to be bitumen painted shall be thoroughly cleaned of any accretion, dust, dirt etc. by scraping, wire brushing or as directed by the Engineer. The surface shall be primed with a coat of asphalt oil used at the rate of not less than 1 gallon /100 square feet. Two coats of hot bitumen paint shall be applied at the rate of 40 lbs/100 sft. each coat. The first coat shall be allowed to dry for about 6 hours before applying the second coat. During operation of painting great care shall be taken to avoid air bubbles. The manufacturer's advice/ recommendations shall be taken to avoid air bubbles. The manufacturer's instructions and Engineer's directions shall be followed.

7. MEASUREMENT AND PAYMENT

7.1 GENERAL

Except otherwise specified herein or elsewhere in the Contract Documents, no measurement and payment will be made for the under mentioned specified works related to the relevant items of the Bills of Quantities. The cost thereof shall be deemed to have been included in the quoted unit rate of the respective items of the BOQ.

The rates quoted by the Contractor in the Bill of Quantities shall include work to be executed under these specification in any floor and at any height except where otherwise specifically stated in the relevant item of Bill of Quantities and the Contractor shall not be entitled to any claim or claim any compensation on this account.

7.1.1 All preparatory work, scrapping, scratching and cleaning.

7.2 BITUMEN COATING

7.2.1 MEASUREMENT

Measurement of acceptably completed works of bitumen coating will be made on the basis of net actual area in square meter as shown on the Drawings or as directed by the Engineer.

7.2.2 PAYMENT

Payment will be made for acceptable measured quantity of bitumen coating on the basis of unit rate per square meter quoted in the Bills of Quantities. The unit rate shall include all cost of surface preparation and shall constitute full compensation for all the works related to the item.

SECTION – 7

PLASTER

1. SCOPE OF WORK

The work covered by this section of specifications consists of furnishing all plant labour, appliances and material and services required for cement plastering, including all items incidental thereto as specified herein and as shown on the Drawings.

2. GENERAL REQUIREMENTS

- 2.1 Contractor shall examine all other sections of the specifications for requirements that affect work of this section whether or not such work is specifically mentioned in this section. Plaster surface shall include walls, partitions, jambs, recesses, heads of doors & windows soffits etc.
- 2.2. Contractor shall co-ordinate work with that of all other trades affecting or affected by work of this section especially all embedded items in walls.

3. MATERIALS

For specification of sand and cement for plastering refer Section II (Materials).

4. WORKMANSHIP

- 4.1. All work shall be done in the best possible manner by skilled workmen of the plastering trade. Contractor will be responsible for results of the highest quality. Unsound and unsightly work shall be removed and replaced by work satisfactory to the Engineer at no additional cost.
- 4.2. All finished surfaces shall be even and properly trowelled. Finished surfaces shall be even in colour, free from stains, marks or defects. Finished surfaces shall be straight-edged and plumb or level in every direction, angles shall be straight, true and perfect.
- 4.3 All work shall be protected from rapid drying- Exterior openings shall be kept properly adjusted to regulate the drying and curing of cement plaster.

5. CEMENT PLASTER APPLICATION

5.1 INSERTS AND EMBEDDED ITEMS

Plastering shall not commence until all metal lath, electric conduits, drainage and sanitary pipes, inlets to tanks, brackets, clamps, doors and window frames and all sorts of inserts are fixed in position. It shall be the responsibility of

the Contractor to make sure that all such work is carried out before starting of plasterwork. Chiselling and repairing of cement plaster shall not be permitted. Before commencing plasterwork Contractor shall check to ensure that all embedded and other items are in place.

5.2 PREPARATION OF MASONRY SURFACE TO BE PLASTERED

All masonry surfaces to be plastered shall be cleaned to remove all matter which will otherwise adversely affect the adhesion of plaster to the surface concerned. All masonry joints and concrete surfaces shall be properly roughened before plaster work is commenced. The surface thus prepared shall be treated uniformly with cement and sand slurry. The slurry to be used shall be one part cement to one part sieved sand by volume with water added to make a thick creamy mix. The slurry shall be applied with a stiff brush on surface that shall be well wetted before the application of the slurry.

5.3 PREPARATION OF CEMENT MORTAR FOR PLASTER

- a. The mortar shall be prepared from prescribed cement mixed with clean sieved sand in the volumetric ratio of one part cement to three parts of sand (1:3) or as specified. The mixtures shall be turned over and over till the ingredients are thoroughly mixed.
- b. Only limited quantity of water shall be added for proper workability and such quantity of the mortar shall be prepared that will be consumed in thirty minutes after preparation. Preparation of mortar in bulk quantity for use during the entire day or for any other times more than that stipulated above is expressly prohibited.

5.4 APPLICATION OF PLASTER

The minimum thickness of plaster shall be 13 mm. If the plaster is to be more than 18 mm thick it shall be done in two layers. The surface of first layer shall be made rough after the initial set. The second layer shall be applied after a period of three (3) days of application of the first layer. The plaster shall not have wavy surfaces and shall be perfectly in line level and plumb. The edges and corners shall represent straight lines. The plaster shall be kept wet continuously for at least 10 (ten) days. Plaster shall be carried in jams, junctions, corners, edges, round surfaces. The plasterwork is to cover all conduits, pipes etc. fixed in the walls and ceiling.

5.5 PATCHING

Plaster containing cracks, blisters, pits, discoloration or any defects shall not be acceptable. Any such plaster or loose plaster shall be removed and replaced with plaster in conformity with these specifications and as directed by the Engineer.

Contractor shall remove completely and provide plaster in lieu of all defective work in patches as directed, at no additional expense to the

employer.

Patching plaster shall match appearance of and shall be finished level with the adjoining plaster.

5.6 DRIPS

The Contractor shall make drips for rainwater protection.

5.7 ALIGNMENT AND SMOOTHNESS

All cement plaster shall be uniformly true in line level and plumb, smooth trowel finished, free of waves and blemishes etc. to the full satisfaction of the Engineer.

5.8 CLEANING AND PROTECTION

Rubbish and debris shall be removed as necessary to make way for work of other trades and as directed by the Engineer.

As each room or space is completed all rubbish, debris, scaffolding and tools should be removed to leave the roof clean.

Protect finished plaster from injury by any source.

Prior to plastering all windows doors and finished metal shall be covered by plastic adhesive tape or any other approved system to completely protect it from damage and defacement.

Contractor shall also protect walls, floors and work of other trades from plaster materials.

6. WATERPROOF PLASTER

6.1 STRUCTURE BELOW GROUND WATER TABLE

All structures to be constructed below ground water level shall be given a waterproofing treatment on the inside and outside. The plaster shall be made by mixing Puddlo or another equivalent water proofing compound approved by the Engineer in the cement-sand mix of 1:3 by volume according to the manufacturer's instructions for treatment and applied in one layer of 19 mm on all required surfaces. Waterproofing compound in sealed containers only shall be allowed. Only water proofing compound duly approved by the Engineer shall be allowed for use. The surfaces to receive waterproofing treatment shall be made rough for bonding. The layer of waterproofing plaster 19 mm thick shall be then applied and its surface shall be made smooth by the use of a trowel or other suitable instrument. The plaster shall be allowed to cure for a minimum of 14 days.

6.2 Waterproof plasterwork shall not be started till all pipes have been installed.

Any damage or leak discovered shall be repaired by the Contractor at his own cost.

7. CUTTING AND PATCHING

When so directed and prior to painting and finishing of cement plastered surfaces, the Contractor shall check all cement plastering throughout the work, including all cutting, patching and refinishing required in a manner satisfactory to the Engineer.

8. PROTECTION AND CLEANING

8.1 During the operation of cement plastering, protect the work of other trades against undue soilage and damage by the exercise of reasonable care and precautions. Repair, replace, or both, any work so damaged and soiled.

8.2 Upon completion of all work remove all rubbish, scaffolding and tools from the work and leave the premises clean and to the Engineer's satisfaction.

9. MEASUREMENT AND PAYMENT

Plasterwork will be measured and paid for the net area over which it is laid. All openings exceeding one sq. metre shall be deducted. The cost for drips and architectural grooves corner jambs and sills shall be included in the unit rate of plaster and no separate payment shall be made for these. All unit rates shall include cost of all, materials, labour, scaffolding and curing etc.

No extra payment shall be made to the Contractor for thicker plaster required due to unevenness in the masonry or defective masonry.

SECTION – 8

BLOCK MASONRY

1. SCOPE OF WORK

The work covered by this section of the specifications consists of furnishing all Plant, Labour, Equipment, Appliances, and materials and in performing all the operations in connection with brick masonry work complete in strict accordance with the specifications herein and the applicable drawings and subject to the terms and conditions of the Contract.

2. MATERIAL

2.1 CEMENT

Cement shall be Portland cement meeting the requirements specified under clause of section of "Concrete."

2.2 AGGREGATES

Aggregates used shall meet the requirements specified under clause of section of "Concrete".

2.3 WATER

Water shall be as specified under clauses of the section of "Concrete".

2.4 CONCRETE MASONRY UNITS.

2.4.1 Concrete masonry units shall be made on the project site and shall be of the size required by the drawings and / or directed by the Engineer Incharge.

2.4.2 The blocs shall be solid or hollow as required and shall be carefully made so that they are true in line and face with square corners and free from all defects.

2.4.3 The concrete for the blocks shall be mixed in the proportion of one (1) part of cement, three (3) parts of sand and six (6) parts of well graded coarse aggregate not exceeding ½" in size.

2.4.4 Concrete blocks shall be machine moulded. The concrete shall be well worked in the moulds, vibrated tamped and pressed to ensure that the blocks are dense and free from voids.

2.4.5 The blocks shall be cured by keep moist continuously for a period of at least ten (10A) days and then shall be allowed to dry in a shady location for atleast eight (8) days before being used in masonry.

- 2.4.6 Where blocks are to be exposed to view they shall have clean, cut straight and true, edges, smooth dense faces of uniform appearance without voids, honeycombs, projections or variation in texture and shall be free from cracks, spells, chips, ragged edges or other defects detrimental of their appearance.
- 2.4.7 Where blocks are to be plastered the exposed surfaces shall have a coarse texture suitable for bonding the plaster as approved by the Consultants.
- 2.4.8 .The average compressive strength of any five blocks priced at random shall be not less than the strength as specified for 1:3:6 concrete under clause of the section of "Concrete".
- 2.4.9 The average moisture content of all concrete masonry units shall not exceed 30% of the total absorption of the units.

3. MATERIAL

Concrete masonry unit shall be stacked on platforms and covered or stored in any other manner approved by the Consultants to protect from contact with the soil and exposure to weather. Care shall be taken in handling to avoid chipping and breakage. Storage piles stacks, or bins shall be so to avoid being disturbed or shall be barricaded to protect the blocks from damaged by construction operations.

4. MORTAR FOR MASONRY

- 4.1 Cement shall be Portland as specified under Clause of the Section of "Concrete".
- 4.2 Fine aggregate shall be clean, hard, durable particles free from laminated material well graded from No. 4 to 100 sieve.
- 4.3 Water shall be clean and free from injurious acids, alkalies and organic impurities.
- 4.4 All mortar fro masonry shall be proportion of one (1) cement and four (4) sand (fine aggregate) and the ingredients shall be mixed by volume.
- 4.5 Mortar shall be mixed thoroughly in a drum type batch mixer for a period of not less than three minutes, using the quantity of water required to obtain the desired workability. Hand mixing shall be subject to approval by the Engineer Incharge and if he allows the mortar materials shall be mixed in a light mortar mixing box. In no case the mixing of mortar shall be done on open platform.
- 4.6 The mortar shall be subject to compressive strength test and the average compressive strength of three numbers 2" cubes of mortar shall be not less than 1,800 lbs per sq. inch at 28 days.
- 4.7 Mortar shall be used in the masonry within half an hour from addition of water

into the mortar. The mortar which has already set shall not be used on the masonry.

5. MASONRY AND JOINTING

- 5.1 All masonry shall be laid plumb, true to the line and level and accurately spaced coursed and with each course breaking joints with the course below. Bond shall be keeping plumb, corners and reveals shall be plumb and true. Chases, grooves, reglet blocks and raked out joints shall be kept free from mortar and other debris.
- 5.2 The thickness and length of various walls shall be as indicated on the drawings.
- 5.3 Unless otherwise shown on the drawings or specified the spaces around forms and other built in items shall be solidly filled with mortar except that joints that are to be caulked shall be raked out $\frac{3}{4}$ inch.
- 5.4 Work required to be built-in with masonry including anchors, wall plugs and accessories shall be built-in as the work progress. Wood plugs and blocking shall not be built into masonry.
- 5.5 All horizontal and vertical joints shall be completely and solidly filled with mortar when and as the blocks are laid.
- 5.6 The thickness of joints shall not exceed $\frac{3}{8}$ " and the joints shall be raked $\frac{1}{2}$ "deep" when the mortar is still fresh so as to give proper bond to the plaster.
- 5.7 Where masonry abuts RCC columns or walls it shall be anchored thereto by means of wire anchors of galvanized metal not less than 10 gauge or 1" wide G.I. strip 22 gauge located at every fourth horizontal joint.
- 5.8 The top course of partitions under slabs beam shall not be laid until the forms have been removed and the roofing placed.
 - i. Masonry walls shall be cured for at least ten
 - ii. Days from the day it is installed.

6. MEASUREMENT AND PAYMENT

All the items of work covered by this section of the specifications shall be measured by the standard method of measurements and paid in accordance with unit rates entered in the Bill of Quantities. No separate payment will be made for masonry anchor etc. required.

SECTION – 9**POLYVINYLCHLORIDE WATER STOPPER****1. DESCRIPTION**

The work shall comprise providing and installing of all types of polyvinylchloride (PVC) water stops and expansion joints, in concrete structures and elsewhere, in accordance with these specifications and to the location, lines, grades and cross-sections shown on the Drawings and/or as directed by the Engineer.

2. MATERIAL REQUIREMENTS

- a. PVC water stops shall be extruded from an elastomeric plastic compound, having basic resin of polyvinylchloride (PVC).
- b. The compound shall contain such additive resins, plasticizers, stabilizers or other materials, needed to ensure following physical characteristics when tested by the US Corps of Engineers Test Methods, as specified below:

Characteristics	Minimum Requirement	Test Method
Tensile strength, using die III	123 kg/cm ² (1750 psi)	568
Ultimate elongation, using die III	350%	573
Low temperature brittleness with no sign of failure such as cracking or chipping	- 35° F	570
Stiffness in flexure, 1/2" span	28 kg/cm ² (400 psi)	571

3. CONSTRUCTION REQUIREMENTS

All the operations of installing, jointing and splicing the water stops shall be carried out in accordance with the recommendations and instructions of the Manufacturer and the directions of the Engineer.

- a. All embedment in concrete, lapping, turning and sealing shall ensure absolute water tightness.
- b. No holes shall be made through any water stops.
- c. The water stops, wherever indicated on drawings or directed by the Engineer, shall be cast

4. INTEGRALLY WITH THE IN-SITU CONCRETE, WITH SEPARATE JUNCTION AND INTERSECTION PIECES, PLACED AND JOINTED AT SITE.

- d. The water stops shall be installed, in such a way that they are held securely, in their correct position, during the placement of concrete.
- e. The concrete shall be fully and properly compacted around the water stops to ensure that no voids or porous areas remain.
- f. Where reinforcement is present; adequate clearance shall be left, between water stops and the reinforcement, to permit proper compaction of concrete.
- g. Splices, in the continuity, or at the intersections of runs of PVC water stops, shall be performed by heat-sealing the adjacent surfaces.
- h. A thermostatically controlled electric source of heat shall be used to make all splices. The correct temperature at which splices should be made will differ with the material used but should be sufficient to melt but not char the plastic.
- i. After splicing, a remoulding iron, with ribs and corrugations to match the pattern of the water stop, shall be used to reform the ribs at the splice. The continuity, of the characteristic components of the cross-section, of the water stop design (ribs, tabular centre axis, protrusions, and the like) shall be maintained across the splice.

5. MEASUREMENT

- a. Measurement, for PVC water stops, will be made in the specified units of length, of the water stops, of specified type and size, acceptably placed, on the basis of the dimensions, in accordance with the Drawings or directions of the Engineer.
- b. No allowance will be made, in the above computed lengths, for the laps and splices.

6. PAYMENT

- c. Payment for, PVC water stops, of specified type and size, will be made for the quantity of water stops, measured in accordance with Article 4, at the unit rates, tendered in the priced Bill of Quantities.
- d. The unit rates tendered, for all items of concrete, shall be deemed to be inclusive of, but not limited to the following:
 - i. Providing all materials including splicing, sealing, jointing and filler materials
 - ii. All operations related with transportation, involved in the process
 - iii. All operations related with storage of materials
 - iv. All sorts of wastages

- v. All operations including installing, splicing, sealing, jointing and securing water stops; laying of sealants and fillers in expansion joints; and protection, maintenance and repairs, of the water stops
- vi. Carrying out all sampling and testing
- vii. All other operations, procedures and requirements necessary to complete the work in accordance with these specifications.

SECTION-10

CAST IRON COVERS WITH FRAMES & LADDER RUNGS

1. SCOPE OF WORK

The work to be done under this section of the specifications consists of furnishing all plant, labour, equipment, appliances, materials and performing all operations required in connection with the installation of RCC & C.I. cover with frame, gratings and ladder rungs, complete as specified herein, as shown on the drawings and or as directed by the Engineer.

2. CAST IRON COVERS WITH FRAME

Cast iron cover and frame shall be of the sizes and duty as specified on the drawings. The specified size means the clear opening. The cover shall be complete with frame. Top of cover shall be roughened in an approved pattern. Locking and lifting arrangement shall also be provided. The frame shall be well set in place at the time of pouring of concrete. The cover shall tightly fit in the frame. It shall be airtight and water-tight. The duty, weight, test and working load for 600mm circular or square C.I. cover and frame shall be as follows:

Class/Duty of Cover and Frame	Gross* Weight (Approx.)	Peak or Test Load	Services Working Load
Extra Heavy Duty	-	900 KN	300 KN
Heavy Duty	225-285 Kg	400 KN	135 KN
Medium Duty	130-140 Kg	50 KN	17 KN
Light Duty	70-80 Kg	10 KN	3.5 KN

* The column of gross weight is indicative only for the duty of manhole/chamber. The Contractor shall ensure that the manhole is rated for above mentioned test load irrespective of the weight.

3. LADDER RUNGS

Galvanized steel ladder rungs shall be fabricated to the size specified on the drawings or as directed by the Engineer. The galvanized mild steel ladder

rungs shall be fitted by approved fittings at locations shown on the drawings or as directed by the Engineer.

4. CAST IRON GRATING AND FRAME

All cast Iron grating and frame shall be of the sizes and duty as specified on the drawings. The specified size means the clear opening. Cast iron grating shall be complete with frame. They shall be of heavy-duty type (200-230kg) to resist heavy traffic loads. The casting shall be sound and free from all defects. The frame shall be set in place at the time of pouring of concrete. Opening in gratings shall be in an approved pattern.

5. RCC COVER WITH FRAME

RCC cover and frame shall of sizes as specified on the drawings. The specified size means the clear opening. The cover shall be complete with frame. Top of cover shall be specified reinforced concrete on steel frame as shown on drawing the outer frame shall be cast iron and shall well set in place at the time of pouring of concrete. The cover shall be air-tightened and water tight.

6. MEASUREMENT AND PAYMENT

6.1 GENERAL

Except otherwise specified therein or elsewhere in the contract documents, no separate measurement and payment will be made for the under-mentioned works related to the relevant BOQ items but shall not be limited to the following. The cost thereof shall be deemed to have been included in the quoted unit rate of the respective items of the Bills of quantities:

- Lock and key
- Applying bituminous paint
- Anchor bars, grouting materials etc

6.2 MEASUREMENT

Measurement of acceptably completed work of cast iron, RCC cover and ladder rungs will be made on the basis of actual number of cover with frame provided and installed in position as shown on the drawings or as directed by the Engineer.

Measurement of acceptably completed works of ladder rungs will be made on the basis of actual number of ladder rungs provided and installed in position as shown on the drawing or as directed by the Engineer.

6.3 PAYMENT

Payment for the acceptable measured number of Cast Iron, RCC cover and ladder rungs shall be made on the basis of unit rate per number quoted in the bills of quantities and shall constitute full compensation for all the works related

to the item.

6.4 MEASUREMENT

Measurement of acceptably completed work of C.I. grating with frame will be made on the basis of actual weight in kilogram, provided and installed in position as shown on the drawings or as directed by the Engineer.

6.5 PAYMENT

Payment for the acceptable measured quantity of grating with frame shall be made on the basis of unit rate per kilogram quoted in the bills of quantities and shall constitute full compensation for all the works related to the item.

SECTION-11

UPVC PIPE

Upvc pipes shall be approved manufacture and confirm to the standard as specified in General section

1 SCOPE OF WORK

The work covered by this section of the specifications consists of furnishing all plant, labour, equipment, appliances and materials and in performing all the operations in connection with lying, jointing, testing, disinfection and commissioning of upvc pipe work complete in strict accordance with the specifications herein and the applicable drawings and subject to the terms and conditions of the contract.

2 STANDARDS AND SPECIFICATION

For sampling testing and tolerance limit, specification BS3505:1968 and PS 3051 1991 shall be followed. The upvc pipes jointing shall be cement solvent joint or Z-joint. The contractor should provide the Technical Detail and Boucher to the Engineer or Engineer's representative for approval.

3 PHYSICAL PROPERTIES

The physical properties of UPVC pipes shall fall with in the following limits

Properties	Value	Unit
Specific Gravity	1.42 - 1.46	-
MECHANICAL		
Tensile strength at 23 °C	450 – 600	kgf/cm ²
Modulus of elasticity at 20°C	30,000	kgf/cm ²
Elongation at break	> 80	%
Impact strength at 0°C	0.5 – 1	Ft lb / in of notch
Impact strength at 20°C	1 – 2	Ft lb / in of notch
Compressive strength	600 – 700	Kgf/cm ²

Bending Strength	1000	Kgf/cm ²
THERMAL		
Specific heat at 20°C	0.24	Cal/gm/°C
Vacate softening point	85	°C
Heat distortion temperature at 18.5 kgf/cm ²	75	°C
Thermal conductivity	0.12 – 0.14	W/m °C
Coefficient of linear thermal expansion	0.08	Mm/mm °C
ELECTRICAL		
Dielectric constant (800 cycle)	3	-
Dielectric strength	425	Volts/mil
Inflammability	Will not support combustion	-
Water absorption (24 hrs at ambient temp.)	0.07	%

4 ABBREVIATIONS

uPVC	Unplasticized polyvinyl chloride
PVC	polyvinyl chloride
BS	British Standard
PS	Pakistan Standard
OD	Outside diameter
PN	Nominal Pressure

5 NOMINAL PRESSURE (PN)

The following class/pressure shall be followed

- Class B (PN=6 bars),
- Class C (PN= 9 bars)
- Class D (PN=12 bars),
- Class E (PN= 15 bars)

6 THICKNESS AND DIAMETER

The diameter and thickness shall be as followed

Nominal size Inch	Mean Outside Diameter	Wall Thickness			
		Class B 6 bar	Class C 9 bar	Class D 12 bar	Class E 15 bar
		min	min	min	min
	max	mm	mm	mm	mm
3"	89.1	2.9	3.5	4.6	5.7
4"	114.5	3.4	4.5	6.0	7.3
5"	140.4	3.8	5.5	7.3	9.0
6"	168.5	4.5	6.6	8.8	10.8

7 UPVC FITTINGS

uPVC fittings shall be approved manufacture and shall be confirm to the standard as specified in General section I For sampling testing and tolerance limit, BS and PS pecification shall be followed.

Metal fittings (cast iron and ductile iron fittings) can be used for diameter ranging 10 inches and above. The metal fittings are connected with the pipe using rubber ring Z-joint system.

8 JOINTING

Solvent Cement joint

Jointing is done by applying a uniform layer of solvent cement to spigot and socket ends of pipes to be jointed together and assembling them with a quick action. Right after jointing, the surplus cement shall be removed and a period of 24 hours should be allowed to elapse before pressure testing. It may be noted that completion.

GUIDE TO THE CONSUMPTION OF LUBRICANT, CLEANER AND SOLVENT CEMENT PER 100 JOINTS

Range of pipe and fittings diameter (mm)

Aprox.	32 – 40	50 – 63	75 - 90	110 – 125	140 - 160
	1" – ¼"	1" – ½"	2 ½" – 3"	4"	5" – 6"

Lubricant (kg)	-	2.0	3.50 – 4.00	4.00 – 5.00	5.0 – 6.5
Cleaner (liter)	0.35 – 0.50	0.65 – 0.90	1.00 – 2.00	3.00 – 5.00	6.5 – 9.0
Solvent Cement (Liter)	0.78 – 1.00	1.30 – 1.800	2.00 – 4.00	6.00 – 10.00	13.0 – 18.0

9 Z-JOINT

Z – Joint is also commonly known as “rubber ring” joint. These joints contain an electrometric sealing component which is automatically compressed to form an effective seal when the spigot end of upvc pipes inserted into the socket.

These joints are not designed to resist end thrust. Therefore, particular care should be taken to ensure that the pipeline is property anchored. Anchor blocks should be designed to withstand the thrust resulting from the maximum pressure to which the pipe is likely to be subjected, normally the test pressure. It is desirable to insulate the uPVC pipe from direct contact with the anchor block by means of a suitable flexible membrane.

10 FLANGED JOINT

Flanged joints can be used to connect uPVC pipes with metal pipes, valves and fittings provided with flanges. Joints are made by the compression of the gasket or a ring seal set in the adaptor of the flange. Flanged joints are also preferable, where there is a need to dismantle pipeline from time to time. Care should be taken while selecting flange accessories their flange should be compatible with the uPVC flange adaptor.

INSTALLATION OF UPVC PRESSURE PIPES

11 INSTALLATION OF BURIED PIPE

Unplasticized PVC pipes must be laid onto a trimmed trench bottom, where soil is uniform, fine grained and free from sharp objects. The trench width must be sufficient to enable the lying and jointing of the pipes and proper compaction around the pipe. The minimum recommended trench width (W) is equal to pipe OD plus 600 mm or as specified in the Drawings.

The minimum depth of cover required for water mains is 1000mm from finished surface level to the crown of the pipe. Thus, the minimum excavated depth (D) of the trench for water mains is pipe OD + 1000mm + Bedding.

The normal thickness of bedding is a min of 100mm. for pipe sizes greater than 8 inches; the bedding thickness should be increased to a minimum of 150mm and or specified in the Bill of Quantities.

Because of the flexible nature of the material the pipe should be suitably anchored at all changes of direction and at fixed points. The anchors should be designed to withstand the maximum thrust developed during hydrostatic pressure testing.

Un plasticized PVC pipes should not be installed in direct sunlight or near any heat source. The liner expansion of uPVC is about six to seven times that of steel, so precaution is to be taken to compensate for it. The pipe line should be installed in such a way as to minimize the stress. The best way of doing this is to arrange piping so that bends occur between anchor points. Along walls pipe rack, hangers, clamps, straps or u-bolt can be used.

12 SUPPORT SPACING

Recommended horizontal and vertical support spacing is given in the table.

*Pipe Outside Diameter	Water Temperature °C				Vertical spacing
	20 °C	30 °C	40 °C	50 °C	
OD	Horizontal Spacing				
mm	cm	cm	cm	cm	cm
16	75	60	40	-	80
20	85	70	50	-	90
25	90	75	55	45	100
32	100	85	65	50	120

13 MEASUREMENT

All UPVC pipes shall be measured according to the work actually done and no allowance will be made for any waste in cutting to the exact length required. The measurement for pipes shall be in running meter nearest to a cm. Of length along the centre line of pipe as actually laid at work sites.

The rate for providing, laying and jointing of UPVC pipes shall be deemed to include the cost of collars/rubber rings, jointing material, testing and extra excavation required for ordinary bedding of pipes and also for collars and pipe sockets, if any.

If any damage is caused to the pipe line during the execution of work or while cleaning/testing, the pipe line as specified. The contractor shall be held responsible for the same and shall replace the damage pipe line and retest the same at his own cost to the full satisfaction of Engineer.

Water for testing of pipeline shall be arranged by Contractor at his own cost.

Pipes shall be brought on site proportionate to the required progress for Thirty days only.

SPECIFICATION STRUCTURE WORKS

SPECIFICATIONS FOR STRUCTURE WORKS (CIVIL)

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SECTION – 1

1.0 GENERAL

- 1.01 This General Specification is to be taken as applying to all the works in this Contract. Figured dimensions on the working drawings shall be followed in preference to the scale.
- 1.02 Until and unless specified otherwise, all goods and materials are to be Pakistan manufactured and to be of the best quality, and where not otherwise specified shall be according to latest engineering practice and conforming to Pakistan Standards (P.S) or British Standard Specifications (B.S.S) or Standard of American Society of Testing Materials (ASTM). The Engineer or the Consultants may also supplement such specifications during the progress of work.
- 1.03 All materials and goods used for such and other items shall be subjected to standard testing and if found below the specified standard such as PS or BSS or ASTM or their equivalent shall be removed from the site immediately at Contractor's own expense. All testing of materials finished and unfinished, shall be carried out by the Contractor at his cost, in the presence of Engineer or Engineer's Representative for which the Contractor shall maintain a reasonably well equipped laboratory of his own, close to the site of work or make any other additional arrangement to the satisfaction and convenience of the Engineer. The Contractor shall include testing charges in his quotations and shall not be entitled to any reimbursement on this account for routine testing.
- 1.04 The Contractor must give early attention to the submission of samples of materials for approval of the Engineer, indicating the names of the manufacturing firms, where applicable especially of cement, sand, aggregates, steel, water, tiles, hard-core and all fittings. Whenever practicable, samples shall be submitted at least three weeks before it is proposed to use the materials. Until and unless specified otherwise and whenever materials are ordered to be forwarded to a testing laboratory other than site laboratory for check / testing.
- 1.05 The Contractor must take all steps necessary to prevent damage or interference with all supply lines such as water, electric power, fuel, telephones, drains, buried cables and any construction designed for the use of the public, government or semi government authorities or the Employer. The Contractor shall be responsible for any damage caused to such services or constructions and settle all claims in respect of such damage.
- 1.06 The Contractor shall protect from injury by covering all work, internally and externally needing protection including new concrete, brickwork, surface renderings, floors, etc., to the satisfaction of the Engineer, including the work of his sub-contractors at his own cost.

- 1.07 The whole work shall be carried out in the best manner in accordance with the instructions contained in these documents and those given by the Engineer from time to time during the progress of the work. The work shall be carried out in conformity with the best of the standard construction practices preferably the British Codes of Practices.
- 1.08 The Contractor shall submit to the Engineer for his approval before beginning the work, a complete plan of the proposed sequence and methods of operations for the execution of the works. Detailed drawings showing the location and construction of dumping and working platforms, gantries, building and all other structures in connection with the Contractor's plant and material storage sheds shall also be submitted to the Engineer for his approval before construction.
- 1.09 Orders and directions may be given orally by the Engineer or his Representative, and shall be received and promptly obeyed by the Contractor or his Representative or any superintendent or foreman or any supervisor of the Contractor whosoever may have charge of the particular part or section of work in relation to which the orders or directions are given, and a confirmation in writing of such order or directions will be given to the Contractor by the Engineer, if so requested. The Contractor shall provide and maintain at his own expense during the performance of the work an office in the vicinity of work. Orders or directions, written or oral, from the Engineer or his Representative delivered at such office shall be considered as delivered to the Contractor. The Contractor's office shall be fitted with a telephone connected to the local Telephone Exchange.
- 1.10 The Contractor shall not use the site for any other purpose than that of carrying out this Contract work. The operations of the Contractor shall be confined to the area immediately adjoining the buildings and the works included in this Contract but site clearance shall be kept to the satisfaction of the Engineer to permit carrying out of other works by other Contractors. The Contractor shall not affix advertisements; neither shall he permit advertisements to be displayed without the written consent of the Engineer.
- 1.11 The contract drawings are the working drawings to guide the Contractor generally about the shape and size of all the structures and fittings. Before proceeding to make preparations, fabrication, execution, erection of any such fittings and other details of any temporary works, scaffolds, railings, shutterings, details of doors, windows, partitions, iron mongery works, etc; the Contractor shall be under obligation to prepare and submit all detailed shop drawings to the satisfaction and the approval of the Engineer, before doing any or all of that described above or as directed. Approval of the contractor's drawings shall not relieve the Contractor for any part of his obligation to meet all the requirements of the specifications or correctness of his drawings.

1.12 No cement work shall be permitted during extreme cold weather when unless otherwise authorized by the engineer.

1.13 **PAYMENT**

Contractor shall not be entitled to any separate or additional payment on account of all these general requirements and any other arrangement or action Contractor has to undertake under the direction of the Engineer for a proper carrying out of the works and meeting all obligations of the Contract.

SECTION - 2

2.0 SITE CLEARING, GRUBBING AND SETTING OUT OF WORKS

2.01 SCOPE OF WORK

The work covered by this section of specifications consist of furnishing all labour, necessary equipment, services, miscellaneous and necessary items required to satisfactorily complete the clearing, grubbing and setting out of the works, as indicated on drawings, specified herein or both.

2.02 CLEARING

Clearing shall consist of cutting, or trimming of trees, if any, and the satisfactory disposal of tree and other vegetation designated for removal, together with the timber snags, bushes, and rubbish occurring within the area. Trees, other vegetation stumps, roots, and bushes in area to be cleared shall be cut off flush with or below the original ground surface except such individual trees, group of trees and vegetation as may be indicated on the drawing or designated by Engineer or his Representative to be left standing. Individual trees and other vegetation, to be left standing shall be thoroughly protected from damage during construction operation, by erection of barriers or by such other means as the circumstances require and as approved by the Engineer's Representative. Clearing operation shall be conducted in a manner that existing structures and installations under construction, employees and others remain safe.

2.03 GRUBBING

Grubbing shall consist of the removal and disposal of all stumps, roots and matted roots in the designated grubbing areas. Stumps, roots, logs and timber and other debris, shall be excavated and removed to a depth not less than 2 feet below any sub-grade level. In areas where the cut is over 3'-6" grubbing shall not be necessary.

2.04 DISPOSAL OF DEBRIS

Timber and other refuse to be disposed off by burning shall be burned at location, approved by the Engineer's Representative, in a manner that will avoid all hazard such as damage to existing structures, construction in progress, trees and vegetation. The contractor shall be responsible for compliance with all pertinent laws and regulations pertaining to the burning of fire. Disposal by burning shall be kept under constant attendance, and residual, until materials will not be permitted to be pushed or placed on the adjacent areas without written approval of the owner/owners. The stones and concrete shall be broken and removed from the site for receiving the structure/flooring where required. All debris shall be disposed off by the Contractor as directed by the Engineer.

2.05 SETTING OUT OF WORKS

The Contractor shall set out the works and shall be responsible for true and perfect setting out of the same and for correctness of the direction, levels, dimension and alignment of all parts thereof. If at any time any error in this respect shall appear during the progress of the works, the Contractor shall, at his own expense, rectify the error to the satisfaction of the Engineer. The Contractor shall construct accurate benchmarks so that the lines and levels can easily be checked by the Engineer.

2.06 DRAINAGE DITCHES

The Contractor shall construct and maintain such ditches, in addition to those shown on drawings or as may be ordered by the Engineer to adequately drain and areas under construction.

2.07 PAYMENT

No separate payment will be made for the work covered under this section, and all costs in connection therewith shall be deemed to be included in the unit rates.

SECTION - 3

3.0 EXCAVATION, FILLING, BACKFILLING AND DISPOSAL

3.01 SCOPE OF WORK

The work covered by this section of the Specifications consists of furnishing all Plant, Labour Equipment Appliances and materials and in performing all operations in connection with excavating, filling, backfilling and disposal for building construction, and other foundations complete in strict accordance with this section of the Specifications and the applicable drawings and subject to the terms and conditions of the Contract.

3.02 BORING LOG DATA

A preliminary report on Sub-Soil investigation and exploratory data of the site area is available for reference only in the office of the Engineer. The Employer or Engineer's predications, regarding character or extent of soil or other sub-surface conditions to be encountered during the work are not binding on the Contractor. The Contractor shall make his own deductions for sub-surface conditions which may affect methods or cost of constructions of the work hereunder and he shall make no claim whatsoever for damages or compensation, should he find conditions during the progress of the work, different from those indicated by the soil investigation report of Engineer.

3.03 EXCAVATION

(a) Classification

Excavation shall include the removal of all materials of every category and nature. If rock is encountered it shall be removed carefully and without excessive noise and vibration. Blasting shall not be resorted to without specific permission in writing from the Engineer.

(b) The excavation shall conform to the dimensions and elevations as indicated on the Drawings. Foundations on made up ground shall be taken down to natural bottom soil as per direction and approval of the Engineer. Excavation shall extend a sufficient distance from walls and footings to allow for placing and removal of forms installation of services and for inspection but the same shall not be paid.

(c) In the event of any excavations being carried out wider or deeper than authorized, the same shall be filled in by the Contractor at his own cost to the required levels with lean concrete if below footing or with properly compacted local river sand if beneath slabs or as directed by the Engineer.

(d) Shoring and Bracing:

The Contractor shall provide at his own cost, where required all shoring walls, supports etc. to the sides of the excavation to prevent sliding or any movement. Where necessary, excavated sides shall be sloped as directed by the Engineer.

(e) Dewatering and Drainage:

The Contractor shall control the grading in the vicinity of site of work in order to prevent any water from running into the excavated areas. He shall at his

own cost keep dry all pits and trenches during construction and all dewatering and pumping out whether due to ground water seepage or otherwise, shall be included in the rates as quoted by the Contractor. The method employed in all cases shall be approved and agreed by the Engineer or his Representative.

(f) Protection of utility lines:

When any existing utility lines whether to be retained or be removed are encountered within the area of operations, the Contractor shall notify the Engineer and his Representative, and shall not proceed until necessary measures are taken for protection or removal of the lines and instructions are obtained from the Engineer.

(g) Excess and undesirable material from excavation not required for fill or backfill of the building site, shall be disposed off, removed and/or deposited as for filling and leveled anywhere on the work site as directed by the Engineer. Earth suitable and meant for backfill shall be stored at site in a manner not to interfere with the progress of construction works.

3.04 **FILL AND BACKFILL**

Where concrete slabs are to be placed on the ground, any loam, organic and other unsuitable material shall be removed. Fill where required to raise the sub-grade for concrete slabs shall be clean, unadulterated local river sand or gravel and shall be free from wood, stones and other debris. Excavated material shall only be used for fill if approved by the Engineer in writing. All the backfill behind the sub-grade walls shall be done with clean local river sand or approved excavated soil. Fill shall be compacted upto 95% modified AASHTO Density by a Power vibratory roller, mechanical rammer, or other approved equipment, in layers not more than 6 inch thick. Each layer shall be uniformly spread, watered to the extent of optimum moisture requirement for the required degree of compaction and then compacted. Contractor shall arrange at his own cost the testing of the filling where required by the Engineer or his Representative, after completion of foundation footings, walls, slabs and other construction below the elevation of the final grades and prior to backfilling. Backfill shall be placed in horizontal layers not more than 6 inches thick and shall have proper moisture content for the required degree of compaction of 95%. Each layer shall be compacted by mechanical tampers or by other suitable equipment approved by the Engineer. Backfill shall be brought to a suitable elevation above grade to provide for anticipated settlement and shrinkage thereof.

Backfill shall not be placed against foundation walls etc., prior to the damp proofing treatment, if specified and approved by the Engineer or his Representative. Backfill shall be brought up evenly on each sidewall as far as practicable. Heavy equipment for spreading and compacting backfill shall not be operated closer to the wall than distance equal to the height of the backfill above the top of footing.

3.05 **COMPACTION:**

Fill and/or backfill within the building or structures and for a distance of 6 ft. outside structures shall be compacted to a density of not less than 95% maximum density at optimum moisture content.

3.06 **ROUGH GRADING:**

(a) Necessary rough grading shall be carried out by the Contractor to establish

grade or construction requirements of the site. Grades not otherwise indicated shall be uniform levels or slopes between points on existing and finished grades. Abrupt changes in slopes shall be rounded. Additional fill required to complete rough grading shall be provided as directed by the Engineer or his Representative.

- (b) Where paving or slabs are specified, all rough grading shall be done to the sub-grade of the base course, removing all large stones and debris and shall be compacted uniform to the correct lines and levels ready to receive the paving or slab. Refilling, where required shall be executed with suitable selected materials in layers not exceeding 6 inch thick and thoroughly compacted to the required density. In place density tests shall be carried out by the Contractor for the approval of the compaction by the Engineer.

3.07 **FOOTING BOTTOM LEVELS:**

The levels as noted in the Drawings are only approximate and must be adjusted in the field with the approval of Engineer, depending on the soil conditions encountered. No concreting shall begin until the soil bearing capacity is substantiated by visual inspection by the Engineer or his Representative. The Contractor in planning his work shall make arrangement and provisions to construct the lowest level footings first.

3.08 **FIELD LEVELS:**

Prior to starting the work, the Contractor shall arrange to take the levels of the piece of land on which the building is located as directed by the Engineer. The same shall be simultaneously checked by the Engineer or his Representative and shall form the basis of payments for excavation and filling etc.

3.09 **DISPOSAL OF SURPLUS EARTH AND RUBBISH:**

All surplus earth and rubbish shall be disposed off at site as directed by the Engineer. The term disposal shall include all operations of loading, unloading, stacking, spreading, rehandling, filling in depressions, including consolidating and ramming in layers not exceeding 6 inch thickness.

3.10 **MEASUREMENTS AND PAYMENTS:**

All excavation shall be measured net and perpendicular and no allowance shall be made for any increase in bulk of the excavated material after excavation or for sloping sides, or widened trenches to accommodate formwork, shoring and bracing etc. Similarly the measurements for filling/backfilling shall be thoroughly compacted and measured net and no allowance shall be made for any increase in bulk after excavation. Excavation, dewatering, filling and Disposal shall include all leads and lifts as specified elsewhere in these specifications. Payment for all the items under this section shall be made at the rates entered in the BOQ appended to the contract and in accordance with the applicable conditions of the contract.

Note:-

1. Imported earth fill item which will be paid separately as per the unit rate quoted in the Bill of Quantities. Appended to the contract and in accordance with applicable condition of the contract.
2. Stone soling item which will be paid separately as per the unit rate quoted in the Bill of Quantities. Appended to the contract and in accordance with applicable condition of the contract.

SECTION - 4

4.0 TERMITE CONTROL

4.01 SCOPE OF WORK:

The work covered by this section of Specification consists of furnishing all labour, materials, equipment, services, miscellaneous and necessary items required to complete Termite Control work, related works as indicated on drawings specified herein or both.

4.02 MATERIALS:

- (a) Pesticides shall be solution of an approved chlorinated hydrocarbon such as 0.5% Dieldrin or 0.5% Aldrin mixed in clean water for application to or in earth, and mixed in pure turpentine for application to wood.
- (b) Pesticides (dieldrin and aldrin) shall be obtained from the Government of Pakistan, Department of Agriculture, 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 his Representative.

4.03 METHOD OF APPLICATION:

Pesticides solution shall be applied with approved pressure spraying equipment maintaining a pressure of 1N/Sq.mm (150 lb/sq.in.) for all applications, to, on, or in earth. Spraying to wood shall be done by hand compression sprayers with an approximate pressure of 0.15 N/Sq.mm (20 lb/Sq.in.).

4.04 EXTENT OF APPLICATION:

- (a) At excavation, all walls and bottoms of all pits or trenches for footings or foundations are to be sprayed. Pesticide shall penetrate to a depth of 1'-0" minimum in porous earth at bottom and 3" minimum at sides of excavations.
- (b) Stockpiled excavated material to be used as back fill is to be treated as above. After back-filling to plinth level, area of the whole building upto 10'-0" outside the building line is again to be sprayed penetrating a minimum of 1 ft. into soil.
- (c) After grading, compaction and sand filling before formation of hard core/soling under floor slabs all areas to be covered shall be sprayed with pesticides, penetrating a minimum of 1 ft. into soil.
- (d) All rough woodwork for the entire project shall be pesticide treated (before application of so lignum in the case of material to receive both treatments). Pesticide shall be sprayed on all surfaces of blocking, furring, planks, scantlings, boards etc. before installations. Spraying shall be once again done at the site, after delivery and before installation. All spraying will be done within one week of working of the material.

4.05 LOCATION AND SCHEDULING:

- (a) Saturation of earth is to be done in such a manner as to in no way disrupt the progress of work.
- (b) Spraying of rough woodwork shall be done on or near the site at location and in such enclosures as proposed by the Contractor and approved by the Engineer. Such work is to be scheduled and done by sufficient skilled personnel as to in no way impede the progress of the work.
- (c) Care shall be exercised to ensure that no marks 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.

4.06 STANDARD:

All methods of termite protections used herein shall be in accordance with the standard practices of National Pest Control Association, U.S.A, and the British Wood Preserving Association.

4.07 GUARANTEE:

The Contractor is to guarantee that the building shall be free from termite (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 guarantee period, the Contractor shall replace at his own cost such damaged 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 and other pests.

4.08 TESTING:

All materials and samples shall be subjected to standard testing in accordance with the standards specified herein and shall be rejected if found below these standards. Rejected materials shall be removed from the site immediately.

4.09 PAYMENT:

Payment will be made for building site on the basis of plinth area covered by this treatment including all ditches, pits, excavation, fills etc. which will be paid separately as per the unit rate quoted in the Bill of Quantities.

SECTION - 5

5.0 WATER

5.01 SCOPE:

The work covered by this section of the Specification consists of furnishing all labour, appliances and in performing all operations in connection with obtaining, conveying and storing water at site of work.

5.02 QUALITY OF WATER:

The water used for construction shall be free from impurities and fit for drinking purpose.

5.03 TESTING:

Water if required, shall be subjected to standard testing at the cost of the Contractor and if found to be unsuitable for construction work then the Contractor shall take such action as directed by the Engineer.

5.04 PAYMENT:

No separate payment will be made for the work covered under this section, and all costs in connection therewith shall be deemed to be included in the unit rates.

5.05 TEMPORARY STORAGE TANK:

The Contractor shall provide on site at his own cost temporary storage water tank with all necessary G.I. Pipes and fittings as per instructions of the Engineer. No separate payment will be made for tank, pipes and accessories, etc. These tanks shall be removed or dismantled or demolished and the area shall be cleaned and made good on completion of work as per direction of Engineer.

SECTION - 6

6.0 CONCRETE

6.01 SCOPE OF WORK:

The work covered by this section of the Specifications consists of furnishing all plants, labour equipment appliances and materials and in performing all operations in connection with concrete work complete in strict accordance with the applicable Drawings and the Specifications herein and subject to the terms and conditions of the Contract.

6.02 GENERAL:

Full cooperation shall be extended to other trades to install embedding items, and form ducts and openings etc. Embedded items shall have been inspected and check tested for concrete and other materials or for mechanical operations and approved before concrete is placed.

6.03 MATERIALS:

6.03.1 CEMENT

- i) Grey/ white Portland Cement shall be normal setting cement of the specific gravity, fineness and chemical composition fully conforming to Pakistan Standard Specifications P.S. No.232:1967 and shall be capable of satisfying all tests such as the tensile strength tests contained therein. Standard test briquettes prepared with 1:3 cement sand mortar shall give the following tensile strengths:

At 3 days not less than 300 Lbs/Sq.in (2.1N/Sq.mm).

At 7 days not less than 400 Lbs/Sq.in (2.8N/Sq.mm).

- ii) Sulphate Resistant Cement where required shall be sulphate Resistant Cement type 'A' fully conforming to Pakistan Standard Specification PS No.612:1967 and satisfying the requirements for fineness, chemical composition strength, setting time and soundness, etc.
- iii) For all types of cements, described in sub-Clauses (i) and (ii) above, the average compressive strength of three concrete cubes shall not be less than 1200 Lbs/Sq.in(8.2 N/Sq.mm) at three days and not less than 2000 Lbs/Sq.in(14 N/Sq.mm) at seven days as described in Ps.No.232.1962. Alternatively, the average compressive strength of three mortar cubes prepared with 1:3 cement and standard silica sand mortar shall not be less than 2200 Lbs/Sq.in(15.2 N/Sq.mm) at three days and not less than 3400 Lbs/Sq.in(23.5 N/Sq.mm) at seven days. The initial setting time shall not be less than 45 minutes and final setting time not more than 10 hours.

- iv) The supply of cement must be so programmed by the Contractor that at no time the quantity of cement stock shall be less than that required for an average consumption of four weeks. Lorry or truck or other means of transportation, for the conveyance of cement to the site of works, shall be clean, dry, metalled lined and covered from top with water proof sheets, so that cement is sufficiently protected from any deterioration during transit.
- v) The Contractor shall provide at his own cost, on the Site, all necessary sheds, which shall be perfectly dry and watertight for the storing of cement to be delivered to the works, to ensure adequate supplies being available at site of work.
- vi) If at any time the Engineer or his Representative considers that any batch of cement may have deteriorated on the site during storage for any reason, he will direct that tests shall be made and that batch of cement on the site shall not be used until it has been shown by test at a laboratory, approved or appointed by the Engineer, to be satisfactory. Contractor shall bear all costs of such testing. Any rejected cement shall be removed from the site by the Contractor without delay. Cement reclaimed from cleaning bags or leaking containers shall not be used.
- vii) Cement shall be consumed in the sequence of receipt of shipments unless otherwise directed by the Engineer or his Representative.

6.03.2 AGGREGATES

- i) All fine and coarse aggregates to be used shall be supplied from approved sources, which shall not be changed without permission in writing from the Engineer. Aggregates shall conform to the test requirements of Pakistan Standard 243:1963 or equivalent.
- ii) Fine aggregates, shall be approved sand and shall be clean, sharp, free from clay, earth, vegetable and organic matters, alkaline or acid reactions or other deleterious matter or impurities.
- iii) Fine aggregates shall conform to Pakistan Standard Specifications PS No.243:1963 "Natural Aggregates for Concrete" and shall be graded as follows:-

B.S.SIEVE NUMBER.	PERCENTAGE (BY WEIGHT) PASSING	
	Grading Zone 1.	Grading Zone 2.
3/8"(9.5 mm)	100	100
3/16"(4.8 mm)	90 - 100	90 - 100
No. 7	60 - 95	75 - 100
No. 14	30 - 70	55 - 90
No. 25	15 - 34	35 - 59
No. 52	5 - 20	08 - 30
No.100	0- 10	00 – 10

- iv) Coarse aggregates shall be approved hard crushed stone from a source approved by the Engineer and shall be clean, free from sand, dust, salt, lime, chalk, clay and organic impurities or other deleterious matter.

- v) Coarse aggregates shall conform to the relevant Pakistan Standard Specifications PS No.243:1963 Coarse aggregate shall be graded as follows:-

FOR CONCRETE CLASSES A, B & C (Nominal Size of Graded Aggregate 3/4" to 3/16" (19 mm to 4.8 mm).

B.S.SIEVE NUMBER	PERCENTAGE (BY WEIGHT) PASSING
1" (25.4mm)	100
3/4" (19 mm)	090 - 100
3/8" (9.5mm)	020 - 55
3/16"(4.8mm)	000 - 10

FOR CONCRETE CLASSES D & E (Nominal Size of Graded Aggregate 1-1/2" to 3/16" (38 mm to 4.8 mm).

1 1/2" (38 mm)	100
1" (25.4 mm)	95 - 100
3/4" (19 mm)	35 - 70
3/8" (9.5mm)	10 - 33
3/16"(4.8mm)	0 - 5

- vi) All aggregates shall be stored on properly constructed paving and in bins and there shall be a physical partition between the stockpiles of coarse and fine aggregate. No mixed up aggregates shall be used in any concrete. Under no circumstances aggregates shall be allowed to be in contact with ground.
- vii) If required, aggregates shall be washed and screened to the satisfaction of the Engineer or his Representative before use by processing through proper screening and washing plant. Adequate time is to be allowed therefore, for the moisture content to become substantially uniform before use in works.
- viii) Sieve analysis and other necessary tests of all aggregates shall be carried out as and when required by the Engineer or his Representative. Samples for such tests shall be taken in the presence of the Engineer or his Representative. All costs in connection with the tests shall be borne by the Contractor.
- ix) All aggregates shall be subject to the approval of the Engineer. Any

batch of aggregates not found to the required standard shall be rejected by the Engineer or his Representative and shall have to be removed from site without delay. Concrete structures executed with rejected aggregates shall be dismantled and rebuilt at the Contractor's expense.

- x) Special fine gravel of 9 mm (3/8") or 12 mm (1/2") maximum size shall be used if and where called for on the Drawings or as directed by the Engineer.
- xi) If suitable gravel meeting with the Specifications is not procured by the Contractor, he will have to arrange suitable crush stone if demanded by the Engineer. No extra payment shall be made to the Contractor to effect this change.

6.03.3 WATER shall be as specified under section on water.

6.04 CLASSIFICATION OF CONCRETE:

Classes of concrete to be used in various parts of the works shall be as indicated on the drawings and mentioned in Bill of Quantities. The concrete of various grades shall be proportioned as set out in Table-I appended hereto.

TABLE-I: Showing minimum required compressive strengths 150 x 300 or 100 x 200 mm test cylinder and minimum quantity of cement required per cum or 100 cft. Of finished concrete for various mixes and under various conditions.

Class of Concrete	Nominal Min. Ratio	Min. Qty. of Cement		Preliminary Cylinder strength			
		Lbs. per 100 cft.	Kg. / Cu. m.	at 7 days		at 28 days	
				Lbs./ Sq. in.	N/ Sq.mm	Lbs./ Sq. in.	N/ Sq.mm
A.	1:1:2	3024	485	3350	23.10	4000	27.58
B.	1:1 1/2:3	2520	404	2800	19.31	3000	20.68
C.	1:2:4	2016	323	2250	15.51	2500	17.24
D.	1:3:6	1344	216	1100	7.58	1500	10.34
E.	1:4:8	1008	161	700	4.82	1000	6.89

6.05 PROPORTIONING OF CONCRETE MIXES:

6.05.1 All concrete shall be proportioned by volume for concrete mixes, unless specifically directed by Engineer to proportion them by weight, when the ratios will also differ. The proportions given above in Table-I are suitable only when the specific gravities of the aggregates are in the region of 2.5. The Contractor shall submit to the Engineer proposed mix designs for concrete to be used, based on preliminary laboratory tests to determine proportion of cement, aggregates and water in the concrete conforming to the quality and strength requirements specified herein. Preliminary test results of at least three different mixes of each class of concrete with varied water cement ratios shall be submitted. The results of 7 days and 28 days cube tests shall be used to establish the ratios between 7 days and 28 days strengths. The Engineer may make adjustments in the ratio of fine to coarse aggregate in the mix for a certain work. Preliminary design of mixes and testing shall be the responsibility of the Contractor. The proportion of voids in the coarse aggregate shall be controlled and if it exceeds 45% than sand and consequently the cement content shall be increased by the Contractor without any charge. If the proportion is less than 40%, sand shall be decreased but not the cement.

6.05.2 MAXIMUM ALLOWABLE WATER CONTENT:

All concrete specimens shall be made, cured and tested in accordance with British Standard or ASTM Standard. A curve representing the relation between the water content and the average 28 days Compressive Strength or earlier strength at which the concrete is to receive its full working load shall be established for a range of values, including all the compressive strengths shown on the plans. The curve shall be established by at least four points each point representing average values for atleast four specimens. The maximum allowable water content for the concrete shall be as determined from this curve and shall correspond to a strength 15% greater than indicated on the plans. No substitution shall be made in the materials used in the work without additional tests in accordance with this procedure to indicate that the quality of the concrete is satisfactory.

6.05.3 SLUMP TEST:

The Slump for concrete, determined in accordance with PS No.422:1964 "Slump Test for Concrete" shall be minimum of 25 mm (1") and a maximum of 75 mm (3") provided the requisite strength is obtained. Corrective additions to remedy deficiencies in aggregate gradations shall be used only with the written approval of the Engineer. When such additions are permitted the materials shall be measured separately for each batch of concrete.

6.06 BATCHING AND MIXING:

6.06.1 Concrete shall be mixed by a mechanical batch type mixing plant with adequate facilities for accurate measurements and control of each material entering the mixer and for changing the proportions to conform to varying conditions of the work. The mixing plant assembly shall permit ready inspection of operations at all times. The plant and its location shall be subject to approval of the Engineer. However, if approved by the Engineer, Volumetric batching can be adopted, using cement by weight, at 20°C or 70°F according to the following table:

Class Mix.	Nominal	Cement		Sand		Coarse Aggregate	
		Lbs.	Kg	Cft.	Litre	Cft.	Litre
A	1:1:2	110	50	1 3	35	2 2	70
B	1:1-1/2:3	110	50	1 3/4	50	3 2	106
C	1:2:4	110	50	2 2	70	5	140
D	1:3:6	110	50	3 2	106	7 2	212
E	1:4:8	110	50	5	140	10	280

Water shall be measured for every batch with due allowance made for water already present in aggregates.

6.06.2 **Batching** units where used shall be supplied with the following items:-

- i) Weighing unit shall be provided for each type of material to indicate the scale load at convenient stages of the weighing operations. Weighing units shall be checked at times directed by and in the presence of the Engineer or his Representative and required adjustments shall be made before further use.
- ii) Water mechanism shall be tight with the valve interlocked so that the discharge valve cannot be opened before the filling valve is fully closed and shall be fitted with graduated gauge.
- iii) Discharge gate shall control the mix to produce a rib boning and mixing of cement with aggregates. Delivery of materials from the batching equipment to the mixer shall be accurate within the following limits:-

<u>MATERIAL</u>	<u>PERCENTAGE BY WEIGHT</u>
Cement	1/2
Water	1/4
Fine Aggregate	1
Coarse Aggregate	2

6.06.3 **MIXING UNIT:**

- i) Operations:
Mixers shall not be charged in excess of noted capacity nor be operated in excess of noted speed. Excessive mixing requiring addition of water to preserve required consistency shall not be permitted. The entire batch shall be discharged before re-charging.
- ii) Mixing time shall be measured from the instant water is introduced into the mixer drum containing all solids. All mixing water shall be introduced before one-fourth of the mixing time has elapsed. Mixing time for mixers of one cubic meter or less shall be 2 minutes; for larger than one cubic meter capacity mixers time shall be increased 15 seconds for each additional half cubic meter or fraction thereof. If an air-entraining agent is used, additional mixing time shall be allowed such as to provide the specified air-content.
- ii) Discharge Lock:

Unless waived by the Engineer device to lock the discharge mechanism, until the required mixing time has elapsed, shall be provided on each mixer.

- iv) No hand mixing under any circumstances even with extra cement shall be permitted. If during concreting, the mixing plant fails, the concrete already poured shall be removed, unless directed otherwise by the Engineer or his Representative.

6.07 SAMPLES AND TESTING:

6.07.1 GENERAL:

Test cubes of concrete shall be prepared and stored by the Contractor, in accordance with PS No.56O:1965, as and when directed by the Engineer or his Representative. Test cubes be tested in a laboratory and the Contractor shall bear the charges for the same. Aggregates shall be tested as prescribed.

6.07.2 CEMENT:

Cement shall be tested as prescribed in Pakistan Standard or British Standard or ASTM Standard.

6.07.3 AGGREGATES:

Aggregates shall be tested as prescribed in relevant Pakistan Standard or British Standard 812. In addition fine aggregates shall be tested for organic impurities in conformity with B.S. 812 or equal ASTM Standard or Pakistan Standard.

6.07.4 REINFORCEMENT:

Reinforcing bars shall be tested as prescribed in relevant Pakistan or British or ASTM Standards. Mesh Reinforcement shall be tested as prescribed in B.S.785 or ASTM A-185.

6.07.5 TESTING OF CONCRETE

- i) The Contractor shall provide for test purposes one set of six cubes taken for each class of concrete poured on each day. The Engineer or his Representative may, however, order for more cube tests if any irregularity is found in the concrete.
- ii) All test cylinder shall be 100 x 200 or 150 x 300 mm size.
- iii) All test cylinder of the same set shall be made from the same batch of concrete.
- iv) Three cubes of the set shall be tested at 7-days and three shall be tested at 28 days or at such ages as directed by the Engineer or his Representative.
- v) All test specimens shall be made and cured in accordance with Pakistan Standard PS 56O:1965 or British Standard B.S. 1881 or ASTM C-31.

- vi) Specimens shall be cured under laboratory conditions except that the Engineer or his Representative may require curing under field conditions.
- vii) All cube moulds shall be steel moulds perfectly true having all internal and the meeting faces machined to a smooth surface.
- viii) If the strength tests of the laboratory controlled specimens for any portion of the work falls below the minimum allowable compressive strength at 28 days required for the class of concrete used in that portion, the Engineer or his Representative shall have the right to order replacement of the effected work.
- ix) All test cubes cast at site shall bear distinguishing mark showing serial number, date of casting, quality of concrete and place from where sample was taken and where that batch of concrete was placed in the structure. A proper daily record of test specimens made, test results obtained shall be maintained by the Contractor and weekly test results shall be submitted to the Engineer or his Representative.
- x) The Engineer or his Representative may require load tests for the part of the structure from where test specimens have shown unsatisfactory results at the cost of the Contractor. In the event that load tests indicate bad quality of concrete, measures as prescribed by the Engineer shall be taken to correct the deficiency at no additional cost to the Department. The nature, description and details of load test shall be determined by the Engineer and shall be binding on the Contractor.

6.08 TRANSPORTING AND PLACING CONCRETE:

- a. Concrete shall be conveyed and deposited as quickly as possible after mixing and shall proceed so that, as far as possible, a complete section of the work is done in one operation.
- b. Transport of concrete shall be in a manner approved by the Engineer's Representative and shall be so as to avoid segregation or loss of ingredients of concrete.
- c. All foundations and portions of work to be concreted shall be approved by the Engineer's Representative before concrete is poured.
- d. All forms and reinforcement shall be completed, cleared inspected and approved before pouring of concrete. No concrete is to be deposited till the Engineer's Representative has inspected and approved in writing all reinforcement, foundations, forms, details, positioning of all fixture and materials to be embedded in concrete, control levels and screeds, etc. and is satisfied with the arrangements the Contractors has made to efficiently proceed with the work such as sufficient labour, materials, plants etc. Such an approval will not relieve the Contractor from any of his obligations under this Contract. Water shall be removed from excavations before concrete is

deposited.

- e. Placing of concrete shall not be permitted when, in the opinion of the Engineer's Representative, the sun heat, wind, cold, snow or limitations or facilities furnished by the Contractor prevent proper placing, finishing and curing of concrete.
- f. All concrete shall be thoroughly compacted and consolidated by means of Pneumatic or mechanical vibrators or other approved compacting method. Care shall be taken to avoid segregation due o excessive vibration. The Contractor shall maintain on site at all times one or more stand-by vibrators. Tapping or other external vibration of forms shall not be allowed, unless so directed by the Engineer's Representative. Compaction shall be done until the whole mass assumes a jelly like appearance and consistency with the water just appearing on the surface. Concrete shall be sufficiently tamped and consolidated around the steel rods, care taken that the vibrator does not touch steel or formwork and into all parts of the moulds in order that no voids or cavities are left. Steel shall not be disturbed during operations of concreting. Concrete shall be brought up in even layers not more than 150 mm (6") thickness and worked against side of forms to give a smooth and uniform surface. No excessive water shall be allowed to come out and lie on the surface of concrete. The concrete must be of such a consistency that after ramming, consolidating and tamping is completed, a thin film of water is just appearing on the surface.
- g. Hardened concrete, debris and foreign material shall be removed from interior of forms and from inner surface of mixing and conveying equipments.
- h. Runways shall be provided for wheeled concrete handling equipment, and such equipment shall not be wheeled over reinforcement, nor shall runways be supported on reinforcement.
- i. Concrete shall not be dropped freely from a height of more than 3.5 m (12 ft) in columns and 1.5 m (5 ft) elsewhere. Incases where an excessive drop is inevitable the Contractor shall provide spouts, down pipes, chutes, or side parts to forms with pockets which will let concrete stop and flow easily into the form without any risk of segregation. The discharge of the spouts, down pipes or chutes shall be controlled so that the concrete may be effectively compacted into horizontal layers not more than 300 mm (12") thick.
- j. Concrete is to be deposited as quickly as possible after mixing and to proceed continuously. Concrete which has attained its initial set or has contained its mixing water for more than 30 minutes shall not be allowed to be placed in the work.
- k. When concrete is laid on hard core, such as subgrade for floor slabs, or other absorbent material, the surface is to be watered, consolidated and, where specified, blinded before the concrete is deposited.

- l. Fresh concrete shall not be placed on previously laid concrete or on old concrete surfaces until the latter has been cleaned of dirt, scum and laitence by wire brushes. The clean surface shall then be thoroughly wetted and grouted with cement slurry as approved by the Engineer's Representative.
- m. Care shall be taken not to disturb newly placed concrete by vibrator, indirect loading or otherwise. No traffic or loading shall be allowed on the concrete until it has thoroughly set and hardened.
- n. Construction joints in concrete shall only be given at locations indicated on the drawings or as approved by the Engineer or his Representative. At the end of the day's work the concrete shall be finished off against a temporary shutter stop, which shall be vertical and securely fixed. Such stops shall be removed within 24 hours of placing of concrete. Construction joints not shown on the drawings shall be reinforced with steel bars or dowels, if deemed necessary by the Engineer or his Representative shall be furnished by the Contractor without any additional payment.
- o. No concrete shall be placed during rains or in inclement weather and all fresh concrete shall be suitably protected from rain-fall and excessive heat or cold.
- p. Should any part of the exposed surface present a rough uneven or imperfect appearance when the shuttering is removed? It shall be picked out to honeycomb depth and refilled and properly re-surfaced or entirely redone as per directions of Engineer or his Representative at the cost of the Contractor.
- q. On removal of the forms and before the skin has had time to harden, all faces of the concrete inside or outside, to be kept exposed shall be rubbed over with carborandum stone, and washed with cement to remove all marks, projections, hollows or any other defect. No extra payment shall be made for this work.

All exposed surfaces and lines of the concrete work are to be true and fair without cracks, bends, windings and distortions of all kinds, and if occurring, shall be removed without any extra charges by the Contractor. All un-plastered concrete works is to be fair face, smooth, pleasing and to the entire satisfaction of the Engineer or his Representative.

- r. A float or screed is to be worked over the exposed surfaces of all concrete work on the flat or curve, so as to render the surfaces perfectly smooth, clear, and to the necessary slopes or falls or as required to receive the floor or roof finishes, according to the drawings, and as directed by the Engineer or his Representative without any extra charges by the Contractor.

6.09 **PROTECTION AND CURING:**

All exposed concrete shall be cured. Curing shall be accomplished by preventing loss of moisture, rapid temperature change and mechanical injury or injury from rain or flowing water for a period of at least ten (10) days. Curing shall be started as soon as the concrete has hardened sufficiently for the surface not to be marked. Curing shall be done either by continuous sprinkling of water on the surface or by covering with sand, hessian, canvas or other approved fabric mats, which shall be kept

continually wet. If required and so directed by the Engineer or his Representative, formed surfaces with forms in position shall also be cured by keeping all forms continually wet. As an alternative, curing of concrete, on all exposed surfaces which could not be kept covered, such as sides of the beams, under side of the slabs, may also be done by sealing concrete surfaces with curing compounds like "Paccacure" or equal so as to arrest loss of moisture from concrete, with approval of Engineer or his Representative. The Contractor shall take special care that curing of concrete is satisfactorily carried out and in accordance with methods specified herein and / or as instructed by the Engineer or his Representative. Any negligence in this regard may result in total rejection of such concrete works, which in the opinion of the Engineer or his Representative have not been adequately cured.

Minimum period of curing for any concrete shall be 10 days or more as directed by the Engineer. All concrete components of concreted structures shall be clearly marked with non-washable paints to indicate the date of placing concrete. During hot weather, curing shall be done even at night.

6.10 FORMWORK:

6.10.1 General

The formwork shall be inclusive of all labour, material, workmanship and alike. All form work and supports thereto shall be designed by the Contractor and relevant drawings shall be submitted to the Engineer and his Representative for approval before the work is put in hand. Such an approval shall not relieve the contractor from all the obligations of the contract or give rise to any claims.

6.10.2 Making Forms

The form-work for columns, beams, slabs lintels fins, shells, blocks, panels, purdees, surrounds for windows, and all other works whether to be precast or cast in situ shall be made of sound and properly seasoned timber or other approved material and shall be rigidly formed and designed by the Contractor to the shapes and forms as per drawings in accordance with the best of the existing practices so as to be able to withstand, without displacement, deflection or deformation movements of any kind, the pressure of the moist concrete and all other loads. For concrete work to show an even finish the timber forms be properly lined with plywood or steel sheets to give a fair face concrete of a homogenous, perfectly even and smooth appearance in exposed surfaces of all beams, columns, walls, slabs, etc.

6.10.3 Rigid with Allowance for Camber and Bulges

It shall be fabricated and erected in position, perfect in alignment, levels and true to plumb and shape and securely braced so as to enable it to stand all weights, live and vibrating to be endured during placing of concrete and its subsequent hardening till the form work is struck. It shall be so sufficiently rigid as not to loose its form and shall be so made for bulging, and deflection as to give the finished concrete to the required lines, plumb, size and shape.

6.10.4 Exposed Surfaces Left Unplastered

For concrete work covered in this contract where concrete Surface is to be exposed

in the finished work and left unplastered, the form-work shall be smoothly faced by using plywood sheets or lining the shuttering with smooth steel sheet or non-absorbent material like formica sheets or in any manner as approved by the Engineer or his Representative, so as to make a perfectly smooth surface of the finished concrete. Where any surface defects on the exposed concrete surfaces occur and which do not impair the structural performance, being in excess of the designed surfaces, and the architectural appearance of the work in the opinion of Engineer or his Representative, such defects may be removed by guniting and grinding with corborandum stone or in any other approved manner, at the cost of the Contractor, otherwise the whole or part of the work may have to be removed and remade good by the Contractor at his own cost. For precast concrete members the forms shall be rigid, exact, and smooth and made of steel.

6.10.5 Materials and Labour

The Contractor shall supply all materials and labour, necessary for a good and speedily erection of form-work such as shuttering, planks, struts, bolts, stays, gangways, boards, fillets etc. and shall do all that is essential in executing the job in a workman like manner to the satisfaction of the Engineer.

6.10.6 Form Work not to Interfere or Injure Work

The form-work shall be so designed and arranged as not be unduly interfere with concrete, during its placing, and easy to be removed without injuring the finished concrete, wedges, clamps, bolts and the rods shall be used, when permitted and where practicable, in making the form work rigid and in holding it to true position.

6.10.7 Opening in Form-work

Wherever the Concreting is required to be carried out within forms of considerable depths, temporary openings in the side of the form shall be provided to facilitate the pouring and consolidation of the concrete. Small temporary openings shall be provided at the bottom of all forms to permit the removal of rubbish etc.

6.10.8 Openings and other details

Provision shall be kept in the form-work such as openings, recesses holes, pockets, fillets, etc for housing services and other architectural details in the finished concrete or on its surface and edges as shown on drawings or as directed by the Engineer or his Representative to fix all necessary inserts, dowels pipes, holdfasts etc. as shown on drawings or as directed.

6.10.9 Joints in Form-work

All joints in the formwork shall be sufficiently closed to prevent undue leakage of mortar for concrete surface not to be exposed in the finished work. The joints in the form-work for all concrete surfaces to be exposed in the finished work shall be close jointed and perfectly smooth so as not to allow any leakage of the mortar from the concrete; and show any appearance of leaking mortar on concrete surface.

6.10.10 Treatment and Inspection of Forms

All rubbish, particularly chipping, shavings, and sawdust etc. shall be removed from the interior of the forms, immediately before fixing of bars. Forms shall be coated

with approved mould oil before reinforcement is placed. Surplus oil on forms and any oil on reinforcing steel shall be removed. Forms surface not exposed to view or normal watering may thoroughly be wetted with soap and water in place of oiling before placing concrete. If the forms are not used within 24 hours, a fresh coat of oil shall be given before placing of concrete.

6.10.11 Striking Shuttering

No struts or timbering which serve the purpose of supporting the shuttering or centering shall be struck and removed without direct permission from the Engineer or his Authorized Representative in writing and the work of striking and removal after the receipt of such permission shall be conducted under the personal supervision of the competent foreman in the employment of the Contractor and the Contractor shall hold himself fully responsible for any consequences whatsoever. In all cases the Engineer or his Authorized Representative will direct and control the minimum period of time for which the forms, shuttering or centering shall remain in place before being struck; but, for the general guidance of the contractor, when normal Portland Cement has been used in the work, the following are to be considered as the minimum periods in days for the main classes of work:

Removal of Shuttering	10 °C (50°F)	20 °C (70°F)
Beams sides, walls & Columns (unloaded)	03	02
Slabs soffits (props left under)	09	06
Removal of props to slabs	18	14
Beams soffits (props left under)	18	12
Removal of props to beams, and shuttering Under shells.	24	18

The Engineer or his Representative may require, however, that any walings, soldiers, struts or other timbers or supports, the removal of which may cause the transference of load to the finished work, to be kept in place for three weeks after the placing of the concrete.

6.10.12 Injury or Damage.

The Contractor shall be responsible for any injury to the work and any consequential damages caused by or arising from the removal and striking of forms, centering and supports, due to striking too soon, and any advice, permission or approval given by the Engineer or his Authorized Representative, relative to the removal and striking of forms, centering and supports shall not relieve the Contractor from the responsibilities herein defined.

6.10.13 Treatment after Removal of Forms.

Any minor surface honey-combing or other irregularities are to be properly made good immediately upon the removal of the form-work and the surface made good to the satisfaction of the Engineer and his Representative. Any small voids shall be neatly stopped with cement mortar consisting of one part of cement to two parts of

sand and the whole surface rubbed over with corborandum stone and cement wash and bring the whole to a smooth and pleasing finish and uniform colour.

No form-work shall be measured and paid for separately and shall be deemed to be included in the unit price of concrete whether cast-in-situ or precast and subsequently fixed in position.

6.11 FINISHING OF FORMED SURFACES

6.11.1 SPECIAL ARCHITECTURAL FINISHES

- i) Textured finishes - Textured form liners may be of form plastic sheet, wood sheet, metal, or other material. Liner panels shall be secured in forms by cementing or stapling, but not by methods which will permit impressions of nail heads, screw heads, washers, or the like to impart to the surface of the concrete. Edges of textured panels shall be sealed to each other or to divider strips (if specified or shown) to prevent bleeding of grout. The sealant used shall be non-staining to the surface.
- ii) Aggregate transfer finishes - Aggregate transfer and other special finishes shall be produced using methods and materials in such a way as to duplicate sample panels prepared in advance.
- iii) Applied finishes - When special finishes are to be applied, the surface of the concrete shall be prepared to ensure permanent adhesion of the finish. If the concrete is less than about 24 hours old, it can be roughened with a heavy wire brush or scoring mechanically or by etching with dilute hydrochloric acid. After roughening the surface shall be washed free of all dust, acid, chemical retarder, and other foreign material before the final finish applied.

6.11.2 RUBBED FINISHES

The following finishes shall be produced to concrete with a smooth form finish. Where smooth rubbed finish is to be applied, the forms shall have been removed and necessary patching completed as soon after placement as possible without jeopardizing the structures.

- i) Smooth rubbed finish - Smooth rubbed finish shall be produced on newly hardened concrete not later than the day following from removal. Surfaces shall be wetted and rubbed with car texture are produced. No cement grout shall be used other than the cement paste drawn from the concrete itself by rubbing process.
- ii) Grout cleaned finish - No cleaning operation shall be permitted until all continuous surfaces to be cleaned are completed. Mix 1 part Portland cement cement and 1 1/2 parts fine sand with sufficient water to produce a grout having the consistency of thick paste. White Portland cement shall be substituted for a part of the grey Portland cement in order to produce color matching the color of the surrounding concrete, as determined by a trial patch. Wet the surface of the concrete sufficiently to prevent absorption of water from the grout and apply the grout uniformly with brushes or a spray gun. Immediately after applying the grout, scrub the surface vigorously with a

cork float or stone to the surface and fill all air bubbles and holes. While the grout is still plastic, remove all excess grout by working the surface with rubber float, sack, or other means. After the surface whitens from drying (about thirty minutes at normal temperatures), rub vigorously with clean burlap. The finish shall be kept damp for at least 36 hours after final rubbing.

- iii) Cork floated finish - Remove from at an early stage, within 2 to 3 days of placement where possible. Remove ties. Remove all burrs and fins. Mix one part Portland cement and one part fine sand with sufficient water to produce a stiff mortar. Dampen wall surface. Apply mortar with firm rubber float or with trowel filling all surface voids. Compress mortar into voids using a slow - speed grinder or stone. If the mortar surface dries too rapidly to permit proper compaction and finishing, apply a small texture with a cork float using a swirling motion.

6.11.3 UNSPECIFIED FINISH

If the finish is not designated and applied finishes are also not indicated the following finishes shall be used as applicable:

- i) Rough form finish - for all concrete surface not exposed to public view.
- ii) Smooth form finish - for all concrete surfaces exposed to public view.

6.11.4 RELATED UNFORMED SURFACE

Tops of walls or buttresses, horizontal off-sets, and similar unformed surfaces occurring adjacent to formed surfaces shall be floated to a texture reasonably consistent with that of the formed surfaces. Final treatment on formed surfaces shall continue uniformly across the unformed surfaces.

6.12 CONSTRUCTION JOINTS:

Construction joints shall be located as indicated on the drawings and/or as approved or directed by the Engineer or his Representative. For slabs and beams construction joints shall be located at mid point of the span unless a secondary beam intersects a main beam at the centre in which case the joints in the main beam shall be off set a distance equal to twice the width of the beam and provision for shear shall be made by the use of inclined reinforcement at the cost of the Contractor. Joint in columns shall be made at the under side of the deepest beam framing thereto. Beam stems shall be poured monolithically unless directed otherwise by the Engineer. Joints not specified or shown on the drawings shall be so located as to least impair the strength and appearance of the work. Except where indicated on the drawings no jointing shall be made in footings or foundations without written approval of the Engineer or his Representative. Construction jointing shall be at right angles to the member and shall be formed against firm stop boards. The stop boards shall be removed as soon as possible after placing the concrete but without the risk of movement of the concrete and the concrete surface shall be well brushed with a hard brush and washed off with a spray of water, two to four hours after casting, to expose the aggregates and provide a key for the next pour. In all liquid retaining structures and other sub-structures pits and trenches etc. PVC or any other approved water stops shall be provided at the construction joint in the

manner shown on the drawings and/or approved by the Engineer or his Representative.

Whenever a section of concrete is left unfinished, for any reasons with the approval of Engineer's Representative, leaving a surface which will be hard set before additional concrete can be joined to it, dovetails, grooves or other bonds with the new work shall be provided at cost of the Contractor. Before depositing fresh concrete upon or against any concrete which has already set, the surface of the set concrete shall be roughened with a cutting tool, any laitance removed, thoroughly cleansed of all foreign matter, well watered and covered with cement grout, and special care shall be taken to ram the fresh concrete thoroughly up and against the set concrete; and, if deemed necessary by the Engineer or his Representative the joints shall be reinforced with steel bars or dowels to be all furnished and done by the Contractor without any additional payment.

6.13 CONCRETE FLOOR SLAB FINISHING:

6.13.1 GENERAL

Concrete slabs shall be finished as described herein. In preparation for finishing, floor slabs shall be struck off to the required level at or below the elevation or grade of the finished floors as shown on the drawings. Floors shall be leveled with a tolerance of 1 mm in 1 m (1/8" in 10 feet) except where drains occur in which case the floors shall be pitched to the drains as indicated on the drawings or as directed by the Engineer.

6.13.2 MONOLITHIC FINISH

All concrete surfaces in floors except where other finish is specified shall be finished by steel floats or straight edges to bring the surface to the required finish level shown on the drawings. While the concrete is still green but sufficiently hardened to bear a man's weight without deep imprint it shall be wood floated to a true even plane with no coarse aggregate visible. Sufficient pressure shall be used on the wood floats to bring moisture to the surface. The concrete shall then be hand troweled to produce a smooth impervious surface free from trowel marks. If necessary, the process shall be repeated so that the final finish shall produce a ringing sound from the trowel. No separate payment shall be made for finishing floor slabs in the fore mentioned manner.

6.13.3 CONCRETE TOPPING

Where indicated on the drawings base slab under concrete topping shall receive a screeded finish. After the base slab is thoroughly cured and when directed concrete topping shall be laid to the thickness as indicated on the drawings in alternate panels of suitable sizes as directed by the Engineer or his Representative.

6.14 ANCHOR BOLTS, INSERTS, SLEEVES, CHASES, RECESSES STEEL FRAMES ETC:

The Contractor shall furnish and place in position accurately shown on drawings, all inserts, sleeves, chases, recesses, etc., supplied by himself or other Contractors, as directed, by the Engineer and full cooperation and co-ordination shall be maintained with other Contractors, sub-contractors in this regard.

6.15 WATERPROOF CONCRETE:

Wherever specified on the drawings all liquid or water retaining structures and those subject to water pressure shall be executed with approved waterproof concrete. The water proofing compound shall be of the approved type and shall be mixed with the concrete in strict accordance with the manufacturer's directions and/or as directed by the Engineer or his Representative.

6.16 CLEANING AND REMOVAL OF RUBBISH:

On completion of works herein the Contractor shall remove all concrete debris, rubbish, shuttering materials, scrapes etc., from the vicinity of the structures completed. All areas shall be cleaned to the satisfaction and approval of the Engineer or his Representative.

6.17 COORDINATION:

The Contractor shall provide chases and openings required for other sections of the work and will co-operate and coordinate with other trades in placing their pipes, ducts, reglets and other built-in-items as the work proceeds.

6.18 EXTERNAL EXPOSED CONCRETE SURFACE:

All external exposed un-plastered concrete surfaces of cast in situ or precast units shall be given smooth or pattern finish as shown in the finishing schedule or as directed by the Engineer or his Representative. No separate payment shall be made to the Contractor for this work and it shall be included in the item rates of the respective concrete items in the bill of quantities.

6.19 PARTICULAR SPECIFICATIONS FOR CONCRETE

- a) Allowable bearing pressure of soil for foundation is marked on the drawing of the foundation. It is to be checked that no foundation is placed on the soil with a lower bearing capacity. In cases any weaker strata is encountered at any level the matter is to be reported to the Engineer for necessary changes in footings.
- b) Level of foundations as indicated on the drawings may be varied at site to reach the suitable strata. This matter is to be decided by the Engineer at site.
- c) Before concreting, the excavated surface to receive the concrete should be cut to proper levels. All loose soil is to be removed.
- d) Minimum cylindrical strength requirements of various concrete mixes at 28 days actually being used for work using ordinary Portland cement shall be as follows:-

Concrete Mix:	1:1:2	-	4000 p.s.i. (Class 'A')
	1:1 1/2:3	-	3000 p.s.i. (Class 'B')
	1:2:4	-	2500 p.s.i. (Class 'C')
	1:3:6	-	1500 p.s.i. (Class 'D')
	1:4:8	-	1000 p.s.i. (Class 'E')
- e) All R.C.C. work shall be in 1:2:4 concrete mix unless otherwise indicated for a

richer mix on the drawing or specified.

- f) All concrete is to be thoroughly vibrated mechanically:
 - i. Any concrete failing to meet the specified strength or not formed as shown on drawings, concrete out of alignment, concrete with surfaces beyond require tolerances or with defective surfaces which cannot be properly repaired or patched in the opinion of Engineer=s Representative shall be removed and replaced at Contractor=s expense. The Engineer=s Representative may reject any defective concrete and order it to be cut out in part or in whole and replaced at the Contractor's expense. Only in case of minor surface defects the Engineer=s Representative may approve a surface treatment immediately after removal.
 - ii. All ties and bolt holes and all repairable defective area shall be patched immediately after removal.
 - iii. All honeycombed and other defective concrete shall be remove down to sound concrete. The area to be patched and area at least 150 mm wide surrounding it shall be dampened to prevent absorption of water from the patching mortar. A bonding grout shall be prepared using a mix of approximately 1 part cement to 1 part fine sand passing a No. 25 B.S. Sieve, shall be mixed to the consistency of thick cream and shall then be well brushed into the surface.
 - iv. The patching mixture shall be made of the same material and of approximately the same proportions as used for the concrete, except that the coarse aggregate shall be omitted and mortar shall consist of not more than 1 part cement to 22 parts sand by damp loose volume. White Portland cement shall be substituted for a part of the grey Portland cement on exposed concrete in order to produce a color matching the color of the surrounding concrete, as determined by a trial patch.
 - v. The quantity of mixing water shall be not more than necessary for handling and placing. The patching mortar shall be mixed in advance and allowed to stand with frequent manipulation with a trowel, without addition of water, until has reached the stiffest consistency that will permit placing.
 - vi. After surface water has evaporated from the area to be patched, the bond coat shall be well brushed into the surface. When the bond coat begins to lose the water sheen, the premixed patching mortar shall be applied. The mortar shall be thoroughly consolidated into place and struck off so as to permit initial shrinkage, it shall be left undisturbed for at least 1 hour before being finally finished. The patched area shall be kept damp for 7 days. Metal tools shall not be used in finishing a patch in a formed wall, which will be exposed.
- g) For heavy concrete members the form work is to be properly designed and approved by the Engineer.
- h) Shuttering should not be struck earlier than the time specified unless otherwise approved by the Engineer.

- i) 18 gauge G.I. binding wire to be used for securely binding the reinforcing bars to avoid dislocation or displacement during concreting.
- j) Clear cover to main reinforcement in concrete members be as follows:-
 - i) For slabs, projections chajjas, fins, walls, staircases precast
Slabs ... 3/4"
 - ii) For beams, Columns, all members of water tank on the side
In contact with water . 1 1/2"
 - iii) For foundations, retaining walls and foundation beams . 2"
- k) All the reinforcing bars are to be properly placed as shown on the working drawings. Steel chairs and concrete spacer blocks are to be used without any extra cost. Concrete spacer blocks are to be properly cured to avoid their damage during concreting, thereby causing displacement of bars. Holes made by bolts etc. introduced for keeping the shuttering in tact should be properly treated after striking the shuttering. No such holes shall be allowed in walls of water retaining structures and earth retaining walls.
- l) All bent up bars in slabs are to be properly secured in position. Workers or trollies shall not be allowed in any case over the reinforcement mesh.
- m) Special care is to be taken to see that all expansion joints shown on the drawings are made in perfect straight line and treated as specified.
- n) Construction joints in beams and slabs shall be located at the centre of the span (such that a proper seat is formed for the next part to be cast); unless otherwise indicated on drawings or approved by the Engineer.
- o) DPC
The Concrete mix of DPC will be CC 1:2:4 as specified in this chapter.
To protect the dampness water proofing agent APudlo@ or any other water proofing agent as approved by the Engineer will be mixed in CC 1:2:4 @ the ratio of 5 lbs per bg of cement. The DPC will be cured for at least 10 days.

6.20 MEASUREMENT AND PAYMENT

All the concrete work shall be measured net as per execution at site in square or cubic feet for the related items and shall be paid at the rate entered in the BOQ appended to the contract in accordance with the conditions of contract. The rates are inclusive of all type of form-work, its erection and removal, all scaffolding, cost of mixing and batching plants, all T&P required for executing and placing the concrete work in position etc. Defective and honey-combed work will not be measured & paid and will be liable to be rejected and redone at contracts' cost.

NOTE:

1. Bitumen coating item which will be paid separately as per the unit rate quoted in the Bill of Quantities. Appended to the contract and in accordance with applicable condition of the contract.
2. PVC water stopper bar item which will be paid separately as per the unit rate quoted in the Bill of Quantities. Appended to the contract and in accordance with applicable condition of the contract.

SECTION - 7

7.0 STEEL REINFORCEMENT

7.01 SCOPE OF WORK:

The work covered by the section of the specification consists of furnishing all materials, tools, labour and in performing all operations in connection with the providing, straightening cutting, bending, binding, fixing, including binding wire, chairs, pins, spacer block complete in strict accordance with this section of the Specifications, the applicable drawings, approved bar bending schedule, and the terms and conditions of the Contract.

7.02 MATERIALS:

- A. Reinforcing steel to be new billet stock of mild steel (plain bar), hard grade (deformed bar) and Ribbed Tor steel as specified on the drawings and shall conform to British Standard Specifications or equivalent ASTM or Pakistan Standard.
- B. The Contractor shall furnish to the Engineer's Representative Manufacturers' mills certificate to guarantee that steel meets the standard, specifications requirements and minimum certified yield stresses as follows:-
 - i) Mild Steel plain bars conforming to B.S.S. 15 or B.S.S. 4449 or PS-231-1962
 - a) Tensile Strength - 438 to 517 N/Sq.mm (28 to 33 tons/Sq.in).
 - b) Yield Strength - 250 N/Sq.mm (16 Tons/Sq.in)
 - c) Elongation - 16% to 24% (av. 20%).
 - ii) Hard grade deformed bars conforming to ASTM, A-615
 - a) Tensile Strength - 560N/Sq.mm (35.7 Tons/Sq.in).
 - b) Yield Strength - 420 N/Sq.mm (60,000 psi).
 - c) Elongation - 11 %
- iii) Ribbed Tor steel conforming to B.S. 4461
 - a) Tensile Strength - 490 N/Sq.mm(70,000 Lbs./Sq.in).
 - b) Yield Strength - 420 N/Sq.mm (60,000 Lbs./Sq.in).
 - c) Elongation - 14.5%
- C. All steel to be true to the Standard Specifications with regard to bend ability specially the hard grade deformed bars under 19 mm (3/4") dia. shall be capable of being bent cold through 90 degree round a bar of four times its own diameter without fractures or injury of any kind. In case of deformed bars over 19 mm (3/4") dia. and under 28 mm (1-1/8") dia. round a bar of 6 times its

own diameter.

D. 18 gauge galvanized wire shall be used for binding the steel reinforcement.

7.03 **TESTING:**

Reinforcement shall be obtained only from manufacturers approved by the Engineer=s Representative.

If and when required samples shall be tested for above specification in an approved laboratory when required by the Engineer or his Representative and all costs of such tests shall be borne by the Contractor.

7.04 **STORAGE**

Reinforcing bars shall be stored on platforms above surface of ground and be free from scales, oil, structural defects prior to placement in works. Rusted or dirty steel bars shall not be used in the works unless brushed and cleaned by proper steel wire brushes and after being approved for use by the Engineer or his Representative.

7.05 **REINFORCEMENT CUTTING AND PLACING**

A. All reinforcement steel shall be cut and bent cold in strict accordance with bar bending schedules approved and drawings supplied by Engineer. The Contractor shall prepare bar bending schedule from approved structural working drawings and instructions to be provided to him by the Engineer. The bending schedules shall be drawn on approved forms and submitted to the Engineer or his Representative for checking and approval. The steel reinforcement shall be cut and bent to sizes as per drawings and approved bending schedules. In case any bars, cut, bent or even fixed in position are found incorrect in dimensions size or shape according to the requirements of the drawings and instructions of Engineer, the Contractor shall replace such steel bars cut bent or fixed in position by correct sized bars at his own cost and no extra payment shall be made to the Contractor on such account. The system of holding bars in place shall ensure that all steel in top section will support weight of workmen without displacement or distortion. Suitable spacers and chairs as approved by the Engineer or his Representative shall be used for supporting and spacing purposes of bars. In case any bars are bent or displaced they shall be straightened or replaced prior to pouring. All reinforcement bars within the limit of a days pour shall be in place and firmly tied with 18 gauge G.I. wires. Bars with kinks or bends not shown on drawings shall not be used.

B. Where indicated in the drawings, mesh shall be of the sizes as shown on drawings and conform to British Standard B.S.785. Mesh reinforcement when used in slabs shall be supported at proper elevations by standard accessories. In slabs on ground, pre cast concrete blocks may be substituted for chairs.

7.06 **LAPS AND SPLICES**

A. No splicing of bars shall be allowed at position other than shown on the

drawings. All lap lengths shall be of the minimum sizes as indicated on the drawings and in no case shall lap length be less than 40 times the diameter of the bigger lapping bars for nominal M.S. bars. Hard grade bars and for steel shall have laps of 50 times the bigger diameter of lapping bars. Splices of adjacent bars shall be staggered unless approved otherwise by the Engineer or his Representative.

- B. All reinforcing steel fixed in position shall be inspected by the Engineers Representative and no concrete shall be poured until steel placement has been approved by the Engineers Representative. For inspection purposes the Contractor shall give to the Engineers Representative reasonable notice before the scheduled pouring time. Clear concrete cover to reinforcement steel shall be as indicated on the drawings/specified.

7.07 MEASUREMENT AND PAYMENT

- A. The quantity to be paid for shall be the calculated in theoretical number of metric ton of reinforcement steel bars or mesh as determined from the approved bar bending diagrams and incorporated in the concrete and accepted, except when reinforcement is paid for under other items.
- B. The weight of plain or deformed bars will be computed from the theoretical weight of plain round bars of the same nominal size as shown in the following tabulation:

Size in.	Weight in lbs per ft.	Size in.	Weight in lbs per ft.
1/4	0.167	3/4	1.502
3/8	0.376	7/8	2.044
1/2	0.668	1	2.670
5/8	1.043	1 1/8	3.380

- C. Clips, ties, separators, and other material used for positioning and fastening the reinforcement in place, and structural steel, shall not be included in the weight calculated for payment under this item. If bars are substituted upon the Contractor's request and as a result more steel is used than specified only the amount specified shall be included.
- D. When laps are made for splices, other than those shown on the drawings or required by the Engineer and for the convenience of the Contractor, the extra steel shall not be measured nor paid for.
- E. When continuous bars are shown on the drawings, without the splices being shown, the necessary steel in the splices will be paid for on the basis of the individual bars not being shorter than 40 ft.
- F. The accepted quantity measured as provided above shall be paid for at the

contract unit price for the items listed in the Bill of Quantities which price and payment shall be full compensation for furnishing materials, labour, equipment and incidentals necessary to complete the item.

SECTION – 8

8.0 DISMANTLING AND DEMOLITION

8.1 SCOPE OF WORK

The scope of work of this section covers dismantling and demolishing of existing works.

8.2 EXECUTION

The existing work as may be required shall be dismantled. Where a portion of the RCC work is to be demolished, the reinforcing steel bars shall be cut carefully where required or cleaned straightened and restored in position. Dismantling shall be carried out with appropriate tools and in such a manner as to avoid unnecessary damage or injury to other adjoining work and to those parts of works which are to be retained and to render unserviceable as little of the material as possible. Any un-necessary damage shall be made good by the Contractor at his own expense.

Where insulation, roof coverings and waterproofing etc. are required to be removed from the roofs, roofs shall be thoroughly cleaned to bare concrete.

Where footings and foundations are required to be removed, the work shall also include excavation, backfill with excavated suitable material and compaction to 95% standard Proctor density.

The unserviceable material and debris shall be disposed off outside the Site limits to the satisfaction of the Engineer and the local authorities, or to a place within the Site, as may be designated in the Contract.

All serviceable materials shall be separated, cleaned and properly stacked within the Site.

All salvaged serviceable materials shall be handed over to the Employer unless provided otherwise in the Bill of Quantities.

8.3 MEASUREMENT

The unit of measurement shall be as indicated in Bill of Quantities. All quantities shall be measured net. In case of demolition of structure, plaster and paint shall not be measured for separate payment.

SECTION – 9

9.0 STRUCTURAL STEEL WORKS

9.1 SCOPE

This Section covers requirements of steels, steel work, fabrication, methods including precautions for erection of steel structures and other general requirements incidental to steel work.

9.2 GENERAL

The applicable requirements of this section as determined by the Engineer shall apply to all structural steel works under this contract. The work covered by this Section consists of all material, labour, plant, equipment and appliances including welding, bolts, nuts, washers, anchor bolts, embedded parts etc. fabrication and erection in accordance with the specifications and as per drawings and as directed by the Engineer.

9.3 DRAWINGS

9.3.1 Design and Working Drawings

These shall be prepared by the Engineer and supplied to the Contractor. These shall contain main dimensions, sizes of member & typical details of joints, list of material etc.

9.3.2 Workshop Drawings

- a) Before proceeding with the manufacture, or fabrication, Workshop drawings shall be prepared by the Contractor from the working drawings supplied, taking into consideration the following instructions:
- Fabrication in convenient sub-assemblies and each shop assembly to be given an erection mark.
 - Milling (machining of bases of supporting plate) for erection without adjustments.
 - Provision of basic elements for/with erection devices.
 - Keeping with the requirements of computed strength of all connections and joints of structures not foreseen in the design and working drawings.
 - Other requirements having an influence on the technology of fabrication transportation and erection of steel structures.
 - Uniformity of elements and parts of the steel structures should be maintained for mass fabrication.
- b) Workshop drawings shall consist of two parts:
1. An erection scheme having the following information:

- Location of erection element in respect of these elements with each other or with the existing steel or reinforced concrete structures.
 - Erection joints showing erection welding thickness and lengths, bolts or rivet diameter and numbers.
 - Chart showing list of assembling marks having columns such as Mark, Description, Quantity, and Weight of each Mark, Total weight and Remarks with grand total in the end.
 - Chart showing list of Erection Bolts, Nuts and Washer having columns such as size, quantity, weight and notes with grand total.
 - The mark for shop assemblies of each erection scheme shall have a different index for example scheme of trusses purlins etc. shall have Marks A1, A2, A3, onwards and another scheme of columns beams etc. shall have Marks B1, B2, B3 and onwards. While marking on the plans, elevations, sections and details the index shall be omitted.
 - The recommended scale of erection scheme is 1:50, 1:100, 1:200, for joints 1:5, 1:10 or 1:20.
 - Except in special cases all scheme drawings shall be made in single fairly thick lines.
 - Erection Scheme shall contain the following notes:
 - i) Erection shall be done using the erection welding and bolts of normal sizes and accuracy according to the joints of the scheme.
 - ii) Quality and type of electrode.
 - iii) Measures against unscrewing of bolts.
 - iv) Erection shall be carried out according to the standard for fabrication and erection of steel structures.
 - v) Painting instructions.
 - vi) References to design and working drawings.
2. A shop assembly drawing containing the following information:
- Each Shop Assembly (Mark) shall be drawn separately showing necessary lines, elevation sections with reference to axis, centre lines, location of holes, cleats, plate's lugs etc. Fully dimensioned with part numbers.
 - Bolts, holes and symbols.
 - Geometrical Setting out dimensions necessary for the assembly of an element. Location and details of joints as calculated by the Fabricators / Engineer.

- Instruction for welding, dimensions of weld (Seams) processing of edges, methods of welding, quality of welded material, length of welds on every element, requirements for welding and method of their control. Specification for Electrode selected according to specification of steel.
- Standards and quality of steel used.
- Parts List.
- Instruction for painting, primer and finish coats with derusting process.
- Recommended scale for assembly drawings are preferably 1:10 or 1:20 and for joints and details 1:1, 1:2 or 1:5.
- Notes for assembly drawings shall be as follows:
 - i) List of symbols for bolts and holes used.
 - ii) List of symbols for welds used.
 - iii) Edge distance (general).
 - iv) Welding thickness (general).
 - v) Material quality of steel used.
 - vi) Type and quality of electrodes to be used.
 - vii) Test for welding if any.
 - viii) Reference to related erection scheme drawings.
 - ix) Reference to design and working drawings.

9.4 MATERIAL

Except otherwise required or stated in the drawings the materials specifications shall conform to the following. Wherever necessary Contractor may use equivalent British Standard or other alternative material subject to approval of the Engineer. Material shall generally conform to the applicable requirement of ASTM A-6.

a) Structural Steel

- Structural steel for structures not requiring Welding shall conform to the requirements of ASTM A-7-66 (for bridges and buildings) or ASTM A-36-77.
- Structural steel for structures requiring welding shall conform to the requirements of ASTM A-36-77 or approved equivalent.

b) Sheet Steel

Sheet steel for structures where no welding is required shall conform to the requirement of ASTM A-366-62T (for Cold Rolled Carbon Steel Sheets commercial quality) or ASTM A-415-64 (Standard specifications for Hot Rolled Carbon Steel Sheets, commercial quality). For structures where welding is required sheet steel shall conform to the requirements of ASTM A-415-64 and steel plate to ASTM A-283-79 (Low and intermediate strength carbon steel plate) or A-514-77 (High-yield-strength, quenched and tempered alloy steel plate, suitable for welding as required).

- c) Filler Metal for Welding
Welding Electrodes for manual shielded metal arc welding shall conform to the specifications for mild steel covered Arc-welding Electrodes, AWS A 5.5 (latest edition). Equivalent locally manufactured electrodes by Pakistan Oxygen may also be used subject to the approval of the Engineer.
- d) Ordinary Bolts, Nuts and Washers
Bolts and nuts shall conform to the requirements of ASTM A-307-65 (Standard specification for low-alloy, carbon steel, externally and internally threaded, standard fasteners). Bolts shall be of Grade A for general application with square or hexagon heads as specified in the drawings. Turned bolts shall also conform to the requirements of ASTM A-307-65, except that the tolerance of the unthreaded portion of the bolt body shall be $+0.0 - 0.15$ mm of the diameter.
- e) Cut Washers
Shall be of structural grade steel and shall conform to the dimension of the manufacturer's regular standard for plain washers for the size and type of bolts used.
- f) Cast Iron
Shall conform to the requirements of ASTM A-48-64 (Standard specifications for Grey Iron Castings) or equivalent.
- g) Iron Pipe
Where iron pipe is called for, it shall be genuine wrought iron fully galvanized. All Threads to be cleaned and coated with rust resistant coating.
- h) Painting Materials
Paintings materials which include emulsions, epoxy based enamel paints, sealers for water proofing, primers, wax, varnishes etc., shall be standard best or top brands produced for each particular kind of material required.

9.5 ALLOWABLE STRESSES

- a) Allowable stresses for steel shall be considered tabulated in Appendix A of specifications for the Design, fabrication and erection of structural steel for buildings; Part 5 of the Manual of Steel Construction published by the American Institute of Steel Construction.
- b) Allowable stresses for rivets, bolts and threaded parts as per table 1.5.2.1 of AISC specifications.
- c) Allowable stresses for welds as per table 1.5.3 of AISC specifications.

9.6 FABRICATION

- a) Straightening Material
Rolled material, before being worked upon, must be straightened within tolerances by ASTM specifications A6. Straightening, necessarily shall be done by mechanical means or by the application of limited amount of localised heat. The temperature of heated areas, as measured by approved methods,

shall not exceed 1100 F for A514 steel or 1200 F for other steels. All material, before and after fabrication shall be straight or curvilinear form as required free from twists.

b) Cutting

As far as possible cutting must be done by shearing. Oxygen cutting shall be done where shear cutting is not possible and shall preferably be done by machine. All edges shall be free from gauges, notches or burs. If necessary the same shall be removed by grinding.

c) Holes punching drilling

Holes shall be punched where thickness of the material is not greater than the diameter of bolt or rivet + 3mm. Where the thickness of the material is greater, the holes shall be drilled or sub-punched and the drill of all sub drilled holes shall be at least 2mm smaller than the nominal diameter of the rivet or bolt. Holes for A514-77 steel plates over 1/2" thick shall be drilled. Holes shall not be allowed to formed gas cutting process.

d) Welding

1. Maximum Thickness of fillet welds

- i) Not more than 1.2 times the lesser thickness of materials being welded.
- ii) At welding of rolled profiles along edges, which are curved, not more than the thickness of the edge minus the radius of the curve.

2. Minimum thickness of fillet welds.

Least thickness for calculation and designing requirements:

Thickness of thicker part	up to 10 mm	11mm to 20mm	20mm to 30mm	31mm to 50mm	Above 50mm
Thickness of Weld for carbon steel.	4	6	8	10	12
Thickness of Weld for low alloy steel	6	8	10	12	-

- 3. Design length of a fillet weld shall not be less the 40 mm or 10 times thickness of fillet weld and not more than 60 times thickness of fillet weld.
- 4. Surfaces to be welded shall be free from loose scale, slag, rust, grease, paint or any other foreign matter except mill scale which withstands vigorous wire brushing.

e) Tolerances

1. A variation of 1 mm is permissible in the overall length of members with both ends finished for contact bearing. The bearing surface is to be prepared to common plane by milling.
 2. Members without end finished for contact bearing which are to be framed to other steel parts of the structure shall have a variation from detailed length not greater than 3mm.
- f) Each piece of steel work after fabrication shall be distinctly marked before delivery to site in accordance with a marking plan for erection assembly.

9.7 SURFACE PREPARATION

- a) All steel work shall be cleaned free from loose scale, rust, dust, slag etc. by using suitable means. Sand blasting shall be carried out wherever so specified by the Engineer.
- b) Steel work to be encased in concrete or surfaces in contact with concrete or grout shall be given a cement wash.
- c) Machine finished surfaces shall be coated with rust preventive compound approved by the Engineer prior to removal from shop and immediately after finishing. Such surfaces shall be protected with wooden pad or other suitable means for transportation. Unassembled pins and bolts shall be oiled and wrapped with moisture resistant paper.
- d) All other surfaces of steel work shall be painted as specified hereunder.
 - Resin based special emulsion paint shall be manufactured by one of Pakistan paint manufacturers, as approved by the Engineer. The paint shall be composed of P.V.A. with pigment of Titanium dioxide with inert extenders, having viscosity of 70-75 K.U. at 25 deg. C and approximate specific gravity of 1.33. The paint shall have flat finish, smooth and free from brush marks and resistant to fungus growth.
 - Enamel paint and primers shall be Dulux as manufactured by M/S Imperial Chemical Industries Pakistan Ltd. or approved equal and shall be applied in accordance with the period instructions of the manufacturers.

No separate payment shall be made for painting of structural steel works. The Contractor shall include all the cost of labour, plant and material for this work in the price as mentioned in the Bill of Quantities.

9.8 ZINC COATING (GALVANIZING)

Where ever specified by the Engineer zinc coating shall be applied in a manner and or a thickness and quality conforming to the requirements of ASTM A-123-65, standard specifications for zinc (Hot galvanized) coating on products fabricated from rolled, pressed, and forged steel shapes, plates, bars and strips.

9.9 INSPECTION AND TESTS

- a) Manufacturer's Works Test certificate for all material used shall be furnished by the contractor for Engineer's scrutiny and approval. The contractor shall provide all necessary facilities to Engineer for inspection of steel structure work during fabrication and erection.
- b) Rolling tolerance of all shapes and profile according to AISC (American Institute of Steel Construction) shall be in accordance with the provisions of the American Society for Testing and Materials Designation A.6 These shall be checked by the Contractor before being worked upon and shall be rejected if found not within limits.
- c) The Contractor shall arrange for analysis and test of all material rolled locally at a testing laboratory selected by the Engineer, for which Contractor will bear all expenses.
- d) Nevertheless neither the fact that the materials have been tested nor that the manufacturers works test certificates have been furnished shall effect the liberty of the Engineer to reject after delivery, material found not according to these specifications.
- e) The inspection of welding shall be performed in accordance with the provisions of Section 6 of the code for Welding in Building Construction, DI. O-69 of the American Welding Society ("Structural Welding Code" AWS DI-1)
- f) Materials or workmanship not in reasonable conformance with the provisions of these specifications shall be rejected at any time during the progress of the work or the completion and erection at site.

9.10 ERECTION

- a) Bracing.
The frame of steel skeleton buildings shall be carried up true and plumb within the limits defined in section 7(h) of the AISC code of standard practice, and temporary bracing shall be introduced wherever necessary to take care of all loads to which the structure may be subjected including the equipment and the operation of the same. Such bracing shall be left in place as long as required for safety. Wherever piles of material, erection equipment and other loads are carried during erection, proper provision shall be made by the contractor to take care of the stresses resulting from such loads.
- b) Alignment & Bolting.
No riveting, permanent bolting or welding shall be done at site during erection until as much of the structure as will be stiffened thereby has been properly aligned. The threaded portion of each bolt shall project through the nut at least one thread.
- c) Painting after Erection.
Before painting of steel which is delivered unpainted is commenced, all surfaces to be painted shall be dry and thoroughly cleaned from all loose scale and rust. The specified protective treatment shall be completed after erection.

9.11 MEASUREMENT & PAYMENT

a) General

- i) The cost of all the works involved within the scope of this specifications as per all the drawings and conditions of contract are covered only within the quoted rate of items of the Bill of Quantities.
- ii) Unless otherwise specified and to the extent provided in the Bill of Quantities no separate or additional payment will be made for the following works, the cost of which shall be deemed to have been included in the quoted rate of the Bill of Quantities item.
 - Providing nuts, bolts, screw, rivets, heads, filets welds and welding rods.
 - Galvanizing and prime coating steel work.
 - Painting Steel Work.
 - All embedded parts other than steel.

b) Measurement

- i) Items of work of structural steel for which the unit rates have been quoted on weight basis shall be measured net as acceptably supplied and installed at site as per drawings / workshop drawings and as per instruction of the Engineer. After measurement the theoretical weights shall be calculated from standard tables of section and weights in the manner followed in the preparation of workshop drawings. The cost of loading and unloading, transportation and handling of structural steel items shall be deemed to be included in the quoted unit rate of the related Bill of Quantities item.
- ii) Measurement of acceptably completed installation and erection works of Structural steel items supplied free of cost by the Employer will be made on the basis of number of tons of structural steel items erected and installed in position as shown on the drawings or as directed by the Engineer. The cost of loading and unloading, transportation and handling of structural steel items shall be deemed to be included in the quoted unit rate of the related Bill of Quantities item.

c) Payment

Payment will be made for acceptable measured quantity of structural steel works on the basis of unit rate quoted in the Bill of Quantities and shall constitute full compensation for all the incidental works related to the item.

SECTION – 10

10.0 PILING

10.1 DESCRIPTION

This work shall consist of performing all operations in connection with furnishing, driving, cutting off and load testing of piles to obtain the specified bearing value complete in place and strictly in accordance with these Specifications and as shown on the Drawings.

The Contractor shall furnish the precast piles in accordance with an itemized list, which will be provided by the Engineer, showing the number and lengths of all piles.

When cast-in-place concrete piles are specified on the Drawings, the Engineer will not furnish the Contractor, an itemized list showing the number and length of piles. When test piles and load tests are required in conformance with sub-items 7.3.8 and 7.3.9 respectively, the data obtained from such test loads will be used in conjunction with other available subsoil information to determine the number and lengths of piles to be furnished. The Engineer will not prepare the itemized list of piles for any portion of the foundation area until all loading tests representative of that portion have been completed.

The contractor shall provide an outline of his proposed method for constructing large diameter pile when submitting his tender; the proposed method of boring being stated.

Not less than two weeks before the contractor proposes to commence piling, detailed proposal for the piling shall be delivered to the Engineer. These proposals shall include full details of materials, equipment and method to be used in the construction of piles.

If it is proposed to use bentonite slurry, this shall also be described.

Work on piling shall not commence until the contractor's proposals have been approved by the Engineer and communicated to the contractor.

The requirements herein are minimum. Strict compliance with these requirements will not relieve the Contractor of the responsibility for adopting whatever additional provisions may be necessary to ensure the successful completion of the work.

The kind and type of piles shall be as shown on the Drawings and / or as specified. No alternate types or kinds of piling shall be used, except with the written approval of the Engineer each time.

10.2 MATERIAL REQUIREMENTS

10.2.1 Types of Piles

a) Untreated Timber Piles

Untreated timber piles shall conform to the requirements of AASHTO M 168.

b) Treated Timber Piles

Treated timber piles shall conform to the requirements of AASHTO M 133 and M 168. Unless otherwise called for on the drawings, the timber piles shall be treated with creosote according to the Standard AWPA C 1 of the American Wood-Preservers Association.

c) Reinforced Concrete Cylindrical Piles

Diameter of reinforced concrete piles shall be as shown on the and may or may not have permanent lining, as shown on the drawing. Reinforcing Steel shall conform to the requirements under Item 404 –Steel Reinforcement. Concrete shall meet all the requirements for specified Class as provided under Item 401 and shall be of Class-D unless otherwise specified.

d) Structural Steel Piles

Structural steel piles shall be rolled steel sections of the type, weight and shape called for on the Drawings. The piles shall be structural steel conforming to the requirements of ASTM A 7 and ASTM A 36, except that steel produced by the Acid-Bessemer's process shall not be used. The steel piles shall be coated with red lead paint conforming to AASHTO M 72 as instructed by the Engineer, unless otherwise specified.

e) Precast Concrete Piles

Concrete for piles shall meet all the requirements for the specified class as provided under Item 401 - Concrete. The concrete shall be of Class-D1 unless otherwise specified.

Reinforcing Steel shall conform to the requirements under Item 404 –Steel Reinforcement.

Prestressed concrete piles shall conform to Item 405 – Prestressed Concrete Structures.

Precast piles shall be made in accordance with the Drawings, and reinforcement shall be placed accurately and secured rigidly in such manner as to ensure its proper location in the completed pile. The concrete cover as measured to the outside face of ties or spirals shall not be less than five (5) cm.

The piles shall be cast separately or, if alternate piles are cast in, a tier, and the intermediate piles shall not be cast until four (4) days after the adjacent piles have been poured. Piles cast in tiers shall be separated by tar paper or other suitable separating materials. The concrete in each pile shall be placed continuously. The completed piles shall be free from stone pockets, porous spots, or other defects, and shall be straight and true to the form specified. The forms shall be true to line and built of metal, plywood, or dressed lumber. A two and half (2.5) cm chamfer strip shall be formed on all edges. Forms shall be watertight and shall not be removed within twenty four (24) hours after the concrete is placed. Piles shall be given a surface finish according to Item 401.3.7 - Concrete Surface Finishing.

Piles shall be cured in accordance with the requirements of Item 401.3.8 (e) - Curing Precast Concrete Piles.

Piles shall not be moved until the tests indicate a compressive strength of eighty (80) percent of the design twenty eight (28) days compressive strength and they shall not be transported or driven until the tests indicate a compressive strength equal to the design twenty eight (28) days compressive strength.

When concrete piles are lifted or moved, they shall be supported at the points shown on the Drawings or, if not so shown, as instructed by the Engineer,

10.2.2 Pile Shoes

Pile shoes when required shall be of the design as called for on the Drawings or by the Engineer.

10.2.3 Pile Splices

Materials for pile splices, when splicing is allowed, shall be of the same quality and characteristics as the materials used for the pile itself and shall follow the requirements given on the Drawings unless otherwise directed by the Engineer.

10.3 CONSTRUCTION REQUIREMENTS

10.3.1 Driven Piles

a. Location and Site Preparation

Piles shall be used where. Indicated on the Drawings or as directed by the Engineer.

All excavations for the foundation in which the piles are to be driven shall be completed before the driving is begun, unless otherwise specified or approved by the Engineer. After driving is completed, all loose and displaced materials shall be removed from around the piles by hand excavation, leaving clean solid surfaces to receive the

concrete for foundations.

b. Determination of Pile Length

The criteria for pile length and bearing capacity will be determined by the Engineer according to the results from test piles and load tests. The piles shall be driven to such depths, that the bearing loads indicated on the Drawings are obtained.

The criterion for pile length may be one of the following:

- 1) Piles in sand and gravel shall be driven to a bearing value determined by use for the pile driving formula or as decided by the Engineer.
- 2) Piles in clay shall be driven to the depth ordered by the Engineer. However, the bearing value shall be controlled by the appropriate pile driving formula if called for by the Engineer.
- 3) Piles shall be driven to refusal on rock or hard layer when so ordered by the Engineer.

The contractor shall be responsible for correct pile lengths and bearing capacities according to the criteria given by the Engineer.

c. Pile Driving

All piles shall be driven accurately to the vertical or the batter as shown on the drawings. Each pile shall, after driving, be within fifteen (15) cm from the theoretical location underneath the pile cap or underneath the superstructure in the case of pile bents. All piles pushed up by the driving of adjacent piles or by any other cause shall be driven down again.

Piles shall be used only in places where a minimum penetration of three (3) meters in firm materials, or five (5) meters in soft materials, can be obtained. Where a soft stratum overlies a hard stratum, the piles shall penetrate to hard material up to a sufficient distance to fix the ends rigidly.

All pile driving equipment is subject to the Engineer's approval. The Contractor is responsible for sufficient weight and efficiency of the hammers to drive the piles down to the required depth and bearing capacity. Hammers shall be gravity hammers, single acting steam or pneumatic hammers or diesel hammers. Gravity hammers shall not weigh less than sixty (60) percent of the combined weight of the pile and driving head and not less than 2,000 Kg. The fall shall be adjusted so as to avoid injury to the pile and shall in no case exceed one (1) m for timber and steel piles and one half (0.5) M for concrete piles unless otherwise specified or approved by the Engineer. The plant and equipment furnished for steam hammers shall have

sufficient capacity to maintain, under working conditions, the pressure at the hammer specified by the manufacturer. The boiler or pressure tank shall be equipped with an accurate pressure gauge and another gauge shall be supplied at the hammer intake to determine the drop in pressure between the gauge and the hammer. When diesel hammers are used, they shall be calibrated with test piling and / or test loads in accordance with Item 7.3.9.

Water jets shall be used only when permitted in writing by the Engineer. When water jets are used, the number of jets and the nozzle volume and pressure shall be sufficient to erode the material adjacent to the pile freely. The jets shall be shut off at a depth not less than three (3) M before final tip elevation is reached, and the piles driven solely by hammer to final penetration as required by the Engineer.

Piles shall be supported in line and position with leads while being driven. Pile driving leads shall be constructed in such a manner as to afford freedom of movement of the hammer, and shall be held in position by guys or steel braces to ensure rigid lateral support to the pile during driving. The leads shall be of sufficient length to make the use of a follower unnecessary, and shall be so designed as to permit proper placing of batter piles. The driving of piles with followers shall be avoided if practicable and shall be done only under written permission from the Engineer.

The method used in driving piles shall not subject them to excessive and undue abuse producing crushing and spilling of the concrete, injurious splitting and brooming of the wood, or deformation of the steel. Manipulation of piles to force them into proper position, if considered by the Engineer to be excessive, will not be permitted.

The pile tops shall be protected by driving heads, caps or cushions in accordance with the recommendations from the manufacturer of the pile hammer and to the satisfaction of the Engineer. The driving head shall be provided to maintain the axis of the pile in line with the axis of the hammer and provide a driving surface normal to the pile.

Full-length piles shall be used where practicable. Splicing of piles when permitted shall be in accordance with the provisions of Item 7.3.5. All piles shall be continuously driven unless otherwise allowed by the Engineer.

d. Pile Driving Formulae

Pile driving formulas may be used to determine the number of blows of hammer per unit of pile penetration needed to obtain the specified bearing capacity for piles driven in the sub-soils at the site. Piles shall be driven to a final resistance as indicated on the plans determined by the following formula:

For drop hammer

$$Q_{all} = WH / [6(S+2.5)]$$

For single-acting steam or air hammers and for diesel Hammers having unrestricted rebound of rams.

$$Q_{all} = WH / [6(S+0.25)] \quad \text{(Use when driven weights are smaller than striking weights)}$$

$$Q_{all} = WH / [6\{S+0.25(WD/WS)\}] \quad \text{(Use when driven weights are larger than striking weights)}$$

For double-acting steam or air hammers and diesel hammers having enclosed rams

$$Q_{all} = E / [6(S+2.5)] \quad \text{(Use when driven weights are smaller than striking weights)}$$

$$Q_{all} = E / [6\{S+0.25(WD/WS)\}] \quad \text{(Use when driven weights are larger than striking weights)}$$

In the above formulas:

Q_{all} = Allowable pile load in Kilograms.

W = Weight of striking parts of hammer in Kilograms.

H = The height of fall in centimetres for steam, and air hammers, and the observed average height of fall in centimetres, of blows used to determine penetration for diesel hammers with unrestricted rebound of hammer.

S = Average net penetration per blow in centimetres for the last 10 to 20 blows of steam, air, or diesel hammer; or for the last 15 centimetres of driving for a drop hammer.

E = The actual energy delivered by hammer per blow in Kilogram - centimetre.

WD = Driven weights in Kilograms

Note: Ratio of driven weights to striking weights should not exceed three.

WS = Weight of striking parts in Kilograms.

Modifications of basic pile driving formula:

a) For piles driven to and seated in rock as high capacity. End-bearing piles: Drive to refusal (approximately four (4) to five (5) blows for the last 0.625 centimetres of driving). Re-drive open end pipe piles repeatedly until resistance for refusal is reached within two and half (2.5) centimetres of additional penetration.

b) For piles driven through stiff compressible materials unsuitable for pile bearing to an underlying bearing stratum:

Add blows attained before reaching bearing stratum to required blows attained in bearing stratum.

c) For piles into limited thin bearing stratum:

Drive to predetermined tip elevation, and determine allowable load by load test.

The bearing power as determined by the appropriate formula in the foregoing list will be considered effective only when it is less than the crushing strength of the pile. Other recognized formula for determining pile-bearing power may be used when given in special specification. However, it shall be understood that the relative merits and reliability of any of the pile formula can be judged only on the basis of comparisons with the results of load tests.

10.3.2 Cast-in-Place Piles

Piles, cast-in-place, shall consist of one of the types either shown on the drawing and / or as specified. The term shaft wherever used in this section, shall mean either piles or shafts.

a. Working Drawings

At least 4 weeks before work on shafts is to begin, the Contractor shall submit to the Engineer for review and approval, an installation plan for the construction of drilled shafts. The submittal shall include the following:

- i. List of proposed equipment to be used including cranes, drills augers, bailing buckets, final cleaning equipment, descending equipment, slurry pumps, sampling equipment, tremies or concrete pumps, casing etc.

- ii. Details of overall construction operation sequence and the sequence of shaft construction in bents or groups.
- iii. Details of shaft excavation methods.
- iv. When slurry is required, details of the method proposed to mix, circulate and descend slurry.
- v. Details of methods to clean the shaft excavation.
- vi. Details of reinforcement placement including support and centralization methods.
- vii. Details of concrete placement, curing and protection.
- viii. Details of any required load tests.
- ix. Other information shown on the plans or requested by the Engineer.

The Contractor shall not start the construction of drilled shafts for which working drawings are required until such drawings have been approved by the Engineer. Such approval will not relieve the Contractor of responsibility for results obtained by use of these drawings or any of his other responsibilities under the contract.

b. Fabrication of Permanent Lining

If shown on the drawings, the contractor shall provide a permanent lining suitable formed of ten (10) mm minimum thickness mild steel plate complying with B.S. 4360. The plates shall be cut and rolled to the inner diameter not less than the nominal diameter of the pile or such larger diameter as to allow the requisite pile diameter hole in the unlined length of pile. The rolled plates shall be connected by full penetration butt welds generally complying with B.S. 5133. No more than three (3) longitudinal seam welds shall be employed in any one cross-section and such welds shall be staggered in position in the cross-section between one length and the next. The dimensional accuracy of the lining shall be as stated on the drawings.

In the case of steel shells or pipes, after being driven and prior to placing reinforcing steel and concrete therein, the steel shells or pipes shall be examined for collapse or reduced diameter at any point. Any shell or pipe, which is improperly driven or broken or shows partial collapse to such an extent as to materially decrease its bearing value, will be rejected. Rejected shells or pipes shall be removed and replaced, or a new shell or pipe shall be driven adjacent to the rejected one. Rejected shells or pipes, which cannot be removed, shall be filled with lean concrete by the Contractor at his expense.

c. Piles Cast in Drill-Borehole**i) Boring Procedure**

The method and equipment of boring generally either the dry method, wet method, temporary. Casing method or permanent casing method shall be one, which maintains stability, verticality or batter (as shown on the Drawing) of the wall and base of borehole by the use of temporary casing and / or bentonite slurry.

All holes shall be drilled to the tip elevation shown on the Drawings, unless otherwise specified or approved by the Engineer. Rejected boreholes shall be filled with lean concrete by contractor at his expense.

The method shall be such that allows soil samples to be taken and in site soil test, (if required) to be carried out during or ahead of boring operations. The method / procedure used in execution of borehole and other operations shall not be such as to cause vibrations resulting in damage to completed or partially completed piles or to adjacent structures, services or other property. The procedure shall not be such as to cause harmful loosening or softening of soil outside the pile that has to be filled with concrete. The equipment used for execution of borehole shall be adequate to ensure that each pile penetrates to the required founding level.

Use of Casing

Suitable casings shall be furnished and placed when required to prevent caving of the hole before concrete is poured. Casing, if used in drilling operations shall be removed from the hole as concrete is poured unless otherwise specified. The bottom of the casing shall be maintained not less than fifty (50) cm below the top of the concrete during withdrawal and pouring operations unless otherwise permitted by the Engineer. Separation of the concrete during withdrawal operations shall be avoided.

Reinforcement

Reinforcement if called for shall conform to the requirements under item 404. The steel shells/pipes shall be of sufficient strength and rigidity to permit driving to the required bearing value or depth without injury. The steel may be either cylindrical or tapered, step tapered or a combination, plain, circular or fluted. All types shall conform to the corresponding ASTM standards. The minimum average tensile strength of steel shall be 3500 Kg/sq.cm (50,000 psi).

When called for on the Drawings or by the Engineer, the steel shells/pipes shall be factory coated on both interior or exterior surfaces by red lead paint

conforming to AASHTO M-72 or as stated in the special specifications. The coating shall not cause any hindrance while assembling the pile section during welding operations.

ii) Temporary Casing Method

The temporary casing of appropriate diameter for locating the pile and piloting the borehole shall be pitched at the exact locations as given on the drawings to ensure that the casing when sunk is within the specified tolerances. The casing shall be sunk to sufficient depth by approved methods. The depth shall be at least sufficient to prevent the ingress of alluvium or other loose materials into the bore when executed below the bottom level of the casing. In addition, the depth shall be such as the contractor considers necessary for the stability of the casing and / or temporary works system during construction in general and for the following conditions and operations in particular during ail conditions of river current which may occur during the period of works:

- a) Open temporary casing to ensure against blow-in of soil.
- b) Concreting of the pile, until temporary casing is extracted.

Safety of Casing

The contractor shall take all such measures and provide such strengthening and bracing as is necessary and to the approval of the engineer to ensure that the temporary casing is not disturbed, overturned, over-stressed or under-eroded in any condition of temporary casing shall be such that it will not disturb the freshly cast concrete and / or permanent lining and / or reinforcement.

Where the use of temporary casing is approved for the purpose of maintaining the stability and over-rapid withdrawal of the boring tools which could lead to excessive removal of soil and water and disturbance of the surrounding ground and when boring through any permeable stratum (including silt), the water level in the boring shall be maintained between one (1) meter and two (2) meters above the external water level, unless the engineer directs' otherwise.

The temporary casings shall be free from significant distortion and of uniform cross sections throughout each continuous length. During concreting they shall be free from encrusted concrete or any internal projections, which might prevent the proper formation of the piles.

Permanent Casing Method

The permanent casing construction method shall be used when required by the plans. This method consists of driving or drilling a casing to a prescribed

depth before excavation begins. If full penetration cannot be attained, the Engineer may require either excavation of material within the embedded portion of the casing or excavation of a pilot hole ahead of the casing until the casing reaches the desired penetration. In some cases, over-reaming to the outside diameter of the casing may be required in order to advance the casing.

The casing shall be continuous between the elevations shown on the plans. Unless shown on the plans, the use of temporary casing in lieu of or in addition to the permanent casing shall not be used except when authorized by the Engineer in writing.

After the installation of the casing and the excavation of the shaft are complete, the casing shall be cut-off at the prescribed elevation and the reinforcing steel and shaft concrete placed within the portion of the casing left in place.

iii) Bentonite Slurry

Where the use of bentonite slurry is approved for the purpose of maintaining the stability of the walls and base of bore, the contractor's proposals in accordance with (sub clause vi) hereof shall include details of the slurry. These shall include inter-alia:

- a) The source of the bentonite
- b) The constitution of the slurry
- c) Specific gravity, viscosity, sheer strength and PH value of slurry.
- d) The methods of mixing, storing, placing, removal and re-circulating the slurry, and
- e) The provision of stand-by equipment.

Tests shall be carried out to ensure that the proposed constitution of the slurry is compatible with the ground water. Proposals for the constitution and physical properties of the slurry shall include average, minimum and maximum values. The specific gravity of the slurry shall not be less than one and three hundredth (1.03) in any case at any time. The contractor shall use additives where necessary to ensure the satisfactory functioning of the slurry.

Manufacturers Certificate

A manufacturer's certificate showing the properties of the bentonite powder shall be delivered to the Engineer for each consignment delivered to site. Independent tests shall be carried out at laboratory approved by the Engineer on samples of bentonite frequently.

Tests on Bentonite Slurry

The Contractor shall carry out tests during the course of the piling to check the physical properties of the bentonite slurry in the works. These tests shall

include inter-alia, density, viscosity, shear strength and PH tests. The test apparatus and test methods shall be those given in "Recommended Practice" Standard by American Petroleum Institute, New York City, 1957, reference API RP29, Section- 1, 11 and V1.

The frequency of tests shall be that which the Contractor considers necessary to ensure that the bentonite slurry is in accordance with his proposals and as such other times as the Engineer may direct.

Should the physical properties of any bentonite slurry deviate outside the agreed limits, such slurry shall be replaced, irrespective of the number of time it has been used by new bentonite slurry of correct physical properties.

Adequate time shall be allowed for proper hydration to take place, consistent with the method of mixing, before using slurry in the works.

Precautions

The Contractor shall control the bentonite slurry so that it does not cause a nuisance either on the site or adjacent waterways or other areas. After use it shall be disposed in a manner to the approval of the Engineer.

The level of the slurry in the bentonite shall be maintained so that the internal fluid pressure always exceeds the external water pressure.

If chiselling is used when boring through hard strata or to overcome obstructions, the stability of the excavation shall be maintained by methods acceptable to the Engineer.

iv) Excavation from Boreholes

The soil and debris from inside the pile boreholes shall be removed by bucket, augur or circulating bentonite slurry provided that no jetting at the foot of the borehole shall be permitted. Methods of excavation, which in the opinion of the Engineer may damage the permanent lining of the pile, shall not be employed.

Should the excavation reveal any soil stratum below the bottom of a pile which, in the opinion of the Engineer, unsuitable for supporting the loads that will be imposed on it, the Contractor shall remove all such sub soil stratum to the satisfaction of the Engineer and shall lengthen the pile if necessary and cost of any such lengthening shall be paid as per this contract.

Excavation shall be carried out as rapidly as possible in order to reduce to a minimum the time in which any strata are exposed to the atmosphere, bentonite slurry or water. In any case, a pile shall not remain unfilled with concrete for period exceeding eighteen (18) hours after completion of borehole. 407-10 The materials from pile excavation shall be disposed so that the same does not interfere with any part of the permanent works of this project, in neat and workmanlike manner.

v) Samples and Tests

The Contractor shall take soil samples as given below or as directed by the Engineer to the designed tip elevation of the pile and shall carry out insitu Standard Penetration tests within, and ahead of borehole on the line of vertical axis of the pile at these locations after one and half (1.5) meter interval. The costs of tests and collection of samples shall be deemed to be included in the unit rates quoted by the Contractor. Each disturbed sample shall, as far as possible, be truly representative of the grading of insitu soil at the point from which it is taken, without contamination by other material. It shall be approximately five (5) Kg in weight and shall be placed in a strong airtight container immediately after its removal from the sampler. The container shall be sealed as soon as the sample has been placed in and shall be taken to the site laboratory for grading, moisture content and Atterberg Limits tests.

The apparatus and procedure for the Standard Penetration Test shall be in accordance with the provisions of ASTM D 1586 Penetration Test and split-barrel sampling of soils and / or ASTM D 1587 thin-walled sampling of soils, (except insofar as any such provisions may conflict with other requirements of the contract).

vi) Limitations of Boring Sequence

Piles shall be constructed in such a manner and sequence as to ensure that no damage is sustained by piles already constructed in adjacent positions. The Contractor shall submit to the Engineer for his approval a programme showing sequence of construction of various piles.

vii) Tolerances

Following construction tolerances shall maintained

- a) The drilled shaft shall be within 3 inches of the plan position in the horizontal plane at the plan elevation for the top of the shaft.
- b) The vertical alignment of the shaft excavation shall not vary from the plan alignment by more than 1 1/4 inch per foot of depth.
- c) After all the shaft concrete is placed, the top of the reinforcing steel cage shall be no more than 6 inches above and no more than 3 inches below plan position.
- d) When casing is used, its outside diameter shall not be less than the shaft diameter shown on the plans. When casing is not used, the minimum diameter of the drilled shaft shall be the diameter shown on the plans for

- diameters 24 inches or less, and not more than 1 inch less than the diameter shown on the plants for diameters greater than 24 inches.
- e) The bearing area of bells shall be excavated to the plan bearing area as a minimum. All other plan dimensions shown for the bells may be varied, when approved, to accommodate the equipment used.
 - f) The top elevation of the shaft shall be within 1 inch of the plan top of shaft elevation.
 - g) The bottom of the shaft excavation shall be normal to the axis of the shaft within 3/4 inch per foot of shaft diameter.

viii) Inspection

After the borehole has reached its final stipulated positions, after the samples have been taken out, as required by the Engineer and the borehole has been completely cleaned of all loose matter and otherwise made ready to receive the reinforcement and thereafter the concrete, the contractor shall so inform the Engineer.

The Engineer shall inspect the soil samples and test results thereon, check the elevation of the bottom of the borehole and the amount and direction, if any, by which the top of the casing is out of position, or out-of-plumb having satisfied himself on these and on any other points which he may consider relevant shall sign permission authorizing the Contractor to proceed with the placing of the reinforcement. The Contractor shall under no circumstances proceed with the placing of reinforcement or with the subsequent concreting without having first obtained the authority signed separately for each and every borehole by the Engineer.

ix) Pile Reinforcement

The reinforcement for each pile shall be assembled and securely tied by means of binding wire and by welded reinforcement rings of twenty five (25) mm diameter bar as shown on the drawings, in such a manner as to form a rigid cage.

The required concrete cover to the reinforcement shall be maintained by suitable spacers securely attached to the reinforcement and of sufficient strength to resist damage during handling of the reinforcement cage into the pile. The distance between the spacers shall be such that the required cover is maintained throughout and that there is no displacement of the reinforcement cage in the course of the concreting operation.

Should the Contractor prefer to lower the reinforcement cage assembly into

the borehole in sections, he may do so provided the same lapping requirements as for assembly on the ground are followed, namely, the longitudinal reinforcement shall be lapped as shown on the drawings and the spiral reinforcement shall be doubled over the lap zones. Spacers maintaining concrete cover shall be located immediately below and above the laps at 4 points spaced around the cage.

10.3.3 **Concreting, of Piles**

In general, item 401 of the General Specifications shall be followed, however, the following particular requirements shall be observed.

i) Materials

Compressive strength of concrete in piles shall be of class A3 as prescribed in Item 401, except if otherwise indicated.

Suitable retarder, plasticiser may be added as approved by the Engineer.

The Contractor shall submit the detailed proposed additive for approval, which shall be approved after laboratory trial mix results. The dosing of retarders shall ensure initial setting time of not less than five (5) hours corresponding to the ambient temperature at which the concreting is proposed to be carried out.

ii) Commencement of Concreting

Prior to placing any concrete:

- a. Any heavy contaminated bentonite slurry, which could impair the free flow of concrete from the tremies pipe, shall be removed.
- b. Any loose or soft material/water soil shall be removed from the bottom of the bore by methods acceptable to the Engineer.

The Contractor shall not proceed with the concreting of the pile until the Engineer gives specific permit to do so after satisfying himself of the:

- Adequacy of the Contractors equipment and arrangement.
- Proficiency of his personnel.
- Cleanliness of the borehole.

Contractor shall have a suitable lighting arrangements at all times for inspecting the entire length of the shells, pipe or hole before placing the reinforcing steel or concrete.

Prior to the concreting a pile, sample of slurry shall be taken from the base of the borehole using an approved sampling device and its specific gravity shall be determined.

iii) Placing of Concrete

The tremies shall be of not less than two hundred and fifty (250) mm diameter made of water-tight construction. The means of supporting the tremies shall be such as to permit the free movement of the discharge end in the concrete in the pile. The tremies pipe shall be fitted with travelling plug, which shall be placed at the top of the pipe before charging the tremies pipe with concrete as barrier between the concrete and water or bentonite slurry, so as to prevent water or bentonite slurry entering the tube and mixing with the concrete. The tremies shall be carefully lowered into the borehole so that the end of the tube shall rest at about one hundred and fifty (150) mm above the bottom of the borehole, with reinforcement in the borehole, and the hopper end of the tremies tube shall be filled with concrete as aforesaid. It shall be slightly raised so that when the concrete reaches the bottom it flows out of the lower end of the tube, and fills the bottom of the borehole. Thereafter, the rate of withdrawal of the tremies shall be gradual so as to ensure the end of the tremies pipe is always one and half (1.5) meters below the top of the concrete in the borehole. An allowance shall be made for the top five hundred (500) mm of concrete in borehole during concreting being unsatisfactory. When the next batch is placed in the hopper the tremies shall be slightly raised but not out of the concrete at the bottom, until the batch discharges to the bottom of the upper. This operation shall be controlled by calculating the volume of concrete required to fill one linear meter of pile and then by measuring the rate of withdrawal of the tube corresponding to the volume of the batch in the hopper. The flow shall then be retarded by lowering the tube. The depth of the concrete in borehole shall be measured at intervals to keep a constant check that the tremies pipe bottom is immersed in concrete.

Concreting in each pile shall be carried out in a continuous operation without stoppages until the pile has been completed.

If the bottom of the tremies pipe ceases to be immersed in the body of the concrete in the pile and the seal is broken, concreting shall cease immediately and such remedial measures as the Engineer may accept or direct shall be carried out. The Contractor shall take precautions to ensure that the concrete is free of voids and shall prevent the entry of water and/or collapse of soil into concrete. If any soil or other deleterious or extraneous materials fall into any pile excavation prior to or during concreting, it shall be removed immediately.

Concreting shall continue until the concrete has reached an elevation five hundred (500) mm higher than the designated pile cut off level shown on the drawings, or as otherwise directed by the Engineer.

The concrete shall be placed in one continuous operation from tip of cut-off elevation and shall be carried out in such a manner as to avoid segregation. The method of placing the concrete and the consistency (slump) shall conform to the requirements of Item 401 or to the satisfaction of the Engineer.

No shell or pipe shall be filled with concrete until all adjacent shells, pipes or piles within a radius of three (3) M or five (5) times the pile diameter, whichever is greater, have been driven to the required resistance.

After a shell or pipe has been filled with concrete, no pile shall be driven within seven (7) meters thereof until at least seven (7) days have elapsed.

10.3.4 Withdrawal of Temporary Casing

If the method of construction involves partial withdrawal of temporary casing as concreting proceeds, a sufficient head of concrete shall be maintained above the bottom of the temporary casing to ensure that no voids are formed within the pile and to prevent the entry of ground water and to prevent the collapse of soil into the concrete.

If such entry or collapse should occur, the temporary casing shall be re-driven before the concrete has set and all defective concrete shall be removed or the construction of the pile shall be abandoned, in which case the provision of the clause herein which refers to "Defective Piles" shall apply.

The withdrawal of the temporary casing shall be carried out before the adjacent concrete has taken its initial set.

The method and timing of withdrawal must be such as to ensure that the space between the pile and the surrounding ground shall be filled with concrete.

10.3.5 Splicing of Piles

Splicing of piles, when permitted by the Engineer, shall be made as shown on the Drawings or as specified with materials having same quality and characteristic as for materials used for the pile itself.

i) Precast Concrete Piles

For precast concrete piles, the splicing shall be done according to one of the following methods unless otherwise specified.

- 1) Using prefabricated joints mounted in the forms and cast together with the pile sections and joined together as specified by the manufacturer and approved by the Engineer. The joints shall be of the design and type as

shown on the Drawings.

- 2) By cutting away the concrete at the end of the pile, leaving the reinforcement steel exposed for a length of forty (40) times steel bar diameters. The final cut of the concrete shall be perpendicular to the axis of the pile. Reinforcement of the same size as that used in the pile shall be welded to the projecting steel and the necessary formwork shall be placed, care being taken to prevent leakage along the pile. The concrete shall be of the same quality as that used in the pile. Just prior to placing concrete, the top of the pile shall be wetted thoroughly and covered with a thin coating of neat cement. or other suitable bonding material to the satisfaction of the Engineer. The forms shall remain in place not less than seven (7) days. The pile shall not be driven until the 28-days design strength is reached.
- 3) Any other method shown on the Drawings or approved by the Engineer.

ii) Steel Piles, Shells or Pipes

For steel piles shells and pipe, the splicing shall be as under:

If the ordered length of the steel pile, pipe, or shell is insufficient to obtain the specified bearing value, an extension of same cross-section shall be spliced to it. Unless otherwise shown on the Drawings, splices shall be made by butt-welding the entire cross-section to form an integral pile using the electric arc method. The sections connected shall be properly aligned so that the axis of the pile will be straight. Piles bent or otherwise injured shall be rejected.

10.3.6 Cutting of Piles

Tops of piles shall be embedded in the concrete footing as shown on the drawings.

Concrete piles shall, when approved by the Engineer, be cut off at such a level that at least five (5) cm of undamaged pile can be embedded in the structure above. If a pile is damaged below this level, the Contractor shall repair the pile to the satisfaction of the Engineer. The longitudinal reinforcement of the piles shall be embedded in the structure above to a length equal to at least (40) times the diameter of the main reinforcing bars. The distance from the side of any pile to the nearest edge of the footing shall not be less than twenty (20) cm.

When the cut-off elevation for a precast concrete pile, steel shell, pipe or for a cast-in-place concrete pile is below the elevation of the bottom of the pile cap, the pile may be built up from the butt of the pile to the elevation of the bottom of the cap by means of a reinforced concrete construction according to Item 401, if approved by the Engineer.

Cut-offs of structural steel piles shall be made at right angles to the axis of the pile. The cuts shall be made in clean, straight lines and any irregularity due to cutting or burning shall be levelled off with deposits of weld metal prior to placing bearing caps.

10.3.7 **Defective Piles**

Any pile delivered with defects such as damaged during driving or cast insitu, placed out of its proper location, incapable or partially capable of permanently carrying the load which it is intended to carry, driven below the elevation fixed by the Drawing or by the Engineer, due to the immature setting of the concrete in the pile or due to caving collapse of the borehole fully or partially, or due to any cause of which Engineer shall be sole judge to determine shall be corrected at the contractor's expense by one of the following methods approved by the Engineer:-

- a) The pile shall be withdrawn and replaced by a new and when necessary, by longer pile.
- b) A second pile shall be driven or cast adjacent to the defective pile.
- c) The pile shall be spliced or built up as otherwise provided herein or the underside of the footing lowered to properly imbed the pile.

The contractor shall undertake such additional tests/works as the Engineer may specify to provide additional foundations to supplement the defective piles and so modify the structure to be supported as to ensure that load will be transferred safely to the additional foundations of existing pile. The contractor shall be responsible for the cost of such additional functions and tests and / or of the extra work carried out in such modification to the structure.

A concrete pile shall be considered defective if it has a visible crack or cracks, extending around the four sides of the pile, or any defect, which, in the opinion of the Engineer affects the strength, or life of the pile.

When a new pile is driven or cast to replace a rejected one, the Contractor, at his expense, shall enlarge the footing as deemed necessary by the Engineer.

10.3.8 **Test Piles**

Test piles which are shown on the Drawings or ordered by the Engineer shall conform to the requirements for piling as specified and shall be so located that they may be cut-off and become a part of the completed structure.

Test piles to be load tested in accordance with Item 7.3.9 shall be driven in locations determined by the Engineer. These piles shall not be utilized in the structure unless otherwise directed.

Test piles driven by the Contractor for his own use in determining the lengths of piles to be furnished may be so located and they may be cut-off and become a part of the completed structure provided that such test piles conform to the requirement for piling in these specifications.

Any pile, which after serving its purpose as a test pile is found unsatisfactory for utilization in the structure, shall be removed if so ordered by the Engineer, or if approved by the Engineer it shall be cut-off below the ground line and footings, but such approval does not in any way relieve the Contractor of his responsibilities.

Test piles shall generally be driven with the same equipment that is to be used for driving foundation piles. When required, the ground shall be excavated to the elevation of the bottom of the footing before the test pile is driven.

When diesel hammers are to be used for driving end bearing piles, or friction piles where the bearing capacity shall be checked by pile driving formulas, the Contractor shall in advance carry out test piling or load tests to determine the energy developed by the hammer. The Contractor may elect one of the following methods for the calibration:

- a) By test driving the same type of piles successively with diesel hammer and gravity or single acting hammer, or by driving two different piles with diesel hammer and gravity or single acting hammer respectively.
- b) By driving test piles to a depth determined by the Engineer and load testing the same piles in accordance with Item 7.3.9.
- c) Calibration tests shall be made at least at two different sites until the results are satisfactory to the Engineer.

Calibration of diesel hammers may not be required if the hammer has been previously calibrated under soil conditions and for the same size and type of pile, provided that the calibration data is accepted by the Engineer.

10.3.9 Load Tests

A load test shall consist of the application of a load equal to a minimum of 2 times the specified bearing capacity or as otherwise provided for herein or as directed by the Engineer. Load tests shall be made where specified and / or where called for by the Engineer. Unless otherwise permitted by the Engineer, the load tests shall be completed before the remaining piles in the same structure are driven or cast.

Load tests shall be made by methods approved by the Engineer. The Contractor shall submit to the Engineer detailed plans of the loading system and apparatus he intends to use at least three (3) weeks in advance. The apparatus shall be so constructed as to allow the various increments of the load to be placed gradually without causing vibration to the test piles. Tension anchor piles if used, shall be of a design and driven to a depth satisfactory to the Engineer. Steel shells or piles whose walls are not of adequate strength to withstand the test loading when empty, shall have the required reinforcement and concrete placed before loading. The load test shall not be started until the concrete has attained a minimum compressive strength of ninety five (95) percent of the design twenty eight (28) days compressive strength. If he so elects, the Contractor may use high early strength cement in the concrete of the load test pile and the tension piles.

Suitable approved apparatus for determining accurately the load on the pile and the settlement of the pile under each increment of load shall be supplied by the Contractor. The apparatus shall have a working capacity of three times the design load for the pile being tested. Reference points for measurement of pile. Settlement shall be sufficiently away from the test pile to preclude all possibility of disturbance.

All pile load settlements shall be measured by adequate devices, such as gauges, and shall be checked by means of an Engineer's level. Increment of deflection shall be read just after each load increment is applied and at 15-minute intervals thereafter. The safe allowable load shall be considered as 50 percent of the load which, continuous application, has caused not more than 6 mm of permanent settlement, measured at the top of the pile.

The first load to be applied to the test pile shall be 50%, of the pile design load and the first increment shall be up to the pile design load by applying additional loads in three equal increments. A minimum period of 2 hours shall intervene between the applications of each increment; except that no increment shall be added until a settlement of less than one tenth (0.1) mm is observed for a 157minute interval under the previously applied increment. If there is a question as to whether the test pile will support the test load, the load increments shall be reduced by fifty (50) percent, at the direction of the Engineer, in order that a more closely controlled failure curve may be plotted. The full test load shall remain on the test pile not less than forty eight (48) hours. The full test load shall then be removed and the permanent settlement read.

When directed by the Engineer load tests shall then be continued beyond the double design load in 10-ton increments to failure or a maximum of three (3) times the design load.

The pile may be considered to have failed when the total permanent settlement exceeds (6) mm.

10.3.10 Backfilling Empty Boring

When each pile has been cast, the empty bores remaining shall not be back-filled unless required by the construction procedures and activities following the completion of piling work.

10.3.11 Pile Records

The Contractor shall keep records of the piles driven or installed. A copy of the record shall be given to the Engineer within two (2) days after each pile is driven. The record form to be used shall be approved by the Engineer. The pile records shall give full information on the following:

Driven Piles	Cast-in-Place Piles
Pile type and dimension	Pile type and nominal dimensions
Driving equipment, type, weight, reach-and efficiency of hammer etc.	Date of boring commenced, level reached each day and date of casting.
Date of casting (for concrete piles) and driving	Soil samples taken from pile boring operation and soil test results.
Details of Reinforcement	Strata and ground water encountered with levels, description shall be in accordance with BSCP 2001.
Test results on concrete	Length of finished pile and tip elevation.
Depth driven & trip elevation	Dia of borehole
For gravity and single-acting hammers : the height of drop	Elevation of the bottom of borehole.
For double acting hammers : the frequency of blows	Date of placing concrete; theoretical and actual quantities of concrete used in pile.
Final set for last 20 blows for every 10 piles and when the Engineer so requires the penetration along the whole driven depth shall be recorded.	Length and diameter of temporary casing and permanent lining and the elevation of the tip of temporary casing and of permanent lining.
Details of any interruption in driving.	Details of Reinforcement.
Level of pile top immediately after driving, and the level when all piles in the group area driven	Details of penetration during boring operation or driving of steel shell (driving records as for driven piles),
Details of re-driving	Quality, consistency and other test results on concrete.
Any other relevant information	Time interval between boring or driving and concreting. Any other relevant information.

10.3.12 Confirmatory Boring

The contractor shall carry out confirmatory boring at bridge site at locations indicated by the Engineer.

Boring shall be carried out with ASTM D 1586 Penetration Test and Split barrel sampling of soil. Additionally, when undisturbed sampling is required, the procedure shall conform to ASTM D 1587, Thin Walled sampling of soil.

Diameter of boreholes shall be twenty (20) centimetres cased throughout its length and shall be down to the designated elevation. In-situ standard penetration test shall be carried out at one and half (1.5) meters interval from designated top elevation to the bottom of the hole. Undisturbed samples shall be taken from substratum. If clay is encountered, undisturbed samples will be taken at interval of three (3) meters.

At least two borings are required at each bridge site. The boring shall extend to a depth of at least three (3) meters below the pile tip elevation as indicated in the drawings.

10.4 **MEASUREMENT AND PAYMENT**

- A. Payment for all the items under this section shall be made at the Unit rates entered in the BOQ appended to the contract and in accordance with the applicable conditions of the contract.

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1 GENERAL

- 1.01 This General Specification is to be taken as applying to all the works in this Contract. Figured dimensions on the working drawings shall be followed in preference to the scale.
- 1.02 Until and unless specified otherwise, all goods and materials are to be Pakistan manufactured and to be of the best quality, and where not otherwise specified shall be according to latest engineering practice and conforming to Pakistan Standards (P.S) or British Standard Specifications (B.S.S) or Standard of American Society of Testing Materials (ASTM). The Engineer or the Consultants may also supplement such specifications during the progress of work.
- 1.03 All materials and goods used for such and other items shall be subjected to standard testing and if found below the specified standard such as PS or BSS or ASTM or their equivalent shall be removed from the site immediately at Contractor's own expense. All testing of materials finished and unfinished, shall be carried out by the Contractor at his cost, in the presence of Engineer or Engineer or his Representative for which the Contractor shall maintain a reasonably well equipped laboratory of his own, close to the site of work or make any other additional arrangement to the satisfaction and convenience of the Engineer. The Contractor shall include testing charges in his quotations and shall not be entitled to any reimbursement on this account for routine testing.
- 1.04 The Contractor must give early attention to the submission of samples of materials for approval of the Engineer, indicating the names of the manufacturing firms where applicable especially of cement, sand, aggregates, steel, water, tiles, hard-core and all fittings. Whenever practicable, samples shall be submitted at least three weeks before it is proposed to use the materials. Until and unless specified otherwise and whenever materials are ordered to be forwarded to a testing laboratory other than site laboratory for check/ testing, the Contractor will be reimbursed the cost of fees for such tests if proved satisfactory, by the Employer. The Contractor, however, will be required to bear the cost of the fees for tests, which proved unsatisfactory.
- 1.05 The Contractor must take all steps necessary to prevent damage or interference with all supply lines such as water, electric power, fuel, telephones, drains, buried cables and any construction designed for the use of the public, government or semi government authorities or the Employer. The Contractor shall be responsible for any damage caused to such services or constructions and settle all claims in respect of such damage.
- 1.06 The Contractor shall protect from injury by covering all work, internally and externally needing protection including new concrete, Formwork, surface renderings, floors, etc., to the satisfaction of the Engineer, including the work of his sub-contractors at his own cost.
- 1.07 The whole work shall be carried out in the best manner in accordance with the instructions contained in these documents and those given by the Engineer

from time to time during the progress of the work. The work shall be carried out in conformity with the best of the standard construction practices preferably the British Codes of Practices.

- 1.08 The Contractor shall submit to the Engineer for his approval before beginning the work, a complete plan of the proposed sequence and methods of operations for the execution of the works. Detailed drawings showing the location and construction of dumping and working platforms, cranes, building and all other structures in connection with the Contractor's plant and material storage sheds shall also be submitted to the Engineer for his approval before construction.
- 1.09 Orders and directions may be given orally by the Engineer or his Representative, and shall be received and promptly obeyed by the Contractor or his Representative or any superintendent or foreman or any supervisor of the Contractor whosoever may have charge of the particular part or section of work in relation to which the orders or directions are given, and a confirmation in writing of such order or directions will be given to the Contractor by the Engineer, if so requested. The Contractor shall provide and maintain at his own expense during the performance of the work an office in the vicinity of work. Orders or directions, written or oral, from the Engineer or his Representative delivered at such office shall be considered as delivered to the Contractor. The Contractor's office shall be fitted with a telephone connected to the local Telephone Exchange.
- 1.10 The Contractor shall not use the site for any other purpose than that of carrying out this Contract work. The operations of the Contractor shall be confined to the area immediately adjoining the buildings and the works included in this Contract but site clearance shall be kept to the satisfaction of the Engineer to permit carrying out of other works by other Contractors. The Contractor shall not affix advertisements; neither shall he permit advertisements to be displayed without the written consent of the Engineer.
- 1.11 The contract drawings are the working drawings to guide the Contractor generally about the shape and size of all the structures and fittings. Before proceeding to make preparations, fabrication, execution, erection of any such fittings and other details of any temporary works, scaffolds, railings, shuttering, details of doors, windows, partitions, iron mongers work, etc.; the Contractor shall be under obligation to prepare and submit all detailed shop drawings to the satisfaction and the approval of the Engineer, before doing any or all of that described above or as directed. Approval of the contractor's drawings shall not relieve the Contractor for any part of his obligation to meet all the requirements of the specifications or correctness of his drawings. On site Mock-up and sample must be prepared and informed to engineer and client two weeks prior for visit.
- 1.12 No cement work shall be permitted during extreme cold weather when unless otherwise authorized by the engineer.

1.13 **PAYMENT**

Contractor shall not be entitled to any separate or additional payment on account of all these general requirements and any other arrangement or action Contractor has to undertake under the direction of the Engineer for a proper carrying out of the works and meeting all obligations of the Contract.

END OF SECTION

2 UNIT MASONRY ASSEMBLIES

2.1 BLOCK MASONRY

2.1.1 SCOPE OF WORK

The work covered by this section of the specifications consists of furnishing all plant, labour, equipment, appliances and materials and in performing all the operations in connection with block masonry work complete in strict accordance with the specifications herein and the applicable drawings and subject to the terms and conditions of the contract.

2.2 MATERIALS

2.2.1 CEMENT

Cement shall be Portland cement meeting the requirements specified under clause of section of "Concrete".

2.2.2 Aggregates

Aggregates used shall meet the requirements specified under clause of section of "Concrete".

2.2.3 Water

Water shall be as specified under clauses of the section of "Water".

2.2.4 Concrete Masonry Units

2.2.4.1 General: Provide shapes indicated and as follows:

- i) Provide special shapes for corners, jambs, sash, control joints, headers, bonding, and other special conditions.
- ii) Provide square-edged units for outside corners, unless indicated as bullnose.

2.2.4.2 CMU units designations: Currently, six ASTM standards apply to units intended primarily for construction of concrete masonry walls, beams, columns, or specialty applications:

Type of Unit is Non-load bearing Concrete Masonry Units and ASTM Designation is C 129

2.2.4.3 Concrete Masonry Units: ASTM C 129 and as follows:

- i) Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 13.1 MPa [7.5 MPa on gross area].
 - a) Normal-weight units: more than 125 lb/cu. ft. (2002 kg/cu. m)
- ii) 2. Weight Classification: Normal weight, unless otherwise indicated.

2.2.4.4 Concrete masonry units shall be made on the project site and shall be of the sizes required by the drawings and / or as directed by the **Engineer**.

2.2.4.5 The blocks shall be solid or hollow as required and shall be carefully made so that they are true in line and face with square corners and free from all defects.

2.2.4.6 The concrete for the blocks shall be mixed in the proportions of one (1) part of cement, three (3) parts of sand and six (6) parts of well graded coarse aggregate not exceeding ½" in size.

2.2.4.7 Concrete blocks shall be machine moulded. The concrete shall be well worked in the moulds, vibrated tamped and pressed to ensure that the blocks are dense and free from voids.

2.2.4.8 The blocks shall be cured by keep moist continuously for a period of at least ten (10) days and then shall be allowed to dry in a shady location for at least eight (8) days before being used in masonry.

2.2.4.9 Where blocks are to be exposed to view they shall have clean, cut straight and true, edges, smooth dense faces of uniform appearance without voids, honeycombs, projections or variation in texture and shall be free from cracks, spells, chips, ragged edges or other defects detrimental of their appearance.

2.2.4.10 Where blocks are to be plastered the exposed surfaces shall have a coarse texture suitable for bonding the plaster as approved by the Engineer.

2.2.4.11 The average compressive strength of any five blocks picked at random shall be not less than the strength as specified for Class 'D' concrete under clause of the section of "Concrete".

2.2.4.12 The average moisture content of all concrete masonry units shall not exceed 30% of the total absorption of the units.

2.3 **HANDLING AND STORAGE**

Concrete masonry unit shall be stacked on platforms and covered or stored in any other manner approved by the Consultants to protect from contact with the soil and exposure to weather. Care shall be taken in handling to avoid chipping and breakage. Storage piles stacks, or bins shall be so located as to avoid being disturbed or shall be barricaded to protect the blocks from damages by construction operations.

2.4 **MORTAR FOR MASONRY**

2.4.1. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures, unless otherwise indicated.

- 1) Do not use calcium chloride in mortar or grout.
- 2) Use mortar cement mortar unless otherwise indicated.
- 3) For exterior masonry, use mortar cement mortar.

2.4.2. Pre-blended, Dry Mortar Mix: Furnish dry mortar ingredients in the form of a pre blended mix. Measure quantities by weight to ensure accurate proportions, and thoroughly blend ingredients before delivering to Project site. Comply with ASTM C 270 Property Specification:

- 1) Wet mix life: <1.5 hours

- 2) 2. Initial adhesion at 28 days: $> 0.3\text{N/mm}^2$
- 3) 3. Bending strength: around 1N/mm^2
- 4) 4. Compressive strength : not less than $5 \pm 1\text{ N/mm}^2$
- 5) 5. Min. cement sand mix: 1:3-4
- 6) 6. Testing: ASTM C 780

2.4.3. Mortar for Unit Masonry: Comply with ASTM C 270 Property Specification. For job mixed mortars, minimum properties shall be as follows:

- 1) Compressive strength : not less than $5 \pm 1\text{ N/mm}^2$
- 2) 2. Min. cement sand mix: 1:3-4
- 3) 3. Bending strength: around 1N/mm^2
- 4) 4. Testing: ASTM C 780

2.4.4. Property specification ASTM C 270:

Mortar	Type	Average Compressive Strength at 28 days, min, psi (MPa)	Air Content Max %
	S	1800 (12.4)	12
	N	750 (5.2)	14
	O	350 (2.4)	14

Aggregate Ratio (Measured in Damp, Loose Conditions): Not less than $2\frac{1}{4}$ and not more than $3\frac{1}{2}$ the sum of the separate volumes of cementitious materials Minimum water retention 75 %

- 1) For masonry below grade or in contact with earth, use Type M.
- 2) For reinforced masonry, use Type S.
- 3) For mortar parge coats, use Type S or Type N.
- 4) For exterior, above-grade, non-load-bearing walls and parapet walls; for interior non-load-bearing partitions; and for other applications where another type is not indicated, use Type N.

2.4.5. Grout for Unit Masonry: Comply with ASTM C 476.

- 1) Use grout of type indicated or, if not otherwise indicated, of type (fine or coarse) that will comply with Table 1.15.1 in ACI 530.1/ASCE 6/TMS 602 for dimensions of grout spaces and pour height.
- 2) Proportion grout in accordance with ASTM C 476, Table 1 or paragraph 4.2.2 for specified
- 3) 28-day compressive strength indicated, but not less than 14 MPa.
- 4) Provide grout with a slump of 203 to 279 mm as measured according to ASTM C 143/C 143M. PART

2.4.6. Cement shall be Portland as specified under Clause of the Section of "Concrete".

2.4.7. Fine aggregate shall be clean, hard, durable particles free from laminated material well graded from No. 4 to 100 sieve.

- 2.4.8. Water shall be clean and free from injurious acids, alkali and organic impurities.
- 2.4.9. All mortar for masonry shall be proportion of one (1) part of cement and four (4) parts of sand (fine aggregate) and the ingredients shall be mixed by volume.
- 2.4.10. Mortar shall be mixed thoroughly in a drum type batch mixer for a period of not less than three minutes, using the quantity of water required to obtain the desired workability. Hand mixing shall be subject to approval by the Engineer and if he allows the mortar materials shall be mixed in a light mortar mixing box. In no case the mixing of mortar shall be done on open platform.
- 2.4.11. The mortar shall be subject to compressive strength test and the average compressive strength of three numbers 50 mm (2") cylinders of mortar shall be not less than 1,800 lbs per sq. inch at 28 days.
- 2.4.12. Mortar shall be used in the masonry within half an hour from addition of water into the mortar. The mortar which has already set shall not be used in the masonry.

2.5 **MASONRY AND JOINTING**

- a) All masonry shall be laid plumb, true to the line and level and accurately spaced coursed and with each course breaking joints with the course below. Bond shall be keeping plumb; corners and reveals shall be plumb and true. Chases, grooves, reglet blocks and raked out joints shall be kept free from mortar and other debris.
- b) The thickness and length of various walls shall be as indicated on the drawings.
- c) Unless otherwise shown on the drawings or specified the spaces around forms and other built in items shall be solidly filled with mortar except that joints that are to be caulked shall be raked out 20 mm (3/4").
- d) Work required to be built in with masonry including anchor, wall plugs and accessories shall be built in as the work progresses. Wood plugs and blocking shall not be built into masonry.
- e) All horizontal and vertical joints shall be completely and solidly filled with mortar when and as the blocks are laid.
- f) (1/2") deep when the mortar is still fresh so as to give proper bond to the plaster.
- g) Where masonry abuts RCC columns or walls it shall be anchored thereto by means of wire anchors of galvanized metal not less than 10 gauge or 25

mm (1") wide G.I. strip 22 gauge located at every fourth horizontal joint.

- h) The top course of partitions under slabs beams shall not be laid until the forms have been removed and the roofing placed.
- i) Masonry walls shall be cured for at least ten days from the day it is erected.

2.6 MATERIALS

a. Mortar

b. Cement

Comply with requirements of BS 12: 1989. Use ordinary Portland cement (grey) unless specified otherwise.

c. Sand

Comply with requirements of BS 1200: 1976 with Amendments 1, 2 & 3, for "Building sands from natural sources". Grading S of table below is preferred.

BS Sieve	Percentage by mass passing BS sieves	
	Type S	Type G
mm		
6.30	100	100
5.00	98 – 100	98 – 100
2.36	90 – 100	90 – 100
1.18	70 – 100	70 – 100
microns		
600	40 – 100	40 – 100
300	5 – 70	20 – 90
150	0 – 15	0 – 25
75	0 -5*	0 – 8**

* 0-10% for crushed stone sands

** 0-1 2 % for crushed stone sands

Store sand at the Site in such a manner that it is not mixed with foreign matter. Methods employed by the Contractor for unloading, loading, handling and storage shall be subject to the approval of the Engineer. Maintain sufficient quantity at the Site at all times to ensure continuous work.

- i) Water
Do not use seawater or brackish water containing more than 100 ppm chloride ion or 2000 ppm sulphate ion for mixing or curing concrete. Water shall be clean and free from harmful matter and shall comply with the requirements of appendix A of BS 3148: 1980. Avoid contamination during storage.
- ii) Mortar composition
Cement to dry sand ratio by volume as specified.
- iii) Mortar batching and mixing
Employ methods and equipment for mixing mortar so as to accurately determine and control the amount of each separate ingredient entering into the mortar, subject to the approval of the Engineer. Unless mixing by hand is allowed by the Engineer, mix mortar in a mixer which shall be of approved design and the mixing time after all the ingredients are in the mixer, except for the full amount of water, shall not be less than two minutes. Mix mortar only in quantities just sufficient for immediate use and waste all mortar not used within 30 minutes after addition of water to the mix. Do not re-tamper mortar. Thoroughly clean and wash mixing troughs and pans at the end of each day's work.
- d. Metal ties
Unless approved otherwise by the Engineer or shown on drawings:
 - i) Cavity wall ties - comply with the requirements of BS 1243: 1978 as approved by the Engineer.
 - ii) Ties for jointing concrete and blockwork - 6mm dia x 300mm long, MS galvanized.

2.7 TIES AND ANCHORS

- 2.7.1. Materials: Provide ties and anchors specified in this article that are made from materials that comply with the following unless otherwise indicated.
 - i) Hot-Dip Galvanized, Carbon-Steel Wire: ASTM A 82/A 82M; with ASTM A 153/ A 153M, Class B-2 coating.
 - ii) Stainless-Steel Wire: ASTM A 580/A 580M, Type 316.
 - iii) Steel Sheet, Galvanized after Fabrication: ASTM A 1008/A 1008M, Commercial Steel, with ASTM A 153/A 153M, Class B coating.
 - iv) Stainless-Steel Sheet: ASTM A 666, Type 316.
 - v) Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.
- 2.7.2. Corrugated Metal Ties: Metal strips not less than 22 mm wide with corrugations having a wavelength of 7.6 to 12.7 mm and an amplitude of 1.5 to 2.5 mm made from 1.52-mm- thick, steel sheet, galvanized after fabrication.
- 2.7.3. Wire Ties, General: Unless otherwise indicated, size wire ties to extend at least halfway through veneer but with at least 16-mm cover on outside face. Outer ends of wires are bent 90 degrees and extend 50 mm parallel to face of veneer.

- 2.7.4. Individual Wire Ties: Rectangular units with closed ends and not less than 100 mm wide.
- i) Z-shaped ties with ends bent 90 degrees to provide hooks not less than 50 mm long may be used for masonry constructed from solid units.
 - ii) Where wythes do not align, use adjustable ties with pintle-and-eye connections having a maximum adjustment of 32 mm.
 - iii) Wire: Fabricate from 6.35-mm- diameter, hot-dip galvanized steel wire.
- 2.7.5. Adjustable Anchors for Connecting to Structural Steel Framing: Provide anchors that allow vertical or horizontal adjustment but resist tension and compression forces perpendicular to plane of wall.
- i) Anchor Section for Welding to Steel Frame: Crimped 6.35-mm- diameter, hot-dip galvanized steel wire.
 - ii) Tie Section: Triangular-shaped wire tie, sized to extend within 25 mm of masonry face, made from 6.35-mm- diameter, hot-dip galvanized steel wire.
- 2.7.6. Adjustable Anchors for Connecting to Concrete: Provide anchors that allow vertical or horizontal adjustment but resist tension and compression forces perpendicular to plane of wall.
- i) Connector Section: Dovetail tabs for inserting into dovetail slots in concrete and attached to tie section; formed from 2.66-mm- thick, steel sheet, galvanized after fabrication.
 - ii) Tie Section: Triangular-shaped wire tie, sized to extend within 25 mm of masonry face, made from 6.35-mm- diameter, hot-dip galvanized steel wire.
 - iii) Corrugated Metal Ties: Metal strips not less than 22 mm wide with corrugations having a wavelength of 7.6 to 12.7 mm and an amplitude of 1.5 to 2.5 mm made from 2.66-mmthick, steel sheet, galvanized after fabrication with dovetail tabs for inserting into dovetail slots in concrete and sized to extend to within 25 mm of masonry face.
- 2.7.7. Provide Adjustable Anchors for Connecting to Structural Steel Framing or Concrete made of stain- less steel sheet or wire where required for location and directed by Engineer.
- 2.7.8. Partition Top anchors: 2.66-mm- thick metal plate with 9.5-mm- diameter metal rod 152 mm long welded to plate and with closed-end plastic tube fitted over rod that allows rod to move in and out of tube. Fabricate from steel, hot-dip galvanized after fabrication. I. Rigid Anchors: Fabricate from steel bars 38 mm wide by 6.35 mm thick by 610 mm long, with ends turned up 51 mm or with cross pins unless otherwise indicated.
- i) Corrosion Protection: Hot-dip galvanized to comply with ASTM A 153/A 153M.

2.8 MISCELLANEOUS MASONRY ACCESSORIES

- 2.8.1. Compressible Filler: Pre-molded filler strips complying with ASTM D 1056, Grade 2A1; compressible up to 35 percent; of width and thickness indicated; formulated from neoprene, urethane or PVC.

- 2.8.2. Preformed Control-Joint Gaskets: Material as indicated below, Made from styrenebutadiene-rubber compound, complying with ASTM D 2000, Designation M2AA-805 or PVC, complying with ASTM D 2287, Type PVC-65406, designed to fit standard sash block and to maintain lateral stability in masonry wall; size and configuration as indicated.
- 2.8.3. Bond-Breaker Strips: Asphalt-saturated, organic roofing felt complying with ASTM D 226, Type I (No. 15 asphalt felt).
- 2.8.4. Weep/Vent Products: Use one of the following unless otherwise indicated:
- i) Wicking Material: Absorbent rope, made from UV-resistant synthetic fiber, 6 to 10 mm in diameter, in length required to produce 50-mm exposure on exterior and 450 mm in cavity. Use only for weeps.
 - ii) Plastic Weep Hole/Vent: One-piece, flexible extrusion made from UV-resistant polypropylene copolymer, designed to fill head joint with outside face held back 3 mm from exterior face of masonry, in color selected from manufacturer's standard.

2.9 **DELIVERY AND STORAGE**

The methods and equipment used for transporting the bricks and mortar shall be such as will not damage the bricks nor delay the use of mixed mortar.

Masonry materials shall be so stored that at the time of use the materials are clean and structurally suitable for use.

2.10 **SCAFFOLDING**

Provide and erect safe scaffolding of adequate strength for use of workmen at all levels and heights. Do not use scaffolding which in the opinion of the Engineer is unsafe, until it has been strengthened and made safe for use of workmen.

2.11 **MEASUREMENT AND PAYMENT**

All the items of work covered by this section of the specifications shall be measured by the standard method of measurements and paid in accordance with unit rates entered in the Bill of Quantities. No separate payment will be made for masonry anchors etc. required.

END OF SECTION

3 METAL

3.1- METAL FABRICATION

PART 1 - GENERAL

3.1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions.

3.1.2 SUMMARY

- A. This Section covers items fabricated from steel, stainless steel or aluminum and are not covered under other Specification Sections, including, but not limited to, the following:
 - 1. Miscellaneous framing and supports.
 - a. Concealed applications where framing and supports are required.
 - b. Countertop support.
 - c. Vanity supports
 - d. Steel framing and supports for mechanical and electrical equipment.
 - e. Steel framing and supports for Architectural applications.
 - 2. Elevator machine beams, hoist beams, and divider beams.
 - 3. Support angles for elevator door sills.
 - 4. Shelf angles.
 - 5. Loose bearing and leveling plates.
 - 6. Steel welded plates and angles for casting into concrete not specified in other Sections.
 - 7. Miscellaneous steel trim including steel angle corner guards, steel edgings and loading-dock edge angles.

This Section includes the following metal fabrications:

- 8. Ladders.
- 9. Floor plate and supports.
- 10. Cast nosings, treads, and thresholds.
- 11. Pipe guards.
- 12. Pipe bollards.
- 13. Column protection guard.

Products furnished, but not installed, under this Section include the following:

- 14. Loose steel lintels.
- 15. Anchor bolts, steel pipe sleeves, and wedge-type inserts indicated to be cast into concrete or built into unit masonry.

Related Sections include the following:

16. 3.0 Section "Cast-In-Situ Concrete" for corner guards to be placed in forms of reinforced concrete columns and for concrete footings required for metal fabrications.
17. 4.0 Section "Unit Masonry Assemblies" for installing loose lintels, anchor bolts, and other items indicated to be built into unit masonry.
18. 9.0 Section "Painting" for field applied paint finishes.

3.1.3 DESIGN REQUIREMENTS

- A. Design Requirements: Design, engineer, fabricate, and install work in compliance with specified standards, performance requirements, material selections, and requirements of this Section and related sections.
 1. Provide work to withstand thermal movement, wind pressure, gravity loads, seismic loads and movement of building structure without failure. Work to remain free from defects.
 - a. **Seismic Load:** Uniform Building Code, 1997 Edition, zone 2A.
 - b. **Wind Loads:** Provide exterior metal fabrications that withstand design wind pressure calculated according to Uniform Building Code (UBC), 1997 Edition, Exposure C, Basic Wind Speed 130 Km/hr.
 - c. **Thermal Movements:** Provide exterior metal fabrications that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
 - 1) Temperature Change (Range): 35 deg C, ambient; 65 deg C, material surfaces.
- B. The design shall ensure that all components including anchors and connections shall comply with the allowable stresses as per relevant ASTM Standards. Load combinations shall be chosen to ensure that no element shall exceed the allowable stresses under any case of loading.

3.1.4 SUBMITTALS

- a. **Product Data:** for non-slip aggregates and non-slip aggregate surface finishes, cast nosings, treads and thresholds, steel floor plate, paint products, and grout.
- b. **Shop Drawings:** Detail fabrication and erection of each metal fabrication indicated. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items.
 - i. Provide templates for anchors and bolts specified for installation under other Sections.
- c. Samples representative of materials and finished products as may be requested by Engineer.

- d. **Mill Certificates:** Signed by manufacturers of stainless-steel sheet certifying that products furnished comply with requirements.
- e. Welding Certificates signed by Contractor certifying that welders comply with requirements specified under the "Quality Assurance" Article.
- f. **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 and addresses of architects/engineers and owners, and other information specified.

3.1.5 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.
- b. **Fabricator Qualifications:** A firm experienced in producing metal fabrications similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units, without delaying the work.
- c. **Engineering Responsibility:** Engage a fabricator who utilizes a qualified and experienced structural engineer to prepare design calculations, shop drawings, and other structural data.
- d. **Welding:** Qualify procedures and personnel according to the following:
 - i. AWS D1.1, "Structural Welding Code--Steel."
 - ii. AWS D1.2, "Structural Welding Code--Aluminum."
 - iii. AWS D1.3, "Structural Welding Code--Sheet Steel."
 - iv. AWS D1.6, "Structural Welding Code--Stainless Steel."
 - v. Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.
 - vi. Qualification tests according to the Structural Steel Code of Practice Prevailing in the country or other international Code or standard may also be accepted by the Engineer.

3.1.6 PROJECT CONDITIONS

- a. **Field Measurements:** Where metal fabrications are indicated to fit walls and other construction, verify dimensions by field measurements before fabrication and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
 - i. Where field measurements cannot be made without delaying the Work, guarantee dimensions and proceed with fabricating products without field measurements. Coordinate construction to ensure that actual dimensions correspond to guaranteed dimensions. Allow for trimming and fitting.

3.1.7 COORDINATION

- a. Coordinate installation of anchorages for metal fabrications. Furnish setting drawings, templates, and directions for installing anchorages, including

sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

PART2 - PRODUCTS

3.1.8 METALS, GENERAL

- A. **Metal Surfaces, General:** For metal fabrications exposed to view in the completed Work, provide materials with smooth, flat surfaces without blemishes. Do not use materials with exposed pitting, seam marks, roller marks, rolled trade names, or roughness.

3.1.9 FERROUS METALS

- A. Steel Plates, Shapes, and Bars: ASTM A 36M, Tensile strength 400 Pa and minimum yield point 250 MPa.
- B. Stainless-Steel Sheet, Strip, Plate, and Flat Bars: ASTM A 666, Type 304.
- C. Stainless Steel:
 - 1. Grade and type designated below for each form required:
 - a) Tubing: ASTM A 554, Grade MT 316
 - b) Pipe: ASTM A 312M, Grade TP 316.
 - c) Castings: ASTM A 743M, Grade CF 8M.
 - d) Plate: ASTM A 167, Type 316.
 - e) Bar Stock: ASTM A 276.
 - 2. Finish: Bright, directional polish; match AISI No. 4 finish.
- D. Rolled-Steel Floor Plate: ASTM A 786M, rolled from plate complying with ASTM A 36/A 36M or ASTM A 283/A 283M, Grade C or D.
- E. Rolled-Stainless-Steel Floor Plate: ASTM A 793.
- F. Steel Tubing: Product type (manufacturing method) and as follows:
 - 1. Cold-Formed Steel Tubing: ASTM A 500.
 - a) Provide tubing with hot-dip galvanized coating per ASTM A 53.
- G. Steel Pipe: ASTM A 53, standard weight (Schedule 40), unless another weight is indicated or required by structural loads.
 - 1. Provide galvanized finish for all steel pipes.
- H. Malleable-Iron Castings: ASTM A 47M, Grade 22010.
- I. Gray-Iron Castings: ASTM A 48M, Class 200, unless another class is indicated or required by structural loads.
- J. Cast-in-Place Anchors in Concrete: Anchors of type indicated below, fabricated from corrosion-resistant materials capable of sustaining, without failure, the load imposed within a safety factor of 4, as determined by testing per ASTM E 488, conducted by a qualified independent testing agency.

1. Threaded or wedge type; galvanized ferrous castings, either ASTM A 47M malleable iron or ASTM A 27/A 27M cast steel. Provide bolts, washers, and shims as needed, hot-dip galvanized per ASTM A 153/A 153M.
- K. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.

3.1.10 ALUMINUM

- a. Aluminum Extrusions: ASTM B 221M, alloy 6063-T6.
- b. Aluminum-Alloy Rolled Tread Plate: ASTM B 632M, alloy 6061-T6.

3.1.11 PAINT

- a. **Shop Primers:** Provide primers that comply with 9.00 Section "Painting."
- b. **Shop Primer for Ferrous Metal:** Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with performance requirements in FS TT-P-664; selected for good resistance to normal atmospheric corrosion, compatibility with finish paint systems indicated, and capability to provide a sound foundation for field-applied topcoats despite prolonged exposure.
- c. **Shop Primer for Ferrous Metal:** Organic zinc-rich primer, complying with SSPC-Paint 20 and compatible with topcoat.
- d. **Galvanizing Repair Paint:** High-zinc-dust-content paint for re-galvanizing welds in galvanized steel, with dry film containing not less than 94 percent zinc dust by weight, and complying with DOD-P-21035 or SSPC-Paint 20.
- e. **Bituminous Paint:** Cold-applied asphalt mastic complying with SSPC-Paint 12, except containing no asbestos fibers, or cold-applied asphalt emulsion complying with ASTM D 1187.

3.1.12 FASTNERS

- a. **General:** Provide Type 304 or 316 stainless-steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B 633, Class Fe/Zn , where built into exterior walls. Select fasteners for type, grade, and class required.
- b. **Bolts and Nuts:** Regular hexagon-head bolts, ASTM F 568M, Property Class 4.6; with hex nuts, ASTM A 563M; and, where indicated, flat washers.
- c. **Anchor Bolts:** ASTM F 1554, Grade 36.
- d. **Machine Screws:** ASME B18.6.7M.
- e. **Lag Bolts:** ASME B18.2.3.8M.
- f. **Wood Screws:** Flat head, carbon steel, ASME B18.6.1.
- g. **Plain Washers:** Round, carbon steel, ASME B18.22M.
- h. **Lock Washers:** Helical, spring type, carbon steel, ASME B18.21.2M.
- i. **Expansion Anchors:** Anchor bolt and sleeve assembly of material indicated below with capability to sustain, without failure, a load equal to six times the load imposed when installed in unit masonry and equal to four times the load imposed when installed in concrete, as determined by testing per ASTM E 488, conducted by a qualified independent testing agency.

- i) Material: Carbon-steel components zinc-plated to comply with ASTM B 633, Class Fe/Zn 5.
- ii) Material: Alloy Group 1 or 2 stainless-steel bolts complying with ASTM F 738M and nuts complying with ASTM F 836M.
- j. **Toggle Bolts:** FS FF-B-588, tumble-wing type, class and style as needed.

3.1.13 GROUT

- a. **General:** Grout shall meet the requirements of 3.0 section, "Cast-in-Place Concrete".
- b. **Non-shrink, Metallic Grout:** Factory-packaged, ferrous-aggregate grout complying with ASTM C 1107, specifically recommended by manufacturer for heavy-duty loading applications.
- c. **Non-shrink, Nonmetallic Grout:** Factory-packaged, non-staining, non-corrosive, nongaseous grout complying with ASTM C 1107. Provide grout specifically recommended by manufacturer for interior and exterior applications.

3.1.14 CONCRETE FILL

Concrete Materials and Properties: Comply with requirements in 3.0 Section "Cast-in-Place Concrete" for normal-weight, air-entrained, ready-mix concrete with a minimum 28-day compressive strength of 20 MPa, unless otherwise indicated.

3.1.15 FABRICATION, GENERAL

- a. Shop Assembly: Preassemble items in shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.
- b. Shear and punch metals cleanly and accurately. Remove burrs.
- c. Ease exposed edges to a radius of approximately 1 mm, unless otherwise indicated. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.
- d. Weld corners and seams continuously to comply with the following:
 - i) Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - ii) Obtain fusion without undercut or overlap.
 - iii) Remove welding flux immediately.
 - iv) At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.
- e. Provide for anchorage of type indicated; coordinate with supporting structure. Fabricate and space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.

- f. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.
- g. Fabricate joints that will be exposed to weather in a manner to exclude water, or provide weep holes where water may accumulate.
- h. Form exposed work true to line and level with accurate angles and surfaces and straight sharp edges.
- i. Remove sharp or rough areas on exposed traffic surfaces.
- j. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners where possible. Use exposed fasteners of type indicated or, if not indicated, Phillips flat-head (countersunk) screws or bolts. Locate joints where least conspicuous.
- k. Form metal fabrications from materials of size, thickness, and shapes indicated but not less than that needed to comply with performance requirements indicated. Work to dimensions indicated or accepted on shop drawings, using proven details of fabrication and support. Use type of materials indicated or specified for various components of each metal fabrication.

3.1.16 MISCELLANEOUS FRAMING AND SUPPORTS

- a. General: Provide steel framing and supports indicated or not indicated that are not a part of structural-steel framework as necessary to complete the Work.
- b. Fabricate units from structural-steel shapes, plates, and bars of welded construction, unless otherwise indicated. Fabricate to sizes, shapes, and profiles indicated and as necessary to receive adjacent construction retained by framing and supports. Cut, drill, and tap units to receive hardware, hangers, and similar items.
 - i) Fabricate units from slotted channel framing where indicated.
 - ii) Where units are indicated to be cast into concrete or built into masonry, equip with integrally welded steel strap anchors 32 mm (1.25") wide by 6 mm (1/4") thick by 200 mm (8") long at 600 mm (24") o.c., unless otherwise indicated.
 - iii) Furnish inserts if units must be installed after concrete is placed.
- c. **FINISH:**
 - i) Interior: Prime painted, unless indicated as galvanized.
- d. Prime miscellaneous framing and supports with zinc-rich primer.

3.1.17 RECEIVING STEEL CAGES

Receiving steel cages are to be included in the steelwork package. Cages are to be designed to incorporate the following:

- a. Total 7 cages size shown on drawings and 10'-0" high.
- b. Cages are to be constructed from steel frames with wire mesh wall and roof cladding. Wire mesh is to be 1/4" bars @ maximum 2" centres both ways

- c. All cages to have 2 roller shutter doors as indicated on the architectural plans. Doors to type 1 cage to have aluminum doors in accordance with the architectural specifications. Roller shutter door controls to incorporate facility that only one door per cage may be open or partly open at any one time.
- d. Design, supply, and insulation to including all fixings, claddings, and flashings required to construct the cages.
- e. All materials to be painted in accordance with specifications.

3.1.18 SHELF ANGLES

- a. Fabricate shelf angles from steel angles of sizes indicated and for attachment to concrete framing. Provide horizontally slotted holes to receive 19-mm 3/4" bolts, spaced not more than 150 mm 6" from ends and 600 mm 24" o.c., unless otherwise indicated.
 - i) Provide mitered and welded units at corners.
 - ii) Provide open joints in shelf angles at expansion and control joints. Make open joint approximately 50 mm 2" larger than expansion or control joint.
- b. Galvanize shelf angles located in exterior walls.
- c. Furnish wedge-type concrete inserts, complete with fasteners, to attach shelf angles to cast-in-place concrete.

3.1.19 LOOSE BEARING AND LEVELING PLATES

- a. Column base plates are not included in this category.
- b. Provide loose bearing and leveling plates for steel items bearing on masonry or concrete construction, made flat, free from warps or twists, and of the required thickness and bearing area. Drill plates to receive anchor bolts and for grouting as required. Galvanize after fabrication.

3.1.20 STEEL WELD PLATES AND ANGLES

Provide steel weld plates and angles not specified in other Sections, for items supported from concrete construction as needed to complete the Work. Provide each unit with not less than two integrally welded steel strap anchors for embedding in concrete.

3.1.21 MISCELLANEOUS STEEL TRIM

- a. Unless otherwise indicated, fabricate units from structural-steel shapes, plates, and bars of profiles shown with continuously welded joints, and smooth exposed edges. Miter corners and use concealed field splices where possible.

- b. Provide cutouts, fittings, and anchorages as needed to coordinate assembly and installation with other work. Provide anchors, welded to trim, for embedding in concrete or masonry construction, spaced not more than 150 mm 6" from each end, 150 mm 6" from corners, and 600 mm 24" o.c., unless otherwise indicated.
- c. Galvanize miscellaneous steel trim in the following locations:
 - i) Exterior.
 - ii) Interior, where indicated.

3.1.22 LOOSE STEEL LINTELS

- a. Unless otherwise indicated on Drawings, provide steel lintels as follows.
- b. Fabricate loose structural-steel lintels from steel angles and shapes of size indicated for openings and recesses in masonry walls and partitions at locations indicated.
- c. Weld adjoining members together to form a single unit where indicated.
- d. Size loose lintels to provide bearing length at each side of openings equal to one-twelfth of clear span, but not less than 200 mm 8", unless otherwise indicated.
- e. Galvanize loose steel lintels located in exterior walls.

3.1.23 STEEL LADDERS

- a. **General:** Fabricate ladders for locations shown, with dimensions, spacings, details, and anchorages as indicated.
 - i) Comply with ANSI A14.3, unless otherwise indicated on Drawings.
- b. **Side rails:** Continuous, 500 x 10 mm (20" x ½") steel flat bars, with eased edges, spaced 460 mm (19") apart.
- c. **Bar Rungs:** 20-mm (¾") - diameter steel bars, spaced 300 mm (12") o.c. maximum.
- d. Fit rungs in centerline of side rails; plug-weld and grind smooth on outer rail faces.
- e. Support each ladder at top and bottom and not more than 1500 mm (5'-0") o.c. with welded or bolted steel brackets.
 - i) Size brackets to support design dead and live loads indicated and to hold centerline of ladder rungs clear of the wall surface by not less than 150 mm (6").
 - ii) Extend side rails using 30-mm (1.25) diameter galvanized steel pipes to a height of 0.90 m above top rung, and return rails to wall or structure unless other secure handholds are provided. If the adjacent structure does not extend above the top rung, goose-neck the extended rails back to the structure to provide secure ladder access

- f. Provide non-slip surfaces on top of each rung, either by coating rung with aluminum-oxide granules set in epoxy-resin adhesive or by using a type of manufactured rung filled with aluminum-oxide grout.
- g. Galvanize ladders, including brackets and fasteners.
- h. Finish is to be field-applied alkyd paint system of color and gloss as selected by the Engineer.

3.1.24 METAL FLOOR PLATE

- a. Fabricate raised-pattern floor plates from rolled-steel floor plate of thickness indicated below:
 - i) Thickness: As indicated.
 - ii) Pattern: As selected from manufacturer's standard patterns.
- b. Fabricate raised-pattern floor plates from rolled-aluminum-alloy tread plate of thickness indicated below:
 - i) Thickness: 6.00 mm (1/8"), unless otherwise higher thickness is indicated.
- c. Include steel angle stiffeners, and fixed and removable sections as indicated.
 - i) Provide flush steel bar drop handles for lifting removable sections, one at each end of each section.

3.1.25 CAST NOSINGS, TREADS AND THRESHOLDS

- a. Fabricate units of material, sizes, and configurations indicated. If not indicated, provide cast-iron units with an integral abrasive finish. Furnish in lengths as required to accurately fit each opening or conditions.
 - i) Cast units with an integral abrasive grit consisting of aluminum oxide, silicon carbide, or a combination of both.
- b. Drill for mechanical anchors with countersunk holes located not more than 100 mm from ends and not more than 300 mm (12") o.c., evenly spaced between ends, unless otherwise indicated. Provide closer spacing if recommended by the manufacturer.
 - i) Provide 2 rows of holes for units over 125 mm (5") wide, with 2 holes aligned at ends and intermediate holes staggered.
- c. Apply black asphaltic coating to concealed bottoms, sides, and edges of cast-iron units set into concrete.
- d. Provide a plain surface texture, except where fluted or cross-hatched surfaces are indicated.

3.1.26 PIPE BOLLARDS

- a. Fabricate pipe bollards from Schedule 40 steel pipe.
 - i) Cap bollards with 6-mm (1/8") - minimum steel plate.
- b. Fabricate bollards with 10-mm (1/2") - thick steel base plates for bolting to concrete slab. Drill base plates at all four corners for 19-mm (3/4") anchor bolts.

- i) Where bollards are to be anchored to sloping concrete slabs, angle base plates for plumb alignment of bollards.
- c. Finish is to be factory-applied manufacturer's standard thermo setting coating including rust inhibition coat and of minimum dry film thickness of 60 microns.

3.1.27 COLUMN PROTECTION GUARDS

- a. **Metal Protection:** Formed steel plates with welded lugs for building into concrete filling. Galvanize protection after fabrication to be not less than 300 gm/m² (28 gm/sft zinc coating intensity).
- b. **Pads:** Prefabricated from ASTM D2000, extruded synthetic rubber with type A shore durometer Hardness of 75, plus or minus 5 when tested according to ASTM D2240. Furnish in thickness as recommended by manufacturer for traffic type, but not less than thickness indicated on Drawings.
- c. **Filling Concrete:** As specified in this Section.
- d. **Finish:** Is to be field-applied epoxy paint system to exposed surfaces of steel and concrete as specified in 9.0 Section "Painting".

3.1.28 FINISHES, GENERAL

- a. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- b. Finish metal fabrications after assembly.

3.1.29 STEEL AND IRON FINISHES

- a. **Galvanizing:** For those items indicated for galvanizing, apply zinc coating by the hot-dip process complying with the following requirements:
 - i) ASTM A 153 for galvanizing iron and steel hardware.
 - ii) ASTM A 123 for galvanizing both fabricated and un-fabricated iron and steel products made of uncoated rolled, pressed, and forged shapes, plates, bars, and strip 0.76 mm thick or thicker.
- b. **Preparation for Shop Priming:** Prepare uncoated ferrous-metal surfaces to comply with minimum requirements indicated below for SSPC surface-preparation specifications and environmental exposure conditions of installed metal fabrications:
 - i) Exteriors (SSPC Zone 1B): SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
 - ii) Interiors (SSPC Zone 1A): SSPC-SP 3, "Power Tool Cleaning."
- c. Apply shop primer to uncoated surfaces of metal fabrications, except those with galvanized finishes and those to be embedded in concrete, sprayed-on fireproofing, or masonry, unless otherwise indicated. Comply with SSPC-PA 1, "Paint Application Specification No. 1," for shop painting.
 - i) Stripe paint corners, crevices, bolts, welds, and sharp edges.

3.1.30 STAINLESS-STEEL FINISHES

- a. Remove tool and die marks and stretch lines or blend into finish.
- b. Grind and polish surfaces to produce uniform, directionally textured, polished finish indicated, free of cross scratches. Run grain with long dimension of each piece.
- c. Bright, Directional Polish: No. 4 finish.
- d. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

3.1.31 ALUMINUM FINISHES

- a. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
- b. As-Fabricated Finish: AA-M10 (Mechanical Finish: as fabricated, unspecified).
- c. Class I, Clear Anodic Finish: AA-M12C22A41 (Mechanical Finish: no specular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, clear coating but with no less 0.025 mm or thicker) complying with AAMA 611.
- d. For powder coat finishes, AAMA 2605 is the high-performance exterior specification. Depending on the manufacturer, a 2605 powder coat may or may not utilize a fluoropolymer resin (PVDF). These finishes are resistant to moisture, weathering, ozone and UV radiation. An application for this finish would include architectural projects that require long term cosmetic and functional protection.

PART3 - EXECUTION

3.1.32 PREPERATION

- A. Coordinate and furnish anchorages, setting drawings, diagrams, templates, instructions, and directions for installing anchorages, including concrete inserts, sleeves, anchor bolts, and miscellaneous items having integral anchors that are to be embedded in concrete or masonry construction. Coordinate delivery of such items to Project site.
- B. Center nosings on tread widths with noses flush with riser faces and tread surfaces.
- C. Set sleeves in concrete with tops flush with finish surface elevations. Protect sleeves from water and concrete entry.

3.1.33 INSTALLATION, GENERAL

- A. **Fastening to In-Place Construction:** Provide anchorage devices and fasteners where necessary for securing metal fabrications to in-place construction. Include threaded fasteners for concrete and masonry inserts, toggle bolts, through-bolts, lag bolts, wood screws, and other connectors.
- B. **Cutting, Fitting, and Placement:** Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.

- C. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.
- D. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.
- E. **Field Welding:** Comply with the following requirements:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.
- F. **Corrosion Protection:** Coat concealed surfaces of aluminum that will come into contact with grout, concrete, masonry, wood, or dissimilar metals with a heavy coat of bituminous paint.

3.1.34 SETTING, BEARING AND LEVELING PLATES

- A. Clean concrete and masonry bearing surfaces of bond-reducing materials, and roughen to improve bond to surfaces. Clean bottom surface of plates.
- B. Set bearing and leveling plates on wedges, shims, or leveling nuts. After bearing members have been positioned and plumbed, tighten anchor bolts. Do not remove wedges or shims but, if protruding, cut off flush with edge of bearing plate before packing with grout.
 - 1. Use non-shrink grout, either metallic or nonmetallic, in concealed locations where not exposed to moisture; use non-shrink, nonmetallic grout in exposed locations, unless otherwise indicated.
 - 2. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

3.1.35 INSTALLING NOSING, TREADS AND THRESHOLDS

- A. Install with anchorage system indicated to comply with manufacturer's written instructions.
- B. Center nosings on tread widths.
- C. For nosings embedded in concrete steps or curbs, align nosings flush with riser faces and level with tread surfaces.
- D. Seal thresholds exposed to exterior with elastomeric sealant complying with 7.0 Section "Joint Sealants" to provide a watertight installation.

3.1.36 INSTALLING PIPE BOLLARDS

- A. Anchor bollards in place with concrete footings. Support and brace bollards in position in footing excavations until concrete has been placed and cured.
- B. Fill bollards solidly with concrete, mounding top surface.

3.1.37 **ADJUSTING AND CLEANING**

- A. **Touchup Painting:** Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
 - 1. Apply by brush or spray to provide a minimum 0.05-mm (1/32") dry film thickness.
- B. **Touchup Painting:** Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in 9.0 Section "Painting."
- C. **Galvanized Surfaces:** Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.

3.2- **ORNAMENTAL HANDRAILS AND RAILINGS**

3.2.1 **GENERAL**

3.2.2 **RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions.

3.2.3 **SUMMARY**

- A. This Section includes the following:
 - i) Stainless steel ornamental handrails and railings.
- B. Related Sections include the following:
 - i) 5.0 Section "Pipe and Tube Railings" for handrails and railings fabricated from pipe and tube components.
 - ii) 5.0 Section "Custom Steel Door".

3.2.4 **PERFORMANCE REQUIREMENTS**

- A. **General:** In engineering handrails and railings to withstand structural loads indicated, determine allowable design working stresses of materials based on the following:
 - i) Stainless Steel: ASCE 8, "Specification for the Design of Cold-Formed Stainless Steel Structural Members."
- B. **Structural Performance of Handrails and Railings:** Provide handrails and railings capable of withstanding structural loads required by ASCE 7 without exceeding allowable design working stress of materials for handrails, railings, anchors, and connections.
- C. **Structural Performance of Handrails and Railings:** Provide handrails and railings capable of withstanding the following structural loads without exceeding allowable design working stress of materials for handrails, railings, anchors, and connections:

1. Handrails Not Serving As Top Rails: Capable of withstanding the following loads applied as indicated:
 - a. Concentrated load of 890 N applied at any point and in any direction.
 - b. Uniform load of 730 N/m applied in any direction.
 - c. Concentrated and uniform loads above need not be assumed to act concurrently.
 2. Infill Area of Guards: Capable of withstanding a horizontal concentrated load of 82.71 N applied to 0.96 Sft. m at any point in system, including panels, intermediate rails, balusters, or other elements composing infill area.
 - a. Load above need not be assumed to act concurrently with loads on top rails in determining stress on guard.
 3. Demonstrate capability of proposed handrail systems by:
 - a. Submission of structural calculations.
 - b. Submission of laboratory test report conducted on the proposed product during the last three years.
- D. Thermal Movements:** Provide handrails and railings that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
1. Temperature Change (Range): 35 deg. C, ambient; 65 deg. C, material surfaces.
- E. Control of Corrosion:** Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.

3.2.5 SUBMITTALS

- A. Product Data:** For manufacturer's product lines of handrails and railings assembled from standard components.
1. Include Product Data for grout, anchoring cement, and paint products.
- B. Shop Drawings:** Show fabrication and installation of handrails and railings. Include plans, elevations, sections, details, and attachments to other Work.
1. For installed handrails and railings indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
- C. Samples for Initial Selection:** Short sections of railing or flat sheet metal Samples showing available mechanical finishes.
- D. Samples for Verification:** For each type of exposed finish required, prepared on components indicated below and of same thickness and metal indicated for the Work. If finishes involve normal color and texture variations, include sample sets showing the full range of variations expected.

1. 150 mm (6") long sections of each different linear railing member, including handrails, top rails, posts, and balusters.
 2. Fittings and brackets.
 3. Welded connections.
 4. Assembled Samples of railings, made from full-size components, including top rail, post, handrail, and infill. Show method of finishing members at intersections. Samples need not be full height.
- E. Samples of exposed fasteners, where exposed fasteners are indicated.
- F. **Qualification Data:** For firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects/engineers and owners, and other information specified.
- G. **Product Test Reports:** Indicating products comply with requirements, based on comprehensive testing of current products.

3.2.6 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.
- B. **Structural/Consulting Engineer Qualifications:** A structural consulting engineer who is legally qualified to practice, and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of handrails and railings that are similar to those indicated for this Project in material, design, and extent.
- C. **Testing Agency Qualifications:** To qualify for acceptance, an independent testing agency shall demonstrate to the Engineer's satisfaction, based on evaluation of agency-submitted criteria conforming to ASTM E 699, that it has the experience and capability to satisfactorily conduct the testing indicated.
- D. **Source Limitations:** Obtain each type of railing through one source from a single manufacturer.
- E. **Mockups:** Before installing handrails and railings, build mockups 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 the completed Work:
1. Build mockups in the location as directed by the Engineer.
 2. Build mockups for each form and finish of railing consisting of three posts, top rail, infill area, and anchorage system components that are full height and are not less than 600 mm (24") in length.
 3. Demonstrate the proposed range of aesthetic effects and workmanship.
 4. Notify the Engineer seven days in advance of dates and times when mockups will be constructed.

5. Obtain the Engineer's approval of mockups before fabricating ornamental handrails and railings.
6. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
7. Demolish and remove mockups when directed.
8. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

3.2.7 STORAGE

- A. Store handrails and railings in a dry, well-ventilated, weathertight place.

3.2.8 PROJECT CONDITIONS

- A. **Field Measurements:** Verify handrail and railing dimensions by field measurements before fabrication and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

3.2.9 COORDINATION

- A. Coordinate installation of anchorages for handrails and railings. Furnish Setting Drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

3.2.10 SCHEDULING

- A. Schedule installation so that handrails and railings are mounted only on completed walls. Do not support temporarily by any means that do not satisfy structural performance requirements.

PRODUCTS

3.2.11 METALS

- A. **General:** Provide metal free from pitting, seam marks, roller marks, stains, discolorations, and other imperfections where exposed to view on finished units.
- B. **Stainless Steel:** Grade or type designated below for each form required.
 1. Tubing: ASTM A 554, Grade MT 304.
 2. Pipe: ASTM A 312/A 312M, Grade TP 304.
 3. Castings: ASTM A 743/A 743M, Grade CF 8 or CF 20.
 4. Plate: ASTM A 666, Type 304.
- C. **Brackets, Flanges, and Anchors:** Cast or formed metal of same type of material and finish as supported rails, unless otherwise indicated.
 1. Provide formed steel brackets with predrilled hole for bolted anchorage and with Snap-on cover that matches rail finish and conceals bracket base and bolt head.

3.2.12 MISCELLANEOUS MATERIALS

- A. **Filler Metal and Electrodes:** Provide type and alloy of filler metal and electrodes as recommended by producer of metal to be welded or brazed and as required for color match, strength, corrosion resistance, and compatibility in fabricated items.

3.2.13 FASTNERS

- A. **Fasteners for Anchoring Handrails and Railings to Other Construction:** Select fasteners of type, grade, and class required to produce connections suitable for anchoring handrails and railings to other types of construction indicated and capable of withstanding design loads.
 - 1. For stainless-steel handrails and railings, use fasteners fabricated from Type 304 stainless steel.
- B. **Fasteners for Interconnecting Handrail and Railing Components:** Use fasteners fabricated from same basic metal as fastened metal, unless otherwise indicated. Do not use metals that are corrosive or incompatible with materials joined.
 - 1. Provide concealed fasteners for interconnecting railing components and for attaching them to other Work, unless exposed fasteners are unavoidable or are standard fastening method for handrail and railing indicated.
- C. **Cast-in-Place and Post installed Anchors:** Anchors of type indicated below, fabricated from corrosion-resistant materials with capability to sustain, without failure, a load equal to six times the load imposed when installed in unit masonry and equal to four times the load imposed when installed in concrete, as determined by testing per ASTM E 488 conducted by a qualified independent testing agency.
 - 1. Chemical anchors.
 - 2. Expansion anchors.

3.2.14 PAINT

- A. **Bituminous Paint:** Cold-applied asphalt mastic complying with SSPC-Paint 12 but containing no asbestos fibers, or cold-applied asphalt emulsion complying with ASTM D 1187.

3.2.15 GROUT AND ANCHORING CEMENT

- A. **Non-shrink, Nonmetallic Grout:** Premixed, factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107. Provide grout specifically recommended by manufacturer for interior and exterior applications.

3.2.16 FABRICATION

- A. **General:** Fabricate handrails and railing systems to comply with requirements indicated for design, dimensions, details, finish, and member sizes, including wall thickness of hollow members, post spacings, and anchorage, but not less than that required to support structural loads.
- B. Assemble handrails and railings in shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for

- reassembly and coordinated installation. Use connections that maintain structural value of joined pieces.
- C. Form changes in direction of railing members as follows:
 - 1. By bending.
 - 2. By flush radius bends.
 - 3. By radius bends of radius indicated.
 - 4. By mitering at elbow bends.
 - 5. By inserting prefabricated flush elbow fittings.
 - 6. By any method indicated above, applicable to change in direction involved.
 - D. Form simple and compound curves by bending members in jigs to produce uniform curvature for each repetitive configuration required; maintain profile of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of handrail and railing components.
 - E. **Welded Connections:** Fabricate handrails and railings for connecting members by welding. Cope components at perpendicular and skew connections to provide close fit, or use fittings designed for this purpose. Weld connections continuously to comply with the following:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove flux immediately.
 - 4. At exposed connections, finish exposed surfaces smooth and blended so that no roughness shows after finishing and welded surface matches contours of adjoining surfaces.
 - F. **Mechanical Connections:** Fabricate handrails and railings by connecting members with railing manufacturer's standard concealed mechanical fasteners and fittings, unless otherwise indicated. Fabricate members and fittings to produce flush, smooth, rigid, hairline joints.
 - 1. Fabricate splice joints for field connection using epoxy structural adhesive where this is manufacturer's standard splicing method.
 - G. **Brackets, Flanges, Fittings, and Anchors:** Provide manufacturer's standard wall brackets, flanges, miscellaneous fittings, and anchors to connect handrail and railing members to other construction.
 - H. Provide inserts and other anchorage devices to connect handrails and railings to concrete or masonry. Fabricate anchorage devices capable of withstanding loads imposed by handrails and railings. Coordinate anchorage devices with supporting structure.
 - I. For railing posts set in concrete, provide preset sleeves of steel not less than 150 mm (6") long with inside dimensions not less than 13 mm (½") larger than outside dimensions of post, and steel plate forming bottom closure.
 - 1. Provide chain with eye, snap hook, and staple across gaps formed by removable railing sections at locations indicated. Fabricate from same metal as railings.
 - J. Shear and punch metals cleanly and accurately. Remove burrs from exposed cut edges.
 - K. Ease exposed edges to a radius of approximately 1 mm (1/32"), unless otherwise indicated. Form bent-metal corners to smallest radius

possible without causing grain separation or otherwise impairing the Work.

- L. Cut, reinforce, drill, and tap components, as indicated, to receive finish hardware, screws, and similar items.
- M. Close exposed ends of railing members with prefabricated end fittings.
- N. **Toe Boards:** Where indicated, provide toe boards at railings around openings and at edge of open-sided floors and platforms. Fabricate to dimensions and details indicated.
- O. **Fillers:** Provide fillers made from steel plate, or other suitably crush-resistant material, where needed to transfer wall bracket loads through wall finishes to structural supports. Size fillers to suit wall finish thicknesses and to produce adequate bearing area to prevent bracket rotation and overstressing of substrate.
- P. Provide sleeves, inserts, and other anchorage devices to connect handrails and railing systems to concrete, masonry, embedded steel plates, and structural steel work. Fabricate anchorage devices capable of withstanding loads imposed by handrails and railing systems. Coordinate anchorage devices with supporting structure.

3.2.17 FINISHES, GENERAL

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipment.
- C. **Appearance of Finished Work:** Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

3.2.18 STAINLESS-STEEL FINISHES

- A. Remove or blend tool and die marks and stretch lines into finish.
- B. Grind and polish surfaces to produce uniform, directionally textured, polished finish indicated, free of cross scratches. Run grain with long dimension of each piece.
- C. Mirrorlike Reflective, Nondirectional Polish: No. 8 finish.
- D. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

EXECUTION

3.2.19 EXAMINATION

- A. Examine plaster and gypsum board assemblies, where reinforced to receive anchors, to verify that locations of concealed reinforcements have been clearly marked for Installer. Locate reinforcements and mark locations if not already done.
- B. Coordinate setting drawings, diagrams, templates, instructions, and directions for installing anchorages, such as sleeves, concrete inserts, anchor bolts, and miscellaneous items having integral anchors that are

to be embedded in concrete, masonry, and terrazzo construction. Coordinate delivery of such items to Project site.

3.2.20 INSTALLATION, GENERAL

- A. Fit exposed connections together to form tight, hairline joints.
- B. **Cutting, Fitting, and Placement:** Perform cutting, drilling, and fitting required for installing handrails and railings. Set handrails and railings accurately in location, alignment, and elevation, measured from established lines and levels and free from rack.
 - 1. Do not weld, cut, or abrade surfaces of railing components that have been coated or finished after fabrication and that are intended for field connection by mechanical or other means without further cutting or fitting.
 - 2. Set posts plumb within a tolerance of 2 mm (1/32") in 1 m (3'-3").
 - 3. Align rails so that variations from level for horizontal members and from parallel with rake of steps and ramps for sloping members do not exceed 5 mm (1/4") in 3 m (3'-3").
- C. Adjust handrails and railings before anchoring to ensure alignment at abutting joints. Space posts at interval indicated, but not less than that required by structural loads.
- D. **Fastening to In-Place Construction:** Use anchorage devices and fasteners where necessary for securing handrails and railings and for properly transferring loads to in-place construction.
- E. **Field Welding:**
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. At exposed connections, finish exposed welds and surfaces smooth and blended so that no roughness or discoloration shows after finishing and welded surface matches contours and finish of adjoining surfaces.
- F. **Non-welded Connections:** Use mechanical or adhesive joints for permanently connecting railing components. Use wood blocks and padding to prevent damage to railing members and fittings. Seal recessed holes of exposed locking screws using plastic cement filler colored to match finish of handrails and railings.
- G. **Welded Connections:** Use fully welded joints for permanently connecting railing components. Comply with requirements for welded connections in "Fabrication" Article whether welding is performed in shop or in field.
- H. **Expansion Joints:** Install expansion joints at locations indicated but not further apart than required to accommodate thermal movement. Provide slip-joint internal sleeve extending 50 mm beyond joint on either side; fasten internal sleeve securely to one side; locate joint within 150 mm (6") of post.

3.2.21 ANCHORING POSTS

- A. Use steel pipe sleeves preset and anchored into concrete for installing posts. After posts have been inserted into sleeves, fill annular space between post and sleeve with the following anchoring material, mixed and placed to comply with anchoring material manufacturer's written instructions.
 - 1. Non-shrink nonmetallic grout.
- B. Form or core-drill holes not less than 125 mm (5") deep and 20 mm (3/4") greater than OD of post for installing posts in concrete. Clean holes of loose material, insert posts, and fill annular space between post and concrete with the following anchoring material, mixed and placed to comply with anchoring material manufacturer's written instructions:
 - 1. Non-shrink, nonmetallic grout.
- C. Cover anchorage joint with a flange of same metal as post, attached to post as follows:
 - 1. Welded to post after placing anchoring material.
 - 2. By set screws.
 - 3. Set flange in clear silicone sealant / adhesive flow surface.
- D. Leave anchorage joint exposed, wipe off surplus anchoring material, and leave 3 mm build-up, sloped away from post.
- E. Anchor posts to metal surfaces with flanges, angle or floor type as required by conditions, connected to posts and to metal supporting members as follows:
 - 1. For stainless-steel railings, weld flanges to post and bolt to metal supporting members.
- F. Where shown on Drawings, fasten posts to face of spandrel construction as indicated and in accordance with manufacturer's instructions.

3.2.22 ANCHORING RAIL ENDS

- A. Anchor rail ends to concrete and masonry with flanges connected to rail ends and anchored with postinstalled anchors and bolts.

3.2.23 CLEANING

- A. Clean stainless steel by washing thoroughly with clean water and soap and rinsing with clean water.

3.2.24 PROTECTION

- A. Protect finishes of handrails and railings from damage during construction period with temporary protective coverings approved by railing manufacturer. Remove protective coverings at the time of Substantial Completion.
- B. Restore finishes damaged during installation and construction period so that no evidence remains of correction work. Return items that cannot be refinished in field to shop; make required alterations and refinish entire unit, or provide new units.

3.3- CUSTOM STEEL DOOR AND FRAMES - GENERAL

3.3..1 RELATED DOCUMENTS

- A. Drawing and provision of the contract, including general and supplementary Conditions.

3.3..2 SUMMARY

- A. This Section includes the following:
 - 1. Steel doors.
 - 2. Steel door frames.
 - 3. Fire-rated door and frame assemblies.
 - 4. Fire-rated window assemblies.
 - 5. Louvers in doors. Steel louvered door.
- B. Related Sections include the following:
 - 1. Section "Unit Block Masonry Assemblies" for building anchors into and grouting frames in masonry construction.
 - 2. 8.0 Section "Door Hardware" for door hardware and weather stripping.
 - 3. 8.0 Section "Glazing" for glass in doors.

3.3..3 PERFORMANCE REQUIREMENTS

- A. **Fire-Rated Door Assemblies:** Assemblies complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to the Consultant, for fire ratings indicated, based on testing according to NFPA 252.
 - 1. Test Pressure: Test at atmospheric pressure.
 - 2. Oversize Fire-Rated Door Assemblies: For units exceeding sizes of tested assemblies, provide certification by a testing agency acceptable to authorities having jurisdiction that doors comply with standard construction requirements for tested and labeled fire-rated door assemblies except for size.
 - 3. Temperature-Rise Rating: If indicated, provide doors that have a temperature-rise rating of 250 deg C maximum in 30 minutes of fire exposure.
- B. **Fire Resisting Door Components:** All components of fire resisting doors and assemblies, including but not limited to: door leaves, frames, ironmongery, hardware and glazing, shall carry identifying labels of an approved independent testing and inspection agency or laboratory, confirming their individual fire resistance rating. The rating of all door components shall be equal to the rating of the door assembly.
- C. **Fire Resisting Door Closers:** All fire resisting doors shall be fitted with door closers that automatically close and positively latch the door. In case of double-leaf doors, the closing system shall ensure that the inactive door leaf (door leaf with strike) closes first prior to active door leaf (door leaf with lock).
- D. Fire rated door assemblies that are tested and certified according to British Standard Specifications (BS) shall also be accepted.
- E. Weather Stripping: provide weather seals to all external doors.
- F. Smoke-Control Door Assemblies: Comply with NFPA 105.

3.3..4 SUBMITTALS

- A. **Product Data:** Include construction details, material descriptions, core descriptions, label compliance, sound and fire-resistance ratings, and finishes for each type of door and frame specified.
- B. **Shop Drawings:** Show fabrication and installation of doors and frames. Include details of each frame type, elevations of door design types, conditions at openings, details of construction, dimensions of profiles and hardware preparation, location and installation requirements of door and frame hardware and reinforcements, and details of joints and connections. Show anchorage and accessories.
- C. **Door Schedule:** Submit schedule of doors and frames using same reference numbers for details and openings as those on Drawings.
 - 1. Coordinate glazing frames and stops with glass and glazing requirements.
- D. **Samples for Initial Selection:** Manufacturer's color charts showing the full range of finishes or colors available for units with factory-applied color finishes.
- E. **Samples for Verification:** For each type of exposed finish required, prepared on Samples not less than 75 by 125 mm (3" x 5") and of same thickness and material indicated for the Work. If finishes involve normal color and texture variations, include sample sets showing the full range of variations expected.
- F. **Construction Samples:** Approximately 300 by 300 mm, (12" x 12") representing the required construction of doors and frames for Project.
 - 1. Doors: Show vertical-edge, top, and bottom construction; insulation; face stiffeners; and hinge and other applied hardware reinforcement. Include louver section and glazing stops if applicable.
 - 2. Frames: Show profile, welded corner joint, welded hinge reinforcement, dust-cover boxes, floor and wall anchors, stops, and silencers. Include panel and louver sections and glazing stops if applicable.
- G. **Product Certificates:** Signed by manufacturers of doors certifying that products furnished comply with or exceed the acceptance criteria of ANSI A250.4 for Level A doors.
- H. **Oversize Construction Certification:** For door assemblies required to be fire rated and exceeding limitations of labeled assemblies, submit certification of a testing agency acceptable to authorities having jurisdiction that each door and frame assembly has been constructed to comply with design, materials, and construction equivalent to requirements for labeled construction.

3.3..5 QUALITY ASSURANCE

- A. **Quality System:** Comply with ISO 9001/9002 Quality System as a minimum. Incorporate all the standard procedures supplied by the Consultant and the Employer.
- B. **Manufacturer Qualifications:** A firm experienced in manufacturing custom steel doors and frames similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.

- C. **Mockups:** Before installing custom steel doors and frames, build mockups 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 the completed Work:
1. Build mockups in the location indicated or, if not indicated, as directed by Consultant.
 2. Build mockups for each custom steel doors and frames, and anchorage system components.
 3. Notify Consultant seven days in advance of dates and times when mockups will be constructed.
 4. Obtain Consultant's approval of mockups before fabricating custom steel doors and frames.
 5. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
 6. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

3.3..6 **WARRANTY**

- A. **Door Manufacturer's Warranty:** Provide written Warranty, signed by manufacturer, Installer, and Contractor, agreeing to repair or replace defective doors that do not fulfill quality and performance requirements or do not comply with tolerances in referenced quality standard such as, but not limited to:
1. Structural failures.
 2. Faulty operation of movable parts and hardware.
 3. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
- B. Warranty shall also include installation and finishing that may be required due to repair or replacement of defective doors.
1. Warranty Period: Three years from date of Substantial Completion.

3.3..7 **DELIVERY, STORAGE AND HANDLING**

- A. Deliver doors and frames palletted, wrapped, or crated to provide protection during transit and Project site storage. Do not use nonvented plastic.
- B. Inspect doors and frames, on delivery, for damage. Minor damage may be repaired provided refinished items match new work and are approved by Consultant; otherwise, remove and replace damaged items as directed.
- C. Store doors and frames under cover at building site. Place units on minimum 100-mm- high wood blocking. Avoid using nonvented plastic or canvas shelters that could create a humidity chamber. If wrappers on doors become wet, remove cartons immediately. Provide minimum 6-mm spaces between stacked doors to permit air circulation.

PRODUCTS

3.3..8 MATERIALS

- A. **Metallic-Coated Steel Sheets:** ASTM A 653/A 653M, CS (commercial steel), Type B; with Z180 zinc (galvanized) or ZF180 zinc-iron-alloy (galvannealed) coating.
- B. **Inserts, Bolts, and Fasteners:** Manufacturer's standard units. Where items are to be built into exterior walls, zinc coat according to ASTM A 153/A 153M, Class C or D as applicable.

3.3..9 DOORS

- A. **General:** Provide flush-design doors, minimum 44 mm thick, (1¾") of seamless construction, unless otherwise indicated. Construct doors with smooth, flush surfaces without visible joints or seams on exposed faces or stile edges.
 - 1. Visible joints or seams around glazed or louvered panel inserts are permitted.
 - 2. For single-acting swing doors, bevel both vertical edges 3 mm (2/16") in 50 mm (2").
 - 3. For double-acting swing doors, round vertical edges with 54-mm (2¼") radius.
- B. **Metallic Core Construction:** Provide the following core construction welded to both door faces:
 - 1. Steel-Stiffened Core: Galvanized steel vertical stiffeners extending full-door height, spaced not more than 150 mm apart and spot welded to face sheets a maximum of 150 mm (16") o.c. Fill spaces between stiffeners with rockwool insulation of minimum 96.00 kg/cu. m (2.72 kg/cft) density applied to inside surfaces of face sheets.
 - 2. Use for all doors internal and external.
 - 3. Thickness of vertical stiffeners shall be equal to or more than thickness of door skins
- C. **Fire Door Cores:** As required to provide fire-protection and temperature-rise ratings indicated.
- D. **Astragals:** As required by NFPA 80 to provide fire ratings indicated. Comply with requirements specified in 8.0 section "Hardware"
- E. **Top and Bottom Channels:** Spot weld metal channel not less than thickness of face sheet to face sheets not more than 150 mm o.c.(6")
 - 1. Reinforce tops and bottoms of doors with inverted horizontal channels of same material as face sheet so flanges of channels are even with bottom and top edges of face sheets.
 - 2. For exterior doors, close bottom edge with metallic-coated steel closing channel and top edge with filler channel of same material, so webs of channels are flush with bottom and top door edges.
- F. **Hardware Reinforcement:** Fabricate reinforcing plates from the same material as door to comply with the following:

1. Hinges and Pivots: 4.2 mm (1/8") thick by 38 mm (1.5") wide by 150 mm (6") longer than hinge, secured by not less than 6 spot welds.
 2. Lock Face, Flush Bolts, Closers, and Concealed Holders: 2.3 mm (1/16") thick.
 3. All Other Surface-Mounted Hardware: 1.3 mm (1/16") thick.
- G. **Interior Doors:** Fabricate face sheets of doors from two 1.30-mm- (2/32") thick metallic-coated, cold-rolled, stretcher-leveled steel sheets and other metal components from hot- or cold-rolled steel sheets.
- H. Thickness of face sheets for fire rated interior doors shall be as recommended by manufacturer to obtain fire rating indicated, but not less than 1.30 mm (2/32").
- I. Thickness of face sheets for interior steel doors to receive armor plates shall be 1.60 mm.
- J. **Exterior Steel Doors:** Fabricate face sheets of doors from two 1.6-mm- (3/32") thick, stretcher-leveled, metallic-coated steel sheets. Provide weep-hole openings in bottom of doors to permit entrapped moisture to escape. Seal joints in top edges of doors against water penetration.

3.3..10 FRAMES

- A. Fabricate frames of full-welded unit construction, with corners mitered, reinforced, and continuously welded full depth and width of frame. Knockdown frames are not acceptable.
1. For exterior use, form frames from 2.00-mm- (4'-0") thick, metallic-coated cold-rolled steel sheets.
 2. For interior use, form frames from metallic-coated cold-rolled steel sheet of the following thicknesses:
 - a) Openings up to and including 1200 mm (48") Wide: 1.60 mm (3/32").
 - b) Openings More Than 1200 mm (48") Wide: 1.7 mm (3/32").
- B. **Hardware Reinforcement:** Fabricate from same material as frame. Minimum thickness of steel reinforcing plates for the following hardware:
1. Hinges and Pivots: 4.2 mm (1/8") thick by 38 mm (1.5") wide by 150 mm (6") longer than hinge, secured by not less than 6 spot welds.
 2. Strikes, Flush Bolts, and Closers: 2.3 mm (2/8").
 3. Surface-Mounted Hold-Open Arms and Panic Devices: 2.3 mm (2/8").
- C. **Mullions and Transom Bars:** Provide closed or tubular mullions and transom bars where indicated. Fasten mullions and transom bars at crossings and to jambs by butt welding. Reinforce joints between frame members with concealed clip angles or sleeves of same metal and thickness as frame.
1. Provide false head member to receive lower ceiling where frames extend to finish ceilings of different heights.
- D. **Head Reinforcement:** Where installed in masonry, leave vertical mullions in frames open at top for grouting.

- E. **Jamb Anchors:** Weld jamb anchors to frames near hinges and directly opposite on strike jamb as required to secure frames to adjacent construction.
 - 1. In-Place Concrete or Masonry: Anchor frame jambs with minimum 9-mm- (6/16") diameter concealed bolts into expansion shields or inserts 150 mm from top and bottom and 650 mm (26") o.c., unless otherwise indicated. Reinforce frames at anchor locations. Except for fire-rated openings, apply removable stop to cover anchor bolts, unless otherwise indicated.
- F. **Floor Anchors:** Provide floor anchors for each jamb and mullion that extends to floor, formed of same material as frame, 1.7 mm (3/32") thick, as follows:
 - 1. Monolithic Concrete Slabs: Clip-type anchors, with two holes to receive fasteners, welded to bottom of jambs and mullions.
 - 2. Cement-Based Screeds: Adjustable type with extension clips, allowing not less than 50-mm height adjustment. Terminate bottom of frames at finish floor surface.
- G. **Head Anchors:** Provide 2 head anchors for frames more than 1066 mm (43") wide and mounted in steel-stud walls.
- H. **Head Strut Supports:** Provide 9-by-50-mm (6/16" x 12") vertical steel struts extending from top of frame at each jamb to supporting construction above, unless frame is anchored to masonry or to other structural support at each jamb. Bend top of struts to provide flush contact for securing to supporting construction above. Provide adjustable wedged or bolted anchorage to frame jamb members.
- I. **Structural Reinforcing Members:** Provide as part of frame assembly, where indicated at mullions, transoms, or other locations to be built into frame.
- J. **Head Reinforcement:** For frames more than 1200 mm (48") wide in masonry wall openings, provide continuous steel channel or angle stiffener, 2.3 mm (2/8") thick for full width of opening, welded to back of frame at head.
- K. **Spreader Bars:** Provide removable spreader bar across bottom of frames, tack welded to jambs and mullions.
- L. **Rubber Door Silencers:** Except on weather-stripped doors, drill stop in strike jamb to receive three silencers on single-door frames and drill head jamb stop to receive two silencers on double-door frames. Install plastic plugs to keep holes clear during construction. Silencers shall be neoprene, UL-rated for fire doors.
- M. **Plaster Guards:** Provide 0.4-mm- thick plaster guards or dust-cover boxes of same material as frame, welded to frame at back of hardware cutouts to close off interior of openings and prevent mortar or other materials from obstructing hardware operation.
- N. External frames shall have continuous grooves along perimeter to house weather stripping.

3.3..11 LOUVERS

- A. **Door Louvers:** Fabricate louvers and mount flush into doors without overlapping moldings on surface of door face sheets. Provide internal support as recommended by louver manufacturer. Prime paint steel louvers after fabrication.

1. Interior Louvers: Sightproof, stationary type, constructed of inverted Y-shaped blades formed of same material as door.
 - a) Steel: 1.00 mm (2/32") thick.
- B. **Fire-Rated Automatic Louvers:** Sight proof louver inserts fabricated from 1.3-mm- thick (2/32") steel, spring operated, and released by 57 deg C fusible links listed and labeled for use in fire-rated door assemblies of type and fire-resistance rating indicated by the same testing and inspecting agency that established fire-resistance rating of door assembly.

3.3..12 STOPS AND MOLDINGS

- A. Provide stops and moldings around solid, glazed, and louvered panels where indicated.
- B. Form fixed stops and moldings integral with frame, unless otherwise indicated.
- C. Provide removable stops and moldings where indicated or required, formed of 0.8-mm- thick steel sheets matching steel frames. Secure with countersunk flat or oval head machine screws spaced uniformly not more than 300 mm (12") o.c. Form corners with butted hairline joints.
- D. Coordinate rabbet width between fixed and removable stops with type of glass or panel and type of installation indicated.

3.3..13 FABRICATION

- A. Fabricate doors and frames rigid, neat in appearance, and free of defects, warp, or buckle. Accurately form metal to required sizes and profiles. Weld exposed joints continuously; grind, fill, dress, and make smooth, flush, and invisible. Where practical, fit and assemble units in manufacturer's plant. Clearly identify work that cannot be permanently factory assembled before shipment, to assure proper assembly at Project site.
 1. Fabricate doors to comply with acceptance criteria of ANSI A250.4 for a Level A door.
- B. For doors with metallic core construction, weld cores to both door face sheets.
- C. For doors with nonmetallic core construction, laminate core material to both door face sheets with waterproof adhesive.
- D. **Exposed Fasteners:** Provide countersunk flat or oval heads for exposed screws and bolts, unless otherwise indicated.
- E. **Thermal-Rated (Insulating) Assemblies:** At exterior locations and elsewhere as shown or scheduled, provide doors and frames fabricated as thermal-insulating assemblies and tested according to ASTM C 236 or ASTM C 976.
 1. Provide thermal-rated assemblies with U-factor matching that of the assembly involving door.
- F. **Hardware Preparation:** Prepare doors and frames to receive hardware, including cutouts, reinforcement, mortising, drilling, and tapping, according to final hardware schedule and templates provided by hardware supplier. Comply with applicable requirements of ANSI A115 Series specifications for door and frame preparation for hardware.

1. Reinforce doors and frames to receive surface-applied hardware. Drilling and tapping for surface-applied hardware may be done at Project site.
 2. Locate hardware as indicated or, if not indicated, according to HMMA 831, "Recommended Hardware Locations for Custom Hollow Metal Doors and Frames."
- G. **Electrical Closets Doors:** Are to comply with the following requirements:
1. Doors are to be proprietary, labeled as one (1) hour fire resistance rated and complying with requirements specified in this Section.
 2. Frames are to be integral with sill to be anchored to underlying sill construction.

3.3..14 **STEEL LOUVERED DOOR**

- A. General: Are to heavy-duty construction, stile-and-rail door leaves with prefabricated framed steel louver panels mechanically fixed flush with stiles and rail of the door leaves.
1. Stiles and rails are to of tubular construction with sound deadening core material. Stiles and top rail are to be 75 mm (3") wide, bottom rail 250 mm (10") high, unless otherwise indicated on Drawings.
 2. Stiles and rails are to be from galvanized sheet steel as specified, 1.30 mm (2/32") thick minimum. Reinforcement for hinge installation is to be minimum 4.00 (3/16") thick galvanized steel plates. Drilling and tapping for surface applied ironmongery may be done on Project Site.
 3. Louver panels are to be pre-fabricated panels from galvanized steel sheets as specified in this Section comprising tubular frame and fixed Z-shaped, blades, 1.60 mm (3/32") thick minimum, in welded construction. Free area shall not be less than 43%.
 4. Furnish doors with louver panels pre-assembled and finished with factory applied baked enamel system including corrosion inhibiting protective coating and baked-on polyester topcoat of minimum dry film thickness of 60 microns. Color is to be selected by the Consultant.
 5. Louver panel fasteners are to be galvanized steel of matching finish.

3.3..15 **FINISHES, GENERAL**

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for cleaning, treating, priming, and when specified, finishing.
- B. Finish products specified in this Section after fabrication.

3.3..16 **METALLIC COATED STEEL FINISHES**

- A. **Surface Preparation:** Clean surfaces with non-petroleum solvent so surfaces are free of oil and other contaminants. After cleaning, apply a conversion coating suited to the organic coating to be applied over it. Clean welds, mechanical connections, and abraded areas, and apply galvanizing repair paint specified below to comply with ASTM A 780.
1. Galvanizing Repair Paint: High-zinc-dust-content paint for re-galvanizing welds in steel, complying with SSPC-Paint 20.

- B. **Factory-Applied Finish:** Immediately after cleaning and pre-treating, apply manufacturer's standard two-coat, air-dried-enamel, baked-enamel, or polyester finish consisting of prime coat and topcoat that complies with ANSI A250.3 acceptance criteria. Comply with paint manufacturer's instructions for applying and baking to achieve a minimum dry film thickness of 0.03 mm for topcoat.
 - 1. Color and Gloss: As selected by Consultant from manufacturer's full range.

EXECUTION

3.3..17 INSTALLATION

- A. **General:** Install doors and frames according to DHI A115.IG and manufacturer's written instructions.
- B. **Frames:** Install steel frames for doors, transoms, sidelights, borrowed lights, and other openings, of size and profile indicated.
 - 1. Where frames are fabricated in sections due to shipping or handling limitations, field splice at approved locations by welding face joint continuously; grind, fill, dress, and make splice smooth, flush, and invisible on exposed faces.
 - 2. Install frames with removable glazing stops located on secure side of opening.
 - 3. Install door silencers in frames before grouting.
 - 4. Remove temporary braces necessary for installation only after frames have been properly set and secured.
 - 5. Check plumb, squareness, and twist of frames as walls are constructed. Shim as necessary to comply with installation tolerances.
 - 6. Apply bituminous coating to backs of frames that are filled with mortar, grout, and plaster containing anti-freezing agents.
 - 7. Set masonry anchorage devices where required for securing frames to in-place concrete or masonry construction.
 - a) Set anchorage devices opposite each anchor location according to details on Shop Drawings and anchorage device manufacturer's written instructions. Leave drilled holes rough, not reamed, and free of dust and debris.
 - 8. Floor anchors may be set with powder-actuated fasteners instead of masonry anchorage devices and machine screws, if so indicated on Shop Drawings.
 - 9. Placing Frames: Set frames accurately in position; plumb; align, and brace securely until permanent anchors are set. After wall construction is complete, remove temporary braces and spreaders, leaving surfaces smooth and undamaged.
 - a) At existing concrete or masonry construction, set frames and secure in place with machine screws and masonry anchorage devices.
 - b) At fire-rated openings, install frames according to NFPA 80.
 - c) Field splice only at approved locations. Weld, grind, and finish as required to conceal evidence of splicing on exposed faces.

- d) Remove spreader bars from each frame only after frame is properly set and secured.
- 10. Hollow core of frames shall be fully filled with cement sand grout.
- 11. Metal-Stud Partitions: Solidly pack mineral-fiber insulation behind frames.
- 12. Masonry Walls: Coordinate installation of frames to allow for solidly filling space between frames and masonry with mortar as specified in 4.0 Section "Unit Masonry Assemblies."
- 13. Concrete Walls: Solidly fill space between frames and concrete with grout. Install grout in lifts and take precautions, including bracing frames, to ensure that frames are not deformed or damaged by grout forces.
- 14. In-Place Concrete or Masonry Construction: Secure frames in place with post installed expansion anchors. Countersink anchors, and fill and make smooth, flush, and invisible on exposed faces.
- 15. In-Place Gypsum Board Partitions: Secure frames in place with post installed expansion anchors through floor anchors at each jamb. Countersink anchors, and fill and make smooth, flush, and invisible on exposed faces.
- 16. Ceiling Struts: Extend struts vertically from top of frame at each jamb to supporting construction above, unless frame is anchored to masonry or to other structural support at each jamb. Bend top of struts to provide flush contact for securing to supporting construction above. Provide adjustable wedged or bolted anchorage to frame jamb members.
- C. **Doors:** Fit non-fire-rated doors accurately in their respective frames, with the following clearances:
 - 1. Jambs and Head: 2 mm (3/32").
 - 2. Meeting Edges, Pairs of Doors: 3 mm (3/32").
 - 3. Bottom: 9 mm (6/16"), if no threshold or carpet.
 - 4. Bottom: 3 mm (3/32"), at threshold or carpet.
- D. **Fire-Rated Doors:** Install with clearances as specified in NFPA 80.
- E. **Smoke Control Doors:** Install according to NFPA 105.

3.3..18 ADJUSTING AND CLEANING

- A. **Final Adjustments:** Check and readjust operating hardware items just before final inspection. Leave work in complete and proper operating condition. Remove and replace defective work, including doors or frames that are warped, bowed, or otherwise unacceptable.
- B. **Factory-Finish Touchup:** Immediately after erection, sand to feather-edge minor scratched, chipped, or damaged areas and apply touchup of compatible air-drying paint. Minor finish imperfections may be repaired provided finish matches new work finish and is approved by Consultant; otherwise, remove and replace.

END OF SECTION

4 WOOD, PLASTIC AND COMPOSITE

4.1 - WOODEN DOORS

GENERAL SECTION

4.1.1.1 RELATED DOCUMENTS

- A. Drawing and general provisions of the contract, including general and supplementary Conditions.

4.1.1.2 SUMMARY

- A. This Section includes the following:
 - 1. Non-fire-rated flush wood doors of semi-solid core.
 - 2. Shop priming flush wood doors.
 - 3. Factory fitting flush wood doors to frames and factory machining for hardware.
 - 4. Louvers for flush wood doors.
- B. Related Sections include the following:
 - 8.0 Section "Steel Doors and Frames" for steel frames to receive flush wood doors.
 - 1. Section "Door Hardware" hardware for flush wood doors.
 - 2. 8.0 Section "Glazing" for glass view panels in flush wood doors.
 - 3. 9.0 Section "Painting".

4.1.1.3 SUBMITTALS

Product Data: For each type of door. Include details of core and edge construction, trim for openings, and louvers.

- 1. Include factory-finishing specifications.
- A. Shop Drawings: Indicate location, size, and hand of each door; elevation of each kind of door; construction details not covered in Product Data; location and extent of hardware blocking; and other pertinent data.
 - 1. Indicate dimensions and locations of mortises and holes for hardware.
 - 2. Indicate dimensions and locations of cutouts.
 - 3. Indicate doors to be factory finished and finish requirements.
- B. Samples for Initial Selection: Color charts consisting of actual materials in small sections for the following:
 - 1. Faces of factory-finished doors with opaque finish. Show the full range of colors available.
- C. Samples for Verification: As follows:
 - 1. Corner sections of doors approximately 200 by 250 mm (8" x 10") with door faces and edgings representing the typical range of color and grain for each species of veneer and solid lumber required. Finish sample with same materials proposed for factory-finished doors.
 - 2. Louver blade and frame sections, 150 mm (6") long, for each material and finish specified.
 - 3. Frames for light openings, 150 mm (6") long, for each material, type, and finish required.

4.1.1.4 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.

- A. Source Limitations: Obtain flush wood doors through one source from a single manufacturer.

4.1.1.5 DELIVERY, STORAGE, AND HANDLING

Protect doors during transit, storage, and handling to prevent damage, soiling, and deterioration. Comply with requirements of referenced standard and manufacturer's written instructions.

- 1. Individually package doors in plastic bags or cardboard cartons.
- 2. Individually package doors in cardboard cartons and wrap bundles of doors in plastic sheeting.
- A. Mark each door with individual opening numbers used on Shop Drawings. Use removable tags or concealed markings.

4.1.1.6 PROJECT CONDITIONS

Environmental Limitations: Do not deliver or install doors until building is enclosed, wet-work is complete, and HVAC system is operating and will maintain temperature and relative humidity at occupancy levels during the remainder of the construction period.

- A. Environmental Limitations: Do not deliver or install doors until conditions for temperature and relative humidity have been stabilized and will be maintained in storage and installation areas during the remainder of the construction period to comply with requirements of the referenced quality standard for Project's geographical location.

4.1.1.7 WARRANTY

Door Manufacturer's Warranty: Provide written Warranty, signed by manufacturer, Installer, and Contractor, agreeing to repair or replace defective doors that have warped (bow, cup, or twist) more than 6.5 mm (4/16") in a 1100-by-2100-mm (44" x 84") section or that show telegraphing of core construction in face veneers exceeding 0.25 mm in a 75-mm (3") span, or do not comply with tolerances in referenced quality standard.

- 1. Warranty shall also include installation and finishing that may be required due to repair or replacement of defective doors.
- 2. Warranty shall be in effect during the following period of time after the date of Substantial Completion:
 - a) Semi-solid-core Interior Doors: Two years.

PRODUCTS

4.1.2.1 WOODS, GENERAL

- A. Woods shall be marked-on as Class-1 stocks which shall be properly treated, adequately seasoned and free from rot or insect attack, splits, shakes or checks, warping, twisting, chipping, loose knots and waming. Provide woods

of wane-free edges. Woods shall conform to the requirements of BS EN No. 942; plywood to BS EN No. 636.

- B. Preservative Treatment:** All woods and plywood used shall be preservative treated. Application is to be carried out after cutting and machining, but before assembly, by a 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.

C. Softwoods

1. Douglas Fir: Yellowish Brown wood of average intensity not less than 570 kg/m³ (16.5 kg/cft) at 12% moisture content.
2. Whitewood: White/pale Yellowish Brown wood of average intensity of 470 kg/m³ (13.32 kg/cft).
3. Or as directed by the Architect.

D. Hardwoods

1. White Oak Wood: Yellowish Brown, fine-grained wood of strong, compact, homogenous fibers and uniform texture. Average intensity shall not be less than 720 kg/m³ (20.40 kg/cft) at 12% moisture content. Or as directed by the Architect.

E. Plywood

1. General: Shall be highest grade to BS EN 636, designated as veneer, with minimal imperfections as peeled. Moisture content shall not exceed 12%. Thickness shall be as specified. Employ plywood glued with INT glues to BS 1203.
2. Softwood Plywood: All layers shall be of softwood.
3. Hardwood Plywood: White Oak plywood; White-Oak veneer 0.90 mm thick minimum shall be factory hot-applied at exposed face of door, cut and match of veneer shall be selected by the Consultant.

4.1.2.2 ACCESSORY MATERIALS

Preservative treatment: Type listed in BS 1282 (except coal tar creosote) obtained from approved manufacturer to provide protection against termites and other destroying organisms.

- A. Adhesives:** Close contact type to BS EN 301 or BS EN 302, suitable for the purpose and compatible with preservative treatment.

4.1.2.3 NON-FIRE RATED SEMI-SOLID-CORE FLUSH WOOD DOORS

General: Non-fire-rated flush wood doors shall be swinging-type side-hinged to jambs of frames with hand of doors as indicated on Drawings, fabricated to the general tolerances of BS No. 4787 and shall consist of a frame (door leaf frame) consisting of stiles and rails constructed of Douglas fir and a core constructed of a lower-density softwood (Whitewood). Core strips shall cover, at least, 67% of door leaf area (Semi-solid core).

- A. **Door Leaf Frame:** Stiles and rails shall be of dimensions as indicated on Drawings but in no case shall the width be less than 140 mm (5.50") for mortise stile or less than 100 mm for other stile and rails, before lipping. Door-leaf-frame components shall be continuously lipped at outer edges with 20 mm (3/4") thick lipping constructed of White Oak wood. Oak lipping shall be fixed to stiles and rails in continuous glued tongue-and-groove joints. Stiles, rails and lipping of door leaf frame shall be constructed in one piece, no jointing or splicing shall be permissible. Joints between stiles and rails shall be glued mortise-and-tenon.
- B. **Semi-Solid Cores:** Shall be horizontal rails of White wood, of uniform width. Ratio of solid to vacant shall be 2:1. Horizontal core rails shall be in one piece. Throughout door leaf height, at least, two horizontal core rails shall be mortise-and-tenon jointed and glued to stiles.
- C. **Facing:** Facing material shall be 6 mm (1/4") thick plywood glued with waterproof glue under pressure to both sides of core. Facing material shall extend flush and uniform, in both directions, between inner edges of lipping. Extend facing in one piece; no jointing or splicing shall be permissible. Type of facing material shall be as follows:
 - 1. Doors of Opaque Finish: Softwood plywood
- D. **Thickness of Doors:** Unless otherwise indicated on Drawings, finish thickness of flush non-fire-rated wood doors shall be 45 mm; (1 3/4") thickness of stiles, rails and core strips shall be 33 mm (1.5") and 45 mm (1 3/4") wood lipping.

4.1.2.4 LOUVERS AND LIGHT FRAMES

Metal Louvers: As follows:

- 1. Blade Type: Vision proof, inverted V.
- 2. Metal and Finish: Extruded aluminum with clear anodic finish, 25micron thick minimum.

4.1.2.5 HARDWARE

Hardware shall be as indicated in Hardware Sets and Door Schedule and as specified in 8.0, Section "Door Hardware".

4.1.2.6 FABRICATION, GENERALLY

Flush wood doors shall be fabricated in accordance with details shown on Drawings, requirements of this Section, general tolerances of BS No. 4787 and other in-contradicting requirements of BS No. 1186: Part 2.

- A. Carefully plan and layout the work to erect wood doors and to accommodate the work of other trades.
- B. Finish wood shall be smoothly dressed and sanded prior to assembly of door inner frames and shall be free from open joints, hammer and machine marks and other defects or surface blemishes.
- C. Re-treat all treated wood which is sawn along the length, ploughed, thickness, 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.
- D. Finish and cut wood at exact dimensions as required. Stile and rails shall be connected only in glued mortise-and tenon joints with horizontal core strips assembled and jointed at their locations between rails, along stiles. The resulting frame shall be robust, firm and square.

- E. Facing material shall be glued to core and frame. No nail-fixing exposed or concealed, for facing material shall be permissible. The assembly shall be glued under pressure with waterproof casein glue and be thoroughly dried and seasoned.
- F. Join lipping at outer perimeter of frame in continuous tongue-and-groove joints with glue.
- G. Factory machine doors for hardware that is not surface applied. Locate hardware as indicated on approved shop drawings. Comply with final hardware schedules, door frame shop drawings, and hardware templates.
 - 1. Coordinate measurements of hardware mortises in metal frames to verify dimensions and alignment before factory machining.
- H. Openings: Cut and trim openings through doors to comply with applicable requirements of referenced standards for kind(s) of door(s) required.
 - 1. Light Openings: Trim openings with moldings of material and profile indicated.
 - 2. Louvers: Factory install louvers in prepared openings.

4.1.2.7 SHOP PRIMING

Doors for Opaque Finish: Shop seal faces and edge of doors including cutouts with one coat of wood primer specified in 9.0 Section "Painting."

PART 2 - EXECUTION

4.1.3.1 EXAMINATION

- A. Examine installed door frames before hanging doors.
 - 1. Verify that frames comply with indicated requirements for type, size, location, and swing characteristics and have been installed with plumb jambs and level heads.
 - 2. Reject doors/ frames with defects.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

4.1.3.2 INSTALLATION

Hardware: For installation, see 8.0 Section "Door Hardware."

- A. Manufacturer's Written Instructions: Install wood doors to comply with manufacturer's written instructions, referenced quality standard, and as indicated.
- B. Job-Fit Doors: Align and fit doors in frames with uniform clearances and bevels as indicated below; do not trim stiles and rails in excess of limits set by manufacturer. Machine doors for hardware. Seal cut surfaces after fitting and machining.
 - 1. Clearances: Provide 3.2 mm (4/32") at heads, jambs, and between pairs of doors. Provide 3.2 mm (4/32") from bottom of door to top of decorative floor finish or covering. Where threshold is shown or scheduled, provide 6.4 mm (4/16") from bottom of door to top of threshold.
 - 2. Bevel non-fire-rated doors 3-1/2 degrees at lock and hinge edges.
- C. Field-Finished Doors: Refer to the following for finishing requirements:
 - 1. 9.0 Section "Painting."

4.1.3.3 **ADJUSTING AND PROTECTING**

Operation: Re-hang or replace doors that do not swing or operate freely.

- A. Protect doors as recommended by door manufacturer to ensure that wood doors are without damage or deterioration at the time of Substantial Completion by the Employer.

4.2- ACCESS DOORS AND FRAMES

GENERAL

4.2.1.1 RELATED DOCUMENTS

- A. Drawing and general provisions of the Contracts, including general and supplementary Condition.

4.2.1.2 SUMMARY

- A. This Section includes the following:
 - 1. Wall access doors and frames.
 - 2. Recessed panels for ceramic tiles.
 - 3. Access panels for suspended gypsum board ceilings.
 - 4. Wood shaft access doors.
- B. Related Sections include the following:
 - 1. 4.0 Section "Unit Masonry Assemblies" for anchoring and grouting access door frames set in masonry construction.
 - 2. 6.0 Section "Rough Carpentry" for materials and workmanship requirements for wooden shaft access doors.
 - 3. 9.0 Section "Gypsum Board Assemblies" for access panels to be installed in suspended gypsum board ceilings.
 - 4. 9.0 Section "Ceramic Tiles" for ceramic tiles and adhesives.
 - 5. 9.0 Section "Painting".

4.2.1.3 SUBMITTALS

- A. **Product Data:** For each type of door and frame indicated. Include construction details relative to materials, individual components and profiles, finishes, and fire ratings (if required) for access doors and frames.
- B. **Shop Drawings:** Show fabrication and installation details of doors and frames. Include plans, elevations, sections, details, and attachments to other Work.
- C. **Samples:** For each door face material, at least 75 by 125 mm (3" x 5") in size, in specified finish.

4.2.1.4 QUALITY ASSURANCE

- A. **Source Limitations:** Obtain each type of doors and frames through one source from a single manufacturer.
- B. **Fire-Rated Access Doors and Frames:** Units complying with NFPA 80 that are identical to access door and frame assemblies tested for fire-test-response characteristics per the following test method and that are labeled and listed by UL, ITS, or another testing and inspecting agency acceptable to authorities having jurisdiction:
 - 1. NFPA 252 for vertical access doors.
- C. **Size Variations:** Obtain Engineer's acceptance of manufacturer's standard-size units, which may vary slightly from sizes indicated.

4.2.1.5 COORDINATION

- A. **Verification:** Determine specific locations and sizes for access doors needed to gain access to concealed equipment, and indicate on schedule specified in "Submittals" Article.

PRODUCTS

4.2.2.1 MATERIALS

- A. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.
- B. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B, with ZF180 zinc-iron-alloy (galvannealed) coating or Z180 mill-phosphatized zinc coating; stretcher-leveled standard of flatness; with minimum thickness indicated representing specified thickness according to ASTM A 924/A 924M.
- C. **Plaster Bead:** Casing bead formed from 0.75-mm (1/32") zinc-coated steel sheet with flange formed out of expanded metal lath and in size to suit thickness of plaster.

4.2.2.2 PAINT

- A. **Shop Primers:** Provide primers that comply with 9.0 Section "Painting."
- B. **Shop Primer for Metallic-Coated Steel:** Organic zinc-rich primer complying with SSPC-Paint 20 and compatible with topcoat.
- C. **Galvanizing Repair Paint:** High-zinc-dust-content paint for re-galvanizing welds in steel, complying with SSPC-Paint 20.
- D. **Epoxy paint:** Provide primers that comply with 9.0 Section "Painting."

4.2.2.3 ACCESS DOORS AND FRAMES

- A. Flush, Insulated, Fire-Rated Access Doors and Trimless Frames: Fabricated from metallic-coated steel sheet.
 - 1. Locations: wall surfaces.
 - 2. Fire-Resistance Rating: As indicated on Drawings.
 - 3. Temperature Rise Rating: 139 deg C at the end of 30 minutes.
 - 4. Door: Flush panel with a core of mineral-fiber insulation enclosed in sheet metal with a minimum thickness of 1.5 mm (2/32").
 - 5. Frame: Minimum 1.5-mm (2/32") thick sheet metal with plaster bead.
 - 6. Hinges: Concealed pin type.
 - 7. Lock: Key-operated cylinder lock, specified in 8.0 Section "Door Hardware".
- B. **Recessed Panels for Ceramic tiles:** Units consisting of frame with expansion casing bead, door, hardware and complying with the following requirements:
 - 1. Frame: Zinc-coated steel sections and shapes.
 - 2. Plaster casing Bead: 0.76 mm (1/32") zinc coated steel casing bead with flange formed out of expanded metal lath.
 - 3. Panel: 2 mm (2/32") zinc coated steel sheet.
 - 4. Finish: Ceramic wall tiles matching adjacent walls adhered with water cleanable epoxy-based adhesive.
 - 5. Hardware: Nickel-plated steel hinges, exposed type and self-latching bolt operated with knurled knob.
- C. **Heavy Duty Gypsum Board Ceiling Panels:** Heavy duty ceiling flush access panel with fully concealed steel frame and gypsum board inlay fastened to door.

1. **Material:** Removable spring-loaded door, integrated safety catches, patented concealed nylon hinge mechanism, rounded or square corners as directed, formed galvanized frames, stainless steel springs, zinc-plated fasteners, self-adhesive rubber gasket and accessories. Frame shall be two-part type fixed to opening edges and recessed door gypsum board inlay.
2. **Latch:** Tamper-resistant cam latch.

Sizes: As indicated on Drawings.

4.2.2.4 **SHAFT ACCESS DOOR**

- A. **Doors:** Solid core from approved softwood. 3 mm (2/16") thick plywood facing and hardwood lipping.
- B. **Frame:** Fabricate from preservative treated hardwood. Joints between stile and rail shall be single dove tail joints. Protect frame surfaces in contact with masonry with approved bitumen-based cold-applied protection coating.
- C. **Anchors:** Type suitable for fixing into concrete or hollow concrete masonry with metal components fabricated from corrosion-resistant material. Use minimum two anchors per each frame jamb or sill.
- D. **General:** Comply with requirements of Sections "Rough Carpentry" and "Flush Wood Doors" for preservative treatment and general workmanship requirements
- E. **Finishing:** Field-applied approved paint type of color selected by Engineer.

4.2.2.5 **FABRICATION**

- A. **General:** Provide access door assemblies manufactured as integral units ready for installation.
- B. **Metal Surfaces:** For metal surfaces exposed to view in the completed Work, provide materials with smooth, flat surfaces without blemishes. Do not use materials with exposed pitting, seam marks, roller marks, rolled trade names, or roughness.
- C. **Steel Doors and Frames:** Grind exposed welds smooth and flush with adjacent surfaces. Furnish attachment devices and fasteners of type required to secure access panels to types of supports indicated.
 1. For trimless frames with plaster bead for full-bed plaster applications, provide zinc-coated expanded metal lath and exposed casing bead welded to perimeter of frames.
- D. **Latching Mechanisms:** Furnish number required to hold doors in flush, smooth plane when closed.
 1. For cylinder lock, furnish two keys per lock and key all locks alike.
 2. For recessed panel doors, provide access sleeves for each locking device. Furnish plastic grommets and install in holes cut through finish.

4.2.2.6 **FINISHES, GENERAL**

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Finish metal fabrications after assembly.

4.2.2.7 **METALLIC-COATED STEEL FINISHES**

- A. **Galvanizing of Steel Shapes and Plates:** Hot-dip galvanize items indicated to comply with applicable standard listed below:

1. ASTM A 123/A 123M, for galvanizing steel and iron products.
 2. ASTM A 153/A 153M, for galvanizing steel and iron hardware.
- B. **Surface Preparation:** Clean surfaces with non-petroleum solvent so surfaces are free of oil and other contaminants. For galvanized surfaces, apply, after cleaning, a conversion coating suited to the organic coating to be applied over it. For metallic-coated surfaces, clean welds, mechanical connections, and abraded areas, and apply galvanizing repair paint specified below to comply with ASTM A 780.
1. **Galvanizing Repair Paint:** High-zinc-dust-content paint for re-galvanizing welds in steel, complying with SSPC-Paint 20.
- C. **Factory Priming for Field-Painted Finish:** Apply shop primer immediately after cleaning and pre-treating.

EXECUTION

4.2.3.1 PREPARATION

- A. Advise installers of other work about specific requirements relating to access door and floor door installation, including sizes of openings to receive access door and frame, as well as locations of supports, inserts, and anchoring devices.

4.2.3.2 INSTALLATION

- A. Comply with manufacturer's written instructions for installing access doors and frames.
- B. Set frames accurately in position and attach securely to supports with plane of face panels aligned with adjacent finish surfaces.
- C. Install access doors with trim less frames flush with adjacent finish surfaces or recessed to receive finish material.
- D. Installation of fire-rated access doors and panels shall maintain same applicable requirements of Standards referenced for installation of fire-rated steel frames in 8.0 Section "Custom Steel Doors and Frames".

4.2.3.3 ADJUSTING AND CLEANING

- A. Adjust doors and hardware after installation for proper operation.
- B. Remove and replace doors and frames that are warped, bowed, or otherwise damaged.

4.3- RIOUGH CARPENTRY

GENERAL - RELATED WORK

1. Architectural Wood Work
2. Gypsum Board System

4.3.1.1 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:

- a. Wood grounds, blockings, nailers.
- b. Temporary and permanent grounds, blockings and supports required by other trades.

4.3.1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions.
 1. Wood grounds, nailers, and blocking.
 2. Wood furring.
 3. Wood sub-frames.

4.3.1.3 PRESERVATIVE TREATMENT

- a. Application is to be carried out after cutting and machining, but before assembly, by processor licensed by the treatment solution manufacturer.
- b. Solution strengths and treatment by pressure, vacuum or immersion process are to be selected to achieve service life and to suit wood treatability.
- c. Moisture content of wood at time of treatment is to be as specified for use in the work.
- d. After treatment, allow wood to dry before use.
- e. For each batch of wood, provide certificate of assurance that treatment has been carried out as specified.
- f. Re-treat all treated wood which is sawn along the length, ploughed, thickened, planed or otherwise extensively processed.
- g. Treat wood surfaces exposed by minor cutting and drilling with two flood coats of solution recommended for the purpose by the treatment solution manufacturer.

4.3.1.4 SUBMITTALS

- a. Samples of all materials used in the work of this Section.
- b. Shop drawings for furring including details, sizes of wood sections, panel, spacings and method of attachment.

4.3.1.5 **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.

4.3.1.6 **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

- a. 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.
- b. Timber shall be kiln dried to a maximum moisture content of 12% by weight.
- c. Timber required to be treated with preservatives or fire retardant shall be seasoned and kiln dried before treatment, and re-dried after treatment.
- d. 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 species to be used in external locations are to be recommended for the purpose.
- e. Hardwood shall comply with BS EN 942. Hard wood to be used in internal locations are to be recommended for the purpose.
 1. Wood used for exterior applications or for interior applications in wet areas shall be factory treated to prevent moisture absorption.

SOFTWOOD

To be either:

- a. Douglas Fir (Standard Grade)
- b. European Redwood
- c. Or as suggested by the Architect.

HARDWOOD

- a. Teakwood
- b. White American Oakwood
- c. Or as suggested by the Architect.

RIGID SHEETS

4.3.2.1 MDF (Fire Resistance)

- a. Medium density fiberboard's for fabric panels, 8-10mm thick.
- b. Strips of MDF around fabric panels edging.
- c. All MDF components to be fire resistant.

4.3.2.2 PLYWOOD

- a. 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.
- b. Marine Quality Plywood: to BS 1088 and BS 4079, excluding plywood made from gaboan.

4.3.2.3 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.

4.3.2.4 FASTNERS

- a. Nails: to BS 1202, Part 1, 2 or 3 generally, but non-ferrous types to Parts 2 or 3 for external use.
- b. Wood Screws: to BS 1210 generally, but non-ferrous types for external use.
- c. Self-Tapping Screws: to BS 4174.
- d. Dowels: mild steel, 10 mm (1/2") diameter, 100 mm (4") long, galvanized to BS EN ISO 1461 after fabrication.
- e. 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.
- f. Plugs: either traditional hardwood plugs, shaped to twist and grip when driven, or proprietary fibre or plastics plugs, or other approved type.

4.3.2.5 TREATMENTS, ADHESIVE AND FINISHES

- a. 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.
- b. 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.

EXECUTION

4.3.3.1 INSTALLATION, GENERAL

- a. 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.
- b. Set rough carpentry to required levels and lines, with members plumb, true to line, cut, and fitted.

- c. 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.
- d. Apply field treatment to cut surfaces of preservative-treated lumber and plywood.
- e. Securely attach rough carpentry work to substrate by anchoring and fastening as indicated.
- f. 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.
- g. Use hot-dip galvanized nails.
- h. Countersink nail heads on exposed carpentry work and fill holes with wood filler.

4.3.3.2 **WOOD GROUNDS, NAILERS, BLOCKING AND SLEEPERS**

- a. Install wood grounds, nailers, blocking, and sleepers where shown and where required for screeding 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.
- b. 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.
- c. Install permanent grounds of dressed, preservative-treated, key-beveled 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.

4.3.3.3 **WOOD FURRING**

- a. Install plumb and level with closure strips at edges and openings. Shim with wood as required for tolerance of finish work.
- b. Firestop furred spaces of walls at each floor level and at ceiling with wood blocking or noncombustible materials, accurately fitted to close furred spaces.
- c. Furring to Receive Wood or Plastic Sheets or Boards: Install 19-by-63-mm actual-size furring at 600 mm o.c., horizontally and vertically. Select furring with no knots capable of producing bent-over nails and damage to paneling.
- d. Furring to Receive Gypsum Board: Install 19 (3/4")-by-38-mm (1½") actual-size furring at 400 mm (16") o.c., vertically.
- e. Furring to Receive Plaster Lath: Install 19 (3/4")-by-38-mm (1½") actual-size furring at 400 mm (16") o.c., vertically.

4.4- INTERIOR ARCHITECTURAL WOODWORK

GENERAL

4.4.1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions.

4.4.1.2 SUMMARY

- A. This Section includes the following:
 - 1. Pantry cupboard.
 - 2. Laboratory bench.
 - 3. Vanities constructed from solid surfacing.
 - 4. Wood base.
- B. Related Sections include the following:
 - 1. 6.0 Section "Rough Carpentry".
 - 2. 9.0 Section "Painting" for field finishing of interior architectural wood works components that need finishing.

4.4.1.3 SUBMITTALS

- A. **Product Data:** For each type of product indicated, including finishing materials and processes.
 - 1. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements.
- B. **Shop Drawings:** Show location of each item, dimensioned plans and elevations, large-scale details, attachment devices, and other components.
 - 1. Show details full size.
 - 2. Show locations and sizes of furring, blocking, and hanging strips, including concealed blocking and reinforcement specified in other Sections.
 - 3. Show locations and sizes of cutouts and holes for items installed in architectural woodwork.
- C. **Samples for Initial Selection:** Manufacturer's color charts consisting of units or sections of units showing the full range of colors, textures, and patterns available for each type of material indicated.
 - 1. Shop-applied transparent finishes.
 - 2. Solid-surfacing materials.
- D. **Samples for Verification:** For the following:
 - 1. Solid-surfacing materials, 150 mm (6") square.
 - 2. Pantry hardware.
 - 3. Plastic-laminate-clad panel products, 200 by 250 mm, (8" x 10") for each type, color, pattern, and surface finish, with separate samples of unfaced panel product used for core.
- E. **Product Certificates:** Signed by suppliers of used woods and rigid sheets certifying that products comply with requirements specified.

4.4.1.4 QUALITY ASSURANCE

- A. **Installer Qualifications:** An experienced installer who has completed architectural woodwork similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.
- B. **Fabricator Qualifications:** A firm experienced in producing architectural woodwork similar to that indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.
- C. **Source Limitations:** Engage a qualified woodworking firm to assume undivided responsibility for production and installation of interior architectural woodwork.

4.4.1.5 PROJECT CONDITIONS

- A. **Field Measurements:** Where woodwork is indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
 - 1. Locate concealed framing, blocking, and reinforcements that support woodwork by field measurements before being enclosed and indicate measurements on Shop Drawings.

4.4.1.6 COORDINATION

- A. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of Work specified in other Sections to ensure that interior architectural woodwork can be supported and installed as indicated.

PRODUCTS

4.4.2.1 WOOD

- A. 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 species to be used in external locations are to be recommended for the purpose.
- B. Hardwood shall comply with BS EN 942. Hardwood to be used in the works are to be recommended for the purpose.
- C. Wood shall be treated to prevent absorption of moisture.
- D. Plastic Laminate: to BS EN 438, color and pattern as follows:
 - 1. Color and Pattern: Shall be selected by Engineer from manufacturer's full range of colors and patterns.
 - 2. Minimum Thickness: 1.20 mm (1/16").
 - 3. Where indicated, select plastic laminate type suitable for post forming application.

4.4.2.2 RIGID SHEETS

- A. 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.

4.4.2.3 FASTENERS

- A. **Nails:** to BS 1202, Part 1, galvanized steel.
- B. **Wood Screws:** to BS 1210 generally, galvanized steel.
- C. **Self-Tapping Screws:** to BS 4174.
- D. **Dowels:** mild steel, 10 mm (1/2") diameter, 100 mm (4") long, galvanized to BS EN ISO 1461 after fabrication.
- E. **Cramps:** mild steel, 25 x 3 x 250 mm (1" x 1/32" x 10") girth, turned up at one end and twice drilled for 3 mm (1/32") screws, fish-tailed at other end for building in and galvanized to BS EN ISO 1461 after fabrication.
- F. **Plugs:** either traditional hardwood plugs, shaped to twist and grip when driven, or proprietary fiber or plastics plugs, or other approved type.

4.4.2.4 FIRE-RETARDANT-TREATED MATERIALS

- A. **General:** Where indicated, use materials impregnated with fire-retardant chemical formulations indicated by a pressure process or other means acceptable to Engineer to produce products with fire-test-response characteristics specified.
 - 1. Do not use treated material that does not comply with requirements of referenced woodworking standard or that is warped, discolored, or otherwise defective.
 - 2. Use fire-retardant-treatment formulations that do not bleed through or otherwise adversely affect finishes. Do not use colorants in solution to distinguish treated material from untreated material.
- B. **Fire-Retardant-Treated Lumber and Plywood by Pressure Process:** Comply with BS 5589. Use the following treatment type:
 - 1. Type: Organic-resin-based formulation thermally set in wood by kiln-drying.
 - 2. Mill lumber before treatment and implement special procedures during treatment and drying processes that prevent lumber from warping and developing discolorations from drying sticks or other causes, marring, and other defects affecting appearance of treated woodwork.
 - 3. Kiln-dry material before and after treatment to levels required for untreated material.
- C. All lumber, wood, fir, plywood or boards used in the works of this Section are to be preservative and fire-retardant treated.

4.4.2.5 SOLID SURFACE MATERIAL

- A. **Solid-Surfacing Material for Counter Top:** Homogeneous solid sheets of filled plastic resin complying with material and performance requirements in ANSI Z124.3, for Type 5 or Type 6, without a pre-coated finish.

4.4.2.6 INSTALLATION MATERIALS, GENERAL

- A. **Furring, Blocking, Shims, and Hanging Strips:** Softwood or hardwood lumber, kiln-dried to less than 15 percent moisture content.

4.4.2.7 FABRICATION, GENERAL

- A. **General:** Comply with requirements of BS 1186-2.
- B. **Wood Moisture Content:** Comply with requirements of referenced quality standard for wood moisture content in relation to ambient relative humidity during fabrication and in installation areas.

- C. Sand fire-retardant-treated wood lightly to remove raised grain on exposed surfaces before fabrication.
- D. Fabricate woodwork to dimensions, profiles, and details indicated.
- E. Complete fabrication, including assembly, finishing, and hardware application, to maximum extent possible, before shipment to Project site. Disassemble components only as necessary for shipment and installation. Where necessary for fitting at site, provide ample allowance for scribing, trimming, and fitting.
 - 1. Notify Engineer seven days in advance of the dates and times woodwork fabrication will be complete.
 - 2. Trial fit assemblies at fabrication shop that cannot be shipped completely assembled. Install dowels, screws, bolted connectors, and other fastening devices that can be removed after trial fitting. Verify that various parts fit as intended and check measurements of assemblies against field measurements indicated on Shop Drawings before disassembling for shipment.
- F. Shop cut openings, to maximum extent possible, to receive hardware, appliances, plumbing fixtures, electrical work, and similar items. Locate openings accurately and use templates or roughing-in diagrams to produce accurately sized and shaped openings. Sand edges of cutouts to remove splinters and burrs.
- G. Fabricated; cabinets and similar items are to be of robust firm neat construction with:
 - 1. Shutters, sashes, drawers and other opening or moving parts working smooth without bound conditions.
 - 2. Clearance between sashes and between jambs and sashes uniform.
 - 3. Level horizontal surfaces and plumb vertical surfaces when installed.

4.4.2.8 SHOP PRIMING

- A. **General:** Priming of interior architectural woodwork required to be performed at fabrication shop are specified in this Section. Refer to 9.0 Section "Painting" for final finishing of installed architectural woodwork and for priming materials to be used.
- B. **Preparations for Priming:** Comply with 9.0 Section "Painting" for sanding, filling countersunk fasteners, sealing concealed surfaces, and similar preparations for priming woodwork, as applicable to each unit of work.
 - a. **Back-priming:** Apply one coat of sealer or primer, compatible with finish coats, to concealed surfaces of woodwork. Apply two coats to end-grain surfaces.

4.4.2.9 PANTRY CUPBOARD AND BENCHES

- A. Base counters and upper cabinets units shall be pre-fabricated units constructed to dimensions and details indicated on Drawings.
- B. Construct units from the following materials so as to have all exposed or semi-exposed surfaces of plastic laminate finish:
 - 1. 19 mm (3/4") thick plywood with post-formed plastic laminate finish at both faces for front doors, bottoms and top of upper cabinet and shelves.
 - 2. 19 mm (3/4") thick solid surfacing material with integral factory formed back splash top of base counter with integral back splash.
 - 3. 6 mm (2/8") thick plywood of plastic laminate finish at one face for units backs and drawer base.

- 4. 19 mm (3/4") thick plywood with post-formed plastic laminate finish for drawers front, sides and back
- C. Plastic laminate sheet veneers shall be as specified in Clause 2.1 of this Section, color and pattern to the selection of the Engineer. Units are to be assembled in manufacturer's standard system to provide neat and robust construction.
- D. Construct sole of base counter, consisting of perimeter sides and intermediate struts, from hardwood solid blocks and finish exposed fronts to match finish of surrounding floors.
- E. Provide metal pre-slotted shelf holders of baked enamel finish complete with removable brackets for shelf supporting. Color is to be to the selection of the Engineer.
- F. Provide manufacturer's standard hardware including hinges, drawer slides, latches and knobs of finish to the selection of the Engineer. All hardware shall be manufactured from stainless steel, alloy 304, of satin finish.
- G. Blocking wood shall be from approved hardwood type.
- H. Construct top of base cabinet units integral with coved back splash from solid surfacing material as specified. Color or colors shall be selected by the Engineer from manufacturer's full range. To the maximum possible extent provide seamless construction. Where seams are unavoidable, align adjacent solid surfacing-material units and factory form seams. Joints are to be dressed smooth with surface scratches removed and entire surface cleaned.

4.4.2.10 WOOD BASES

- A. Are to be constructed from White Oak hardwood.
- B. Fabricate to dimensions and details indicated.
- C. Furnish in length as long as practice.
- D. Corners are to be mitered at 45 degrees.
- E. Finish of bases shall be transparent stained varnish as specified in section "Painting".

4.4.2.11 VANITIES

- A. Furnish vanities pre-fabricated in the workshop from solid surfacing material. Color(s) shall be selected by the Engineer.
- B. Fabricate vanities to dimensions indicated on Drawings and details indicated on approved shop drawings. Comply with the following sheet thickness:
 - Vanity: 20.0 mm (3/4")
 - Aprons and backsplash: 13.0 mm (1/2").
- C. Provide seamless vanity construction with pre-opened holes for assembly of lavatories. Use approved samples of lavatories for fixing size of holes. Comply with manufacturer's printed instructions for fabrication of vanities.

EXECUTION

4.4.3.1 PREPARATION

- A. Condition woodwork to average prevailing humidity conditions in installation areas before installation.
- B. Before installing architectural woodwork, examine shop-fabricated work for completion and complete work as required, including removal of packing and back priming.

4.4.3.2 **INSTALLATION**

- A. **Quality Standard:** Install woodwork to comply with BS 1186-2 and details indicated on Drawings and approved shop drawings.
- B. Install woodwork level, plumb, true, and straight. Shim as required with concealed shims. Install level and plumb (including tops).
- C. Scribe and cut woodwork to fit adjoining work, and refinish cut surfaces and repair damaged finish at cuts.
- D. Fire-Retardant-Treated Wood: Handle, store, and install fire-retardant-treated wood to comply with recommendations of chemical treatment manufacturer, including those for adhesives used to install woodwork.
- E. Anchor woodwork to anchors or blocking built in or directly attached to substrates. Secure with countersunk, concealed fasteners and blind nailing as required for complete installation. Use fine finishing nails or finishing screws for exposed fastening, countersunk and filled flush with woodwork and matching final finish if transparent finish is indicated.
- F. Fix wood bases with pre-drilled, expansion-type wall plugs fabricated from hard nylon and galvanized-steel wood screws of suitable length and diameter at maximum intervals of 750 mm (30"). Counter sink heads of screws in wood and overfill with approved wood filler of matching color as adjacent finished stained wood.
- G. Refer to 9.0 Section "Painting" for final finishing of installed architectural woodwork components that need finishing.

4.4.3.3 **ADJUSTING AND CLEANING**

- A. Repair damaged and defective woodwork, where possible, to eliminate functional and visual defects; where not possible to repair, replace woodwork. Adjust joinery for uniform appearance.
- B. Clean woodwork on exposed and semi exposed surfaces.

END OF SECTION

4.5 - POLYCARBONATE RESIN PANELS

PART 1 GENERAL

4.5.1. SECTION INCLUDES

- A. Polycarbonate plastic glazing.
- B. Abrasion-resistant polycarbonate plastic glazing.
- C. Enhanced UV-resistant polycarbonate plastic glazing.
- D. Flame inhibiting polycarbonate plastic glazing.
- E. Laminated polycarbonate plastic glazing for security applications.
- F. Multiwall Enhanced UV-resistant polycarbonate plastic glazing.

4.5.2. REFERENCES

- A. ANSI Z 97.1 - American National Standard for Glazing Materials Used in Buildings -- Safety Performance Specifications and Methods of Test.
- B. ASTM C 297 - Standard Test Method for Tensile Strength on Flat Sandwich Constructions in Flatwise Plane.
- C. ASTM D 256 - Standard Test Method for Determining the Pendulum Impact Resistance of Notched Specimens of Plastics.
- D. ASTM D 638 - Standard Test Method for Tensile Properties of Plastics.
- E. ASTM D 790 - Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
- F. ASTM D 792 - Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement.
- G. ASTM D1003 Standard Test Method for Haze and Luminous transmittance of Transparent Plastics.
- H. ASTM D 1929 - Standard Test Method for Ignition Properties of Plastics.
- I. ASTM F 1233 - Standard Test Method for Security Glazing Materials and Systems.
- J. ASTM F 1915 - Standard Test Method for Glazing for Detention Facilities.
- K. UL 752 Standard for Bullet-Resisting Equipment.

4.5.3. SUBMITTALS

- A. Submit under provisions of Section 01300.
- B. Product Data: Manufacturer's data sheets on each product to be used, including:
 - 1. Physical properties including data on material weight, wind load capacity, light transmission, shading coefficient, and thermal expansion
 - 2. Preparation instructions and recommendations.
 - 3. Storage and handling requirements and recommendations.
 - 4. Installation methods and glazing procedures, including edge engagement guidelines.
- C. Selection Samples: For each finish product specified, two complete sets of color chips representing manufacturer's full range of available colors and patterns.
- D. Verification Samples: Submit samples for each finish product specified, two samples, minimum size 6 inches (150 mm) square, representing actual product and framed on two adjacent sides to show glazing system.
- E. Manufacturer's Certificates: Certify products meet or exceed specified requirements.

4.5.4. DELIVERY, STORAGE, AND HANDLING

- A. Deliver polycarbonate sheets on enclosed pallets.
- B. Store products in manufacturer's unopened packaging until ready for installation.
- C. Store in dry, well-ventilated and covered areas at temperatures below 80 degrees F (27 degrees C).
- D. Handle polycarbonate sheets carefully to prevent damage; do not drop, slide, or drag.

4.5.5. PROJECT CONDITIONS

- A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

4.5.6. WARRANTY

- A. Provide manufacturer's written warranty covering breakage.
- B. Provide manufacturer's written warranty covering breakage, loss of light transmission, and yellowing.
- C. Provide manufacturer's written warranty covering breakage, abrasion resistance, coating failure, loss of light transmission, and yellowing.
- D. Provide manufacturer's written 15 year warranty covering breakage, abrasion resistance, coating failure, loss of light transmission, and yellowing.

PART 2 PRODUCTS

4.5.7. POLYCARBONATE SHEET GLAZING

- A. Polycarbonate Sheet: Comply with ANSI Z 97.1 and with properties as follows:
 - 1. Specific gravity: 1.2, per ASTM D 792.
 - 2. Tensile strength, yield: 9,000 psi (62 MPa), per ASTM D 638.
 - 3. Tensile strength, ultimate: 9,500 psi (65 MPa), per ASTM D 638.
 - 4. Tensile modulus: 345,000 psi (2378 MPa), per ASTM D 638.
 - 5. Flexural strength at 5 percent strain: 13,500 psi (93 MPa), per ASTM D 790.
 - 6. Flexural modulus: 345,000 psi (2378 MPa), per ASTM D 790.
 - 7. Izod impact strength (0.125 inch (3.2 mm) notched): 12-16 ft lb/in/in (641 - 854 J/m) of notch, per ASTM D 256.
 - 8. Self-ignition temperature: 1070 degrees F (577 degrees C), per ASTM D 1929.
 - 9. Flash ignition temperature: 870 degrees F (466 degrees C), per ASTM D 1929.
 - 10. Thickness and colour : as indicated on drawing.
- B. Enhanced UV Resistant Type: plastic glazing sheet
- C. UV and Abrasion Resistant Type: hard-coated plastic glazing sheet.
- D. UV and Abrasion Resistant Type: hard-coated plastic glazing sheet.
- E. Flame Inhibiting Plastic Glazing: solid flame inhibiting polycarbonate sheet. Meets requirements of UL 94 V-0 test criteria.
 - 1. Heat deflection temperature at 264 psi, 270 degrees F (132 degrees C), per ASTM D 648.
 - 2. Heat deflection temperature at 66 psi, 280 degrees F (138 degrees C), per ASTM D 648.

4.5.8. LAMINATED POLYCARBONATE SHEET GLAZING

A. Polycarbonate Laminated Sheet: Comply with ANSI Z 97.1 and with properties as follows:

1. Specific gravity: 1.2, per ASTM D 792.
2. Tensile strength, yield: 9,000 psi (62 MPa), per ASTM D 638.
3. Tensile strength, ultimate: 9,500 psi (65 MPa), per ASTM D 638.
4. Tensile modulus: 340,000 psi (2343 MPa), per ASTM D 638.
5. Flexural strength at 5 percent strain: 13,500 psi (93 MPa), per ASTM D 790.
6. Flexural modulus: 345,000 psi (2378 MPa), per ASTM D 790.
7. Izod impact strength (0.125 inch (3.2 mm) notched): 12-16 ft lb/in/in (641 - 854 J/m) of notch, per ASTM D 256.
8. Self-ignition temperature: 1077 degrees F (581 degrees C), per ASTM D 1929.
9. Flash ignition temperature: 872 degrees F (467 degrees C), per ASTM D 1929.

B. Containment Glazing:

1. Provide two-ply polycarbonate laminate with the following properties:

- a. Overall Thickness: 0.375 inches (9.5 mm).
- b. Conforms to ASTM F 1915, Grade 3.
- c. Forced entry ratings: ASTM F1233 Class III Sequence 12; H.P. White TP- 0500.02 Level II Step 11.
- d. Ballistic Rating: H.P. White TP-0500.02 Level A (.38 Special).
- e. Gage: 0.380 inch, plus/minus 5 percent tolerance.
- f. Weight: 2.5 pounds per sq ft.
- g. Shading coefficient: 0.92.
- h. Light transmittance (clear): 86 percent.
- j. Color: Custom color to match Architect's sample.

2. Provide three-ply polycarbonate laminate with the following properties:

- a. Overall Thickness: 0.5 inches (12.7 mm).
- b. Conforms to ASTM F 1915, Grade 2.
- c. Forced entry ratings: ASTM F1233 Class III Sequence 15; H.P. White TP-0500.02 Level II Step 12.
- d. Ballistic Rating: H.P. White TP-0500.02 Level A (.38 Special).
- e. Gage: 0.525 inch, plus/minus 5 percent tolerance.
- f. Weight: 3.3 pounds per sq ft.
- g. Shading coefficient: 0.90.
- h. Light transmittance (clear): 83 percent.
- j. Color: Custom color to match Architect's sample.

3. Provide three-ply polycarbonate laminate with the following properties:

- a. Overall Thickness: 0.75 inches (19 mm).
- b. Conforms to ASTM F 1915, Grade 1.
- c. Forced entry ratings: ASTM F1233 Class IV Sequence 26; H.P. White TP-0500.02 Level IV Step 31
- d. Ballistic Rating: H.P. White TP-0500.02 Level B (9 mm).
- e. Gage: 0.775 inch, plus/minus 5 percent tolerance.
- f. Weight: 4.9 pounds per sq ft.
- g. Shading coefficient: 0.87.
- h. Light transmittance (clear): 77 percent.
- j. Color: Custom color to match Architect's sample.

4.5.9. MULTI WALL POLYCARBONATE SHEET GLAZING

A. Polycarbonate Sheet: Comply with ANSI Z 97.1 and with properties as follows:

1. Specific gravity: 1.2, per ASTM D 792.
2. Tensile strength, yield: 9,000 psi (62 MPa), per ASTM D 638.
3. Tensile strength, ultimate: 9,500 psi (65 MPa), per ASTM D 638.
4. Tensile modulus: 345,000 psi (2378 MPa), per ASTM D 638.
5. Flexural strength at 5 percent strain: 13,500 psi (93 MPa), per ASTM D 790.
6. Flexural modulus: 345,000 psi (2378 MPa), per ASTM D 790.
7. Izod impact strength (0.125 inch (3.2 mm) notched): 12-16 ft lb/in/in (641 - 854 J/m) of notch, per ASTM D 256.
8. Self-ignition temperature: 1070 degrees F (577 degrees C), per ASTM D 1929.
9. Flash ignition temperature: 870 degrees F (466 degrees C), per ASTM D 1929.

B. Multi Wall Glazing:

I. Provide twin wall polycarbonate sheet with the following properties:

- a. Overall Thickness: 4 mm.
- b. Rib distance: 6 mm.
- c. Color/Light Transmittance:
 - 1) Clear 1099 / 79 percent.
 - 2) White 1146 / 77 percent.
 - 3) Bronze 1850 / 59 percent.
 - 4) White 1125 / 21 percent.
 - 5) Blue 1545 / 42 percent.
 - 6) Green 1650 / 55 percent.
- d. Heat Transfer Coefficient: 4.1 w/m² K per ASTM C 976.
- e. Coefficient of Thermal Expansion: 0.065 mm/m degrees C.
- f. Possible expansion due to heat and moisture: 3 mm/m.
- g. Maximum service temperature without load. 120 degrees C.
- h. Coextruded UV protective layer on exterior face.

II. Twin wall polycarbonate sheet with the following properties:

- a. Overall Thickness: 6 mm.
- b. Rib distance: 6 mm.
- c. Color/Light Transmittance:
 - 1) Clear 1099 / 81 percent.
 - 2) White 1146 / 78 percent.
 - 3) Bronze 1850 / 61 percent.
 - 4) White 1125 / 21 percent.
 - 5) Blue 1545 / 44 percent.
 - 6) Green 1650 / 58 percent.
 - 7) Clear 4099 No drop.
- d. Heat Transfer Coefficient: 3.7 w/m² K per ASTM C 976.
- e. Coefficient of Thermal Expansion: 0.065 mm/m degrees C.
- f. Possible expansion due to heat and moisture: 3 mm/m.
- g. Maximum service temperature without load. 120 degrees C.
- h. Weighted sound reduction index: 10 db.
- i. Coextruded UV protective layer on exterior face.

III. Twin wall polycarbonate sheet with the following properties:

- a. Overall Thickness: 8 mm.
- b. Rib distance: 10.5 mm.
- c. Color/Light Transmittance:
 - 1) Clear 1099 / 81 percent.
 - 2) White 1146 / 78 percent.
 - 3) Bronze 1850 / 61 percent.
 - 4) White 1125 / 21 percent.
 - 5) Blue 1545 / 44 percent.
 - 6) Green 1650 / 58 percent.
 - 7) Clear 4099 No drop.
- d. Heat Transfer Coefficient: 3.3 w/m² K per ASTM C 976.
- e. Coefficient of Thermal Expansion: 0.065 mm/m degrees C.. f. Possible expansion due to heat and moisture: 3 mm/m.
- g. Maximum service temperature without load. 120 degrees C.
- h. Coextruded UV protective layer on exterior face.

IV. Twin wall polycarbonate sheet with the following properties:

- a. Overall Thickness: 10 mm.
- b. Rib distance: 10.5 mm.
- c. Color/Light Transmittance:
 - 1) Clear 1099 / 80 percent.
 - 2) White 1146 / 70 percent.
 - 3) White 1140 IQ-Relax (Heat Reflecting) 70 percent.
 - 4) White 1125 / 19 percent.
 - 5) Blue 1545 / 42 percent.
 - 6) Green 1650 / 54 percent.
 - 7) Bronze 1850 / 56 percent.
 - 8) Clear 4099 No drop.
- d. Heat Transfer Coefficient: 3.1 w/m² K per ASTM C 976.
- e. Coefficient of Thermal Expansion: 0.065 mm/m degrees C..
- f. Possible expansion due to heat and moisture: 3 mm/m.
- g. Maximum service temperature without load. 120 degrees C.
- h. Coextruded UV protective layer on exterior face.

V. Wall polycarbonate sheet with the following properties:

- a. Overall Thickness: 8mm.
- b. Rib distance: 6mm.
- c. Color/Light Transmittance:
 - 1) Clear 1099 / 68 percent.
 - 2) White 1146 / 61 percent.
 - 3) White 1140 IQ-Relax (Heat Reflecting) 52 percent.
 - 4) Clear 4099 No drop.
- d. Heat Transfer Coefficient: 2.76 w/m² K per ASTM C 976.
- e. Coefficient of Thermal Expansion: 0.065 mm/m degrees C..
- f. Possible expansion due to heat and moisture: 3 mm/m.
- g. Maximum service temperature without load. 120 degrees C.

- h. Coextruded UV protective layer on exterior face.
- 6. Provide wall polycarbonate sheet with the following properties:
 - a. Overall Thickness: 25 mm.
 - b. Rib distance: 25 mm X structure.
 - c. Color/Light Transmittance:
 - 1) Clear 1099 / 54 percent.
 - 2) White 1146 / 40 percent.
 - 3) White 1140 IQ-Relax (Heat Reflecting) 37 percent.
 - d. Heat Transfer Coefficient: 1.6 w/m² K per ASTM C 976.
 - e. Coefficient of Thermal Expansion: 0.065 mm/m degrees C.
 - f. Possible expansion due to heat and moisture: 3 mm/m.
 - g. Maximum service temperature without load. 120 degrees C.
 - h. Weighted sound reduction index: 19 dB.
 - i. Coextruded UV protective layer on exterior face.

4.5.10.ACCESSORIES

- A. Glazing Accessories: As recommended by manufacturer of plastic glazing sheet for wet or dry glazing installations.
- B. Glazing Accessories: In accordance with Section 08850 - Glazing Accessories.
- C. Sealants: In accordance with Section 07900 - Joint Sealants

PART 3 EXECUTION

4.5.11.EXAMINATION

- A. Do not begin installation until openings have been properly prepared.
- B. Inspect and verify that frame openings are correct size and conform to recommendations of the plastic glazing sheet manufacturer.
- C. If opening preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

4.5.12.PREPARATION

- A. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.
- B. Clean frame contact surfaces with compatible solvent and wipe dry. Do not allow solvent to pool in glazing channels.
- C. Immediately prior to installation, expose glazing edges of plastic sheet by peeling back factory-applied protective masking to a dimension sufficient for edge engagement.

4.5.13.INSTALLATION

- A. Install plastic glazing in accordance with manufacturer's recommendations for edge engagement and expansion allowance.
- B. Sawing:
 - 1. Cut using triple chip design saw blades at steady feed rate. Do not force material through saw.
 - 2. Sand or scrape cut edges smooth after sawing.
- C. Mechanical Attachment:
 - 1. Drill slightly oversized holes through plastic glazing and frames.

2. Install nuts, bolts and washers according to manufacturer's recommendations.
3. Use material backer strips with same strength and ballistic characteristics as glazing material.
4. Ensure bolts are not overtightened.
- D. Non-mechanical Installation:
 1. Use wet or dry gaskets compatible with plastic glazing material.
 2. b. Insert glazing tape between metal frame and plastic glazing and ensure there is no contact between frame and glazing material.
- E. Employ only sealants and glazing accessories that have been approved by manufacturer of plastic glazing sheet.
- F. Remove protective masking immediately after all glazing operations are completed.

4.5.14.PROTECTION

- A. Protect installed products until completion of project.
- B. Affix polyethylene film or other covering approved by plastic glazing sheet manufacturer to framing members, as required to protect plastic glazing from other construction operations.
- C. Repair or replace damaged products before Substantial Completion.

4.5.15.MAINTENANCE

- A. Wash plastic glazing sheets regularly using soft cloth or sponge and mild soap and water solution.
- B. Dry using chamois or sponge
- C. Do not use abrasive cleaners or sharp instruments such as razor blades or scrapers that may gouge plastic glazing sheet surfaces.

5- THERMAL AND MOISTURE PROTECTION

5.1- LIQUID APPLIED WATERPROOFING

GENERAL

5.1.1.1 RELATED WORK

- A. Section 3.00 - Concrete.

5.1.1.2 WORK INCLUDED

- A. Fluid applied cold applied one or two component polyurethane membrane waterproofing. For internal application.
- B. Protective covering.

5.1.1.3 REFERENCE

- A. ANSI/ASTM D412 - Rubber Properties in Tension.
- B. ANSI/ASTM D746 - Test for Brittleness Temperature of Plastics and Elastomeric by Impact.
- C. ASTM C836 - High Solids Content, Cold Liquid-applied Elastomeric Waterproofing Membrane for Use With Separate Wearing Course.
- D. ASTM D624 - Rubber Property - Tear Resistance.
- E. ASTM D2240 - Rubber Property - Durometer Hardness.
- F. ASTM E96 - Water Vapour Transmission of Materials.

5.1.1.4 QUALITY ASSURANCE

- A. **Membrane Manufacturer:** Company specializing in liquid waterproofing membrane systems with eight years minimum experience.
- B. **Applicator:** Company specializing in application of specified waterproofing with five years minimum experience and approved by manufacturer.

5.1.1.5 FIELD SAMPLE

- A. Provide field sample of installed membrane.
- B. Field sample to represent conditions of finished work including internal and external corners, seam jointing, attachment method, sealing and counter flashing cover, and control and expansion joints.
- C. Approved sample may be incorporated as part of the Work.

5.1.1.6 SUBMITTALS

- A. Submit shop drawings and product data under provisions of General Requirements.
- B. Submit shop drawings detailing special joint or termination conditions and conditions of interface with other materials.
- C. Submit product data for liquid membrane compound, flexible flashing, joint cover sheet, and joint and crack sealants, with temperature range for application of waterproofing membrane.
- D. Submit manufacturer's installation instructions under provisions Contract Documents.

5.1.1.7 ENVIRONMENTAL REQUIREMENTS

- A. Do not apply waterproofing during inclement weather or when air substrate temperature is below 5 degrees C.
- B. Liquid water proofing should be non-toxic.

5.1.1.8 **WARRANTY**

- A. Provide (10) ten years warranty under provisions of General Conditions of Contract.
- B. Warranty includes coverage of materials and installation and resultant damage from failure of installation to resist penetration of moisture.
- C. Warranty includes coverage of waterproofing failure to resist penetration of water except where such failures are the result of structural failures of building. Hairline cracking of concrete due to temperature change or shrinkage is not considered as structural failure.

PRODUCTS

5.1.2.1 **ACCEPTABLE MANUFACTURERS**

- A. Carisle Corporation System Liqueal
- B. Chevron USA (Asphalt Div) System C.I.M.
- C. Floorlite - Andek System Rooftex
- D. Tremco Ltd System Tremproof 60
- E. Fosroc Nitoproof 10

Note: The products and manufacturer specified herein are specified for the purpose of establishing minimum quality standards. Products equal to or better than those specified will be considered acceptable. The decision of acceptability shall rest with Engineer/Engineer Representative.

5.1.2.2 **MATERIAL**

- A. **General:** Provide liquid applied waterproofing, and other required materials produced by one manufacturer.
- B. **Waterproofing Membrane:** Pitch Modified, High Polymer one part Polyurethane Elastomeric Membrane Type. Trowel apply membrane at areas indicated on Drawings to receive "Waterproofing", consisting of a high polymer and polyurethane applied in multiple layers forming a seamless waterproofing membrane to a minimum thickness of 1.5mm.
- C. The Physical properties of the membrane must satisfy the following criteria:
 - 1. Specific Gravity : 1.2
 - 2. Solid Contents : 92% minimum
 - 3. Application Temperature : 5 degrees C to 45 degrees C
 - 4. Cure Time : 4 – 6 Hour
 - 5. Shore "A" Hardness : 30 degrees C
 - 6. Tensile Strength : 20N/mm²
 - 7. Ultimate Elongation : 680%
 - 8. Accelerated Weathering: 12000 Hours. No appreciable deterioration.
- D. Sealer (For Substrate): As recommended by manufacturer.

- E. Cant Strips: As recommended by manufacturer.

5.1.2.3 **ACCESSORIES**

- A. Surface Conditioner: as recommended by membrane manufacturer.
- B. Elastic Flashings: 1.2 as recommended by membrane manufacturer.
- C. Joint and Crack Sealant: As recommended by membrane manufacturer.
- D. Cant: as detailed on drawings.

5.1.2.4 **PROTECTIVE MATERIALS**

- A. Protection Board: 3mm thick, (2/32") asphalt impregnated board manufactured by W.R. Meadows.
- B. Tack-free Surfacers: Normal Portland Cement.
- C. Separation Sheet: Sheet polyethylene, 0.15 mm thick (1/32").

EXECUTION

5.1.3.1 **EXAMINATION**

- A. Verify surfaces are solid, free of frozen matter, loose particles, cracks, pits, rough projections, and foreign matter detrimental to adhesion and application of waterproofing.
- B. Do not apply waterproofing to damp, frozen, dirty, dusty, or deck surfaces unacceptable to manufacturer and applicator.
- C. Verify items, which penetrate surfaces to receive waterproofing, are securely installed.
- D. Beginning of installation means acceptance of substrate.

5.1.3.2 **PREPARATION**

- A. Clean and prepare surfaces to receive waterproofing, in accordance with manufacturer's instructions.
- B. Apply mastic to seal penetrations, small cracks, and honeycomb in substrate.
- C. Protect adjacent surfaces not designated to receive waterproofing.
- D. Apply surface conditioner at a rate recommended by membrane manufacturer.

5.1.3.3 **APPLICATION**

- A. Apply membrane in accordance with manufacturer's instructions.
- B. Apply and spread membrane to minimum 2mm thickness, averaging 2.5mm in thickness.
- C. Continue membrane up vertical surfaces minimum 150mm (6") or as indicated on drawings.
- D. Seal items projecting through membrane.
- E. Install membrane flashing and seal into membrane.
- F. Reinforce membrane over static or moving joints.

5.1.3.4 **FIELD QUALITY CONTROL**

- A. On completion of horizontal membrane installation, dam installation in preparation for flood testing.
- B. Flood to minimum depth of 30mm (1.25"). with clean water. After 48 hours, check for leaks.
- C. If leaking is found, patch using new waterproofing materials; repeat flood-test. Repair damage to building.
- D. When area is proved watertight, drain water and remove dam.

5.1.3.5 **PROTECTION**

- A. Immediately after cooling, dust membrane with Portland Cement at rate of approximately 4 kg/10 sq m (4kg / 108 Sft).
- B. Apply protection boards over cured membrane surface. Scribe boards around pipes and projections.
- C. Close off area to prevent un-authorized traffic or work over membrane until final concrete topping is applied.

PART 3 - LOCATION OF THE WORKS

- A. In toilets, pantries and preparation areas, below tiling 2 – Below screed at delivery yard area 3 – Below cold rooms flooring in structurally recessed areas.

5.2- ROOF WATERPROOFING

GENERAL

5.2.1- RELATED DOCUMENT

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and 1.0 Specification Sections, apply to this Section.

5.2.2- SUMMARY

- A. This Section includes Roof waterproofing.
- B. Related Sections include the following:
 - 1. Section "Cast-in-Place Concrete" for formwork, water stops, and finishing concrete walls and slabs to receive waterproofing.
 - 2. 4.0 Section "Unit Masonry Assemblies" for preparing concrete unit masonry walls to receive waterproofing.
 - 3. 9.0 Section "Portland Cement Plaster" for plaster finishes to be applied over waterproofing.

5.2.3- SUBMITTALS

- A. Product Data: Include construction details, and material descriptions and installation instructions for waterproofing.
- B. Product Certificates: For waterproofing, signed by product manufacturer.
- C. Qualification Data: For Installer and manufacturer.
- D. Material Test Reports: For waterproofing.
- E. Manufacturer's inspection reports of completed installation.
- F. Warranty: Special warranty specified in this Section.

5.2.4- QUALITY ASSURANCE

- A. Installer Qualifications: An employer of workers trained and approved by manufacturer.
- B. Mockups: Provide mockups of waterproofing to verify selections made under sample submittals and to demonstrate aesthetic effects.
 - 1. Engineer will select locations of mockups that represent typical surfaces and conditions for applications of waterproofing.
 - a. Vertical and Horizontal Surfaces: Provide samples of at least one sq.m.
 - 2. Apply waterproofing according to requirements for the completed Work after permanent lighting and other environmental services have been activated.
- C. Pre-installation Conference: Conduct conference at Project site to comply with requirements. Review methods and procedures related to waterproofing including, but not limited to, the following:
 - 1. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
 - 2. Review required certifying procedures.

5.2.5- PROJECT CONDITIONS

- A. Weather Limitations: Proceed with application only when existing and forecasted weather conditions permit waterproofing to be performed according to manufacturer's written instructions and warranty requirements.
- B. Proceed with waterproofing work only after pipe sleeves, vents, curbs, inserts, drains, and other projections through the substrate to be waterproofed have been completed. Proceed only after concrete and masonry substrate defects, including honeycombs, voids, and cracks, have been repaired to provide a sound substrate free of forming materials, including reveal inserts.
- C. Ambient Conditions: Proceed with waterproofing work only if temperature is maintained at 4.4 deg C or above during work and cure period and space is well ventilated and kept free of water.

5.2.6- WARRANTY

- A. Special Warranty: Manufacturer's standard form in which Installer agrees to repair or replace components of waterproofing that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Failure to maintain watertight conditions within specified warranty period.
 - 2. Warranty Period: Ten years from date of Substantial Completion.

PRODUCTS

5.2.7- MATERIALS

- A. Waterproofing: A prepackaged, white-colored proprietary blend of Portland cement, specially treated sand, and active chemicals that, when mixed with water and applied, penetrates by capillary action into concrete or masonry and reacts chemically with free lime in the presence of water to develop growth within concrete or masonry capillaries to produce an impervious, dense, waterproof concrete or masonry with properties meeting or exceeding the following criteria:
 - 1. Permeability: 0 for water at 10 m when tested according to CE CRD-C 48.
 - 2. Compressive Strength: 28 MPa when tested according to ASTM C 109M.
- B. Patching Compound: Cementations waterproofing and repair mortar for filling and patching tie holes, honeycombs, reveals, and other imperfections; with properties meeting or exceeding the following criteria:
 - 1. Compressive Strength: 52.44 MPa at 28 days when tested according to ASTM C 109M.
 - 2. Flexural Strength: 4.8 MPa at 28 days when tested according to ASTM C 348.
 - 3. Shrinkage: Minus 0.093 percent at 28 days and plus 0.073 percent at 90 days when tested according to ASTM C 596.
- C. Plugging Compound: Cementations compound with hydrophobic properties; resistant to water and moisture but vapor permeable for all standard applications (vertical, overhead and horizontal surfaces not exposed to vehicular traffic); with properties meeting or exceeding the following criteria:
 - 1. Permeability: 9 m when tested according to CE CRD-C 48.

2. Compressive Strength: 41.4 MPa at 28 days when tested according to ASTM C 109M.
3. Flexural Strength: 6.9 MPa at 28 days when tested according to ASTM C 348.
4. Bond Strength: 2.1 MPa at 14 days when tested according to ASTM C 321.

D. Water: Potable

5.2.8- PROPORTION AND DESIGN OF PROTECTIVE TOPPING MIX

- A. Protective Topping: Measure, batch, and mix Portland cement and sand in the proportion of 1:3 and water. Blend together with mechanical mixer to required consistency.

EXECUTION

5.2.9- EXAMINATION

- A. Acceptance of Conditions: Examine substrates, with Applicator present, where waterproofing is to be applied.
1. Proceed with application only after unsatisfactory conditions have been corrected.
 2. Notify Engineer in writing of active leaks or structural defects that would affect system performance.

5.2.10- PREPARATION

- A. Protect other work from damage from cleaning, preparation, and application of waterproofing. Provide temporary enclosure to confine spraying operation and to ensure adequate ambient temperatures and ventilation conditions for application.
- B. Stop active water leaks according to waterproofing manufacturer's written instructions.
- C. Repair damaged or unsatisfactory concrete or masonry according to manufacturer's written instructions.
- D. Surface Preparation: Comply with waterproofing manufacturer's written instructions to remove efflorescence, chalk, dust, dirt, mortar spatter, grease, oils, curing compounds, and form-release agents to ensure that waterproofing bonds to concrete or masonry surfaces.
1. Clean concrete surfaces according to ASTM D 4258.
 - a) Scratch- and Float-Finished Concrete: Etch with 10 percent muriatic (hydrochloric) acid solution according to ASTM D 4260.
 - b) Prepare smooth-formed and trowel-finished concrete by mechanical abrading or abrasive-blast cleaning according to ASTM D 4259.
 2. Concrete Joints: Clean reveals according to waterproofing manufacturer's written instructions.

5.2.11- APPLICATION

- A. General: Comply with waterproofing manufacturer's written instructions for application.
1. Dampen surface for several hours prior to application with water and maintain damp condition until applying waterproofing.
 2. Apply waterproofing to positive-side surfaces.
 3. Number of Coats: Two for spray application.
 4. Dampen surface between coats.
- B. Final Coat Finish: Smooth.

- C. Moist-cure waterproofing for three days immediately after application has set, followed by two days of air drying as recommended in writing by manufacturer.
- D. Waterproofing Treatment Extensions: Extend waterproofing treatment as follows:
 - 1. Onto columns integral with treated walls.
 - 2. Onto interior non-treated walls intersecting exterior treated walls, for a distance of 600 mm (24") for cast-in-place concrete.
 - 3. Onto exterior walls and onto both exterior and interior columns, for a height of 300 mm, (12") where floors, but not walls, are treated.
 - 4. Onto every substrate in areas indicated for treatment, including pipe trenches, pipe chases, pits, sumps, and similar offsets and features.
- E. Protective Floor Topping: Apply 40-mm- (1 1/2") thick, protective topping over floor surfaces.

5.2.12- PROTECTION

- A. Protect applied waterproofing from rapid drying, severe weather exposure, and water accumulation. Maintain completed Work in moist condition for not less than three days by procedures recommended in writing by waterproofing manufacturer. Protect waterproofing from temperatures below 2 deg C.

5.2.13- FIELD QUALITY CONTROL

- A. Inspection: Manufacturer's representative to inspect completed application and to provide a written report that application complies with manufacturer's written instructions.

5.3 - WATERPROOFING

GENERAL

5.3.1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including Conditions of Contract and 1.0 Section Specification Sections, apply to this Section.

5.3.1.2 SUMMARY

- A. This Section includes the following:
 - 1. Two-ply modified bituminous sheet waterproofing.
- B. Related Sections: include the following:
 - 2. Section "Cast-in-Place Concrete" for concrete curing and finishing.

5.3.1.3 PERFORMANCE REQUIREMENTS

- A. Provide waterproofing that prevents the passage of water.

5.3.1.4 SUBMITTALS

- A. **Product Data:** Include manufacturer's written instructions for evaluating, preparing, and treating substrate, technical data, and tested physical and performance properties of waterproofing.
- B. **Shop Drawings:** Show locations and extent of waterproofing. Include details for substrate joints and cracks, sheet flashings, penetrations, inside and outside corners, tie-ins with adjoining waterproofing, and other termination conditions.
- C. **Samples:** For the following products:
 - 1. 300 by 300 mm (12") square of waterproofing.
- D. **Installer Certificate:** Signed by sheet waterproofing manufacturer certifying that the Installer complies with specified requirements.
- E. **Product Test Reports:** From a qualified independent testing agency acceptable to the Engineer, indicating and interpreting test results of waterproofing for compliance with requirements, based on comprehensive testing of current waterproofing formulations.
- F. **Sample Warranty:** Before starting waterproofing, copy of waterproofing manufacturer's and Installer's warranty, stating obligations, remedies, limitations, and exclusions.

5.3.1.5 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.
- B. **Installer Qualifications:** A qualified Installer who is authorized, approved, or licensed by sheet waterproofing manufacturer to install manufacturer's products; and who is eligible to receive waterproofing warranty specified.
- C. **Source Limitations:** Obtain waterproofing materials through one source from a single manufacturer.
- D. **Mockup:** Apply waterproofing to at least 15 sq. m (161 Sft) of deck and/or wall to demonstrate surface preparation, crack and joint treatment, corner treatment, and execution quality.

1. Construct mockup in the location and of the size indicated or, if not indicated, as directed by the Engineer.
2. Notify the Engineer 7 days in advance of dates and times when mockup will be constructed.
3. Obtain the Engineer's approval of mockup before starting sheet waterproofing.
4. If the Engineer determines mockup does not comply with requirements, reapply waterproofing until mockup is approved.
5. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

E. **Pre-Installation Conference:** Conduct conference at Project site to comply with requirements in 1.0 Section "Project Management and Coordination." Review requirements for waterproofing, including surface preparation specified under other Sections, substrate condition and pretreatment, minimum curing period, forecasted weather conditions, special details and sheet flashings, installation procedures, testing and inspection procedures, and protection and repairs.

5.3.1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver liquid materials to Project site in original packages with seals unbroken, labeled with manufacturer's name, product brand name and type, date of manufacture, and directions for storing and mixing with other components.
- B. Store liquid materials in their original undamaged packages in a clean, dry, protected location and within temperature range required by waterproofing manufacturer.
- C. Remove and replace liquid materials that cannot be applied within their stated shelf life.
- D. Store rolls according to manufacturer's written instructions.
- E. Protect stored materials from direct sunlight.

5.3.1.7 PROJECT CONDITIONS

- A. **Environmental Limitations:** Apply waterproofing within range of ambient and substrate temperatures recommended by waterproofing manufacturer. Do not apply waterproofing to a damp or wet substrate.
 - a) Do not apply waterproofing in rain, fog, or mist.
- B. Maintain adequate ventilation during preparation and application of waterproofing materials.

5.3.1.8 WARRANTY

- A. **Manufacturer's Warranty:** Provide written warranty, signed by waterproofing manufacturer and Installer, and countersigned by the Contractor, agreeing to replace waterproofing material that does not comply with requirements or that does not remain watertight within specified warranty period. Warranty includes responsibility for removing and replacing construction and other work that conceals modified bituminous sheet waterproofing.
 1. Warranty Period: 10 years after date of Substantial Completion.

PRODUCTS

5.3.2.1 SHEET WATERPROOFING

- A. **APP-Modified Bituminous Sheet, Smooth Surfaced:** ASTM D 6222, Grade S, Type I or II, polyester reinforced, atactic-polypropylene-modified bituminous sheet, smooth surfaced; suitable for application indicated and installation method specified; for use as follows:
 1. Use: Base and top plies of two-ply, modified bituminous sheet waterproofing.
- B. **Physical Properties:** Provide APP-modified bituminous sheet materials with the following properties when tested according to ASTM D 5147:
 1. Thickness: 4.5 mm.
 2. Tensile Strength: 15.75 kN/m at minus 18 deg. C (minus 0.4 deg. F) in each direction.
 3. Elongation at Maximum Load: 20 percent minimum at minus 18 deg. C (minus 0.4 deg. F) in each direction.
 4. Tear Strength: 378 N minimum.
 5. Low-Temperature Flexibility: Pass at minus 10 deg. C (14 deg. F).

5.3.2.2 AUXILIARY MATERIALS

- A. **General:** Furnish auxiliary materials recommended by waterproofing manufacturer for intended use and compatible with sheet waterproofing.
- B. **Asphalt Primer:** ASTM D 41.
- C. **Asphalt:** ASTM D 312, Type III or Type IV, as recommended by sheet waterproofing manufacturer.
 1. Label each container or provide certification with each load of bulk asphalt identifying type of asphalt and indicating softening point, minimum flash point, equiviscous temperature, and finished blowing temperature.
- D. **Cants and Miscellaneous Accessories:** Provide cants and miscellaneous accessories recommended by sheet waterproofing manufacturer for intended use.
- E. **Waterproofing and Sheet Flashing Accessories:** Provide sealants, pourable sealers, cone and vent flashings, inside and outside corner flashings, termination reglets and bars, and other accessories recommended by waterproofing manufacturer for intended use.
- F. **Protection Course:** The following or, at the Contractor's option, alternative means of protection as recommended by waterproofing manufacturer for intended use, and acceptable to the Engineer.
 1. Sand – cement screed layer.
 2. Semi rigid sheet of fiberglass or mineral – reinforced asphaltic core, pressure laminated between two asphalt – saturated fibrous liners and as follows:
 - a. Thickness : 3 mm.
 - b. adhesive: Rubber based solvent type recommended by waterproofing manufacturer for type of protection course.

EXECUTION

5.3.3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, for compliance with requirements and other conditions affecting performance.
 - 1. Do not proceed with installation until after the minimum concrete curing period recommended by waterproofing manufacturer.
 - 2. Verify that substrate is visibly dry and free of moisture. Test for capillary moisture by plastic sheet method according to ASTM D 4263.
 - 3. Notify the Engineer in writing of anticipated problems using waterproofing over substrate.
 - 4. Proceed with installation only after unsatisfactory conditions have been corrected.

5.3.3.2 SURFACE PREPARATION

- A. Clean, prepare, and treat substrate according to manufacturer's written instructions. Provide clean, dust-free, and dry substrate for waterproofing application.
- B. Remove grease, oil, bitumen, form-release agents, paints, curing compounds, and other penetrating contaminants or film-forming coatings from concrete.
- C. Remove fins, ridges, mortar, and other projections and fill honeycomb, aggregate pockets, holes, and other voids.
- D. Prepare, fill, prime, and treat joints and cracks in substrate. Remove dust and dirt from joints and cracks according to ASTM D 4258.
- E. Mask off adjoining surfaces not receiving waterproofing to prevent spillage and overspray affecting other construction.
- F. Prepare, treat, and seal vertical and horizontal surfaces at terminations and penetrations through waterproofing and at drains and protrusions according to manufacturer's written instructions.
- G. Install and secure cants, reinforcement strips, flashings and miscellaneous accessories to comply with manufacturer's written instructions and requirements for treatments at construction joints, horizontal to vertical surface intersections, inside and outside corners, perimeters, and edges.

5.3.3.3 MODIFIED BITUMINOUS SHEET INSTALLATION

- A. Install modified bituminous sheet over areas to receive waterproofing, according to manufacturer's written instructions and applicable recommendations.
 - 1. Unroll sheet and allow to relax for the minimum time period required by manufacturer.
- B. **Two-Ply, Modified Bituminous Membrane:** Install 2 plies of modified bituminous sheet waterproofing, consisting of a base ply and a finish ply.
 - 1. Base- and Finish-Ply Application: Torch apply each ply to substrate.
- C. **Horizontal Application:** Apply sheets from low point to high point to ensure that side laps shed water.
- D. **Laps:** Accurately align sheets, without stretching, and maintain uniform side and end laps of minimum dimensions required. Stagger end laps. Heat-weld side and end laps and completely seal by rolling, leaving no voids.
 - 1. Repair tears and voids in laps and lapped seams not completely sealed.

- E. Repair tears and voids in waterproofing not complying with requirements. Slit and flatten fishmouths and blisters. Patch with sheet waterproofing extending 150 mm beyond repaired areas in all directions.
- F. Correct deficiencies to satisfaction of the Engineer, or remove sheet waterproofing that does not comply with requirements, repair and prepare substrates, re-apply waterproofing and repair flashings.

5.3.3.4 PROTECTION COURSE INSTALLATION

- A. Install protection course over waterproofing membrane according to manufacturer's written instructions and before beginning subsequent construction operations. Minimize exposure of membrane.

5.3.3.5 PROTECTION AND CLEANING

- A. Do not permit foot or vehicular traffic on unprotected horizontal membrane.
- B. Protect installed waterproofing and protection course from damage due to ultraviolet light, harmful weather exposures, physical abuse, and other causes. Provide temporary coverings where installation may be subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.
- C. Clean spillage and soiling from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

5.4 - SHEET METAL FLASHING AND TRIM

GENERAL

5.4.1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Section 1 Specification Sections, apply to this Section.

5.4.1.2 SUMMARY

- A. This Section includes the following sheet metal flashing and trim.
 - 1. Formed roof flashing and trim.
- B. Related Sections include the following:
 - 1. Section "Cast-in-Place Concrete" for installing reglets.
 - 2. 4.0 Section "Unit Block Masonry Assemblies" for installing through-wall flashing, reglets, and other sheet metal flashing and trim.
 - 3. 6.0 Section "Rough Carpentry" for wood nailers, curbs, and blocking.
 - 4. 7.0 Section "Metal Roof Panels" for factory-formed metal roof panels and flashing and trim not part of sheet metal flashing and trim.
 - 5. 7.0 Section "Metal Wall Panels" for factory-formed metal wall panels and flashing and trim not part of sheet metal flashing and trim.
 - 6. 7.0 Section "Joint Sealants" for field-applied sheet metal flashing and trim sealants.

5.4.1.3 PERFORMANCE REQUIREMENTS

- A. General: Install sheet metal flashing and trim to withstand wind loads, structural movement, thermally induced movement, and exposure to weather without failing, rattling, leaking, and fastener disengagement.
- B. Fabricate and install roof edge flashing and copings capable of resisting the following forces according to:
 - 1. **Wind Loading:** Design fascia panels to withstand wind forces calculated in accordance with the UBC for a basic wind speed of 130 km/h, Importance Factor 1.00, and Exposure Category "C".
- C. **Thermal Movements:** Provide sheet metal flashing and trim that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, hole elongation, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Provide clips that resist rotation and avoid shear stress as a result of sheet metal and trim thermal movements. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
 - 1. Temperature Change (Range): 35 deg. C, ambient; 65 deg. C, material surfaces.
- D. Water Infiltration: Provide sheet metal flashing and trim that do not allow water infiltration to building interior.

5.4.1.4 SUBMITTALS

- A. **Product Data:** For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
- B. **Shop Drawings:** Show layouts of sheet metal flashing and trim, including plans and elevations. Distinguish between shop and field assembled work. Include the following:
 - 1. Identify material, thickness, weight, and finish for each item and location in Project.
 - 2. Details for forming sheet metal flashing and trim, including profiles, shapes, seams, and dimensions.
 - 3. Details for fastening, joining, supporting, and anchoring sheet metal flashing and trim, including fasteners, clips, cleats, and attachments to adjoining work.
 - 4. Details of expansion-joint covers, including showing direction of expansion and contraction.
- C. **Samples for Initial Selection:** For each type of sheet metal flashing and trim indicated with factory-applied color finishes.
 - 1. Include similar Samples of trim and accessories involving color selection.
- D. **Samples for Verification:** For each type of exposed finish required, prepared on Samples of size indicated below:
 - 1. Sheet Metal Flashing: 300 mm long. Include fasteners, cleats, clips, closures, and other attachments.
 - 2. Trim: 300 mm long. Include fasteners and other exposed accessories.
 - 3. Accessories: Full-size Sample.
- E. **Qualification Data:** For firms and persons specified in Article 1.4, "Quality Assurance" to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of the Engineers and Employers, and other information specified.

5.4.1.5 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.
- B. **Sheet Metal Flashing and Trim Standard:** Comply with SMACNA's "Architectural Sheet Metal Manual." Conform to dimensions and profiles shown unless more stringent requirements are indicated.
 - 1. **Copper Standard:** Comply with CDA's "Copper in Architecture Handbook."
- C. **Mockups:** Build mockups to demonstrate aesthetic effects and set quality standards for fabrication and installation.
 - 1. Mockup of roof level, including built-in gutter fascia trim apron flashing, approximately 1200 mm long, including supporting construction cleats, seams, attachments, underlayment, and accessories.
 - 2. Approval of mockups is for other material and construction qualities specifically approved by the Engineer in writing.

3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless such deviations are specifically approved by the Engineer in writing.
 4. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.
- D. **Pre-installation Conference:** Conduct conference at Project site to comply with requirements in 1 Section "Project Management and Coordination."
1. Meet with the Employer, Engineer, Employer's insurer if applicable, Installer, and installers whose work interfaces with or affects sheet metal flashing and trim including installers of roofing materials, roof accessories, unit skylights, and roof-mounted equipment.
 2. Review methods and procedures related to sheet metal flashing and trim.
 3. Examine substrate conditions for compliance with requirements, including flatness and attachment to structural members.
 4. Document proceedings, including corrective measures and actions required, and furnish copy of record to each participant.

5.4.1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver sheet metal flashing materials and fabrications undamaged. Protect sheet metal flashing and trim materials and fabrications during transportation and handling.
- B. Unload, store, and install sheet metal flashing materials and fabrications in a manner to prevent bending, warping, twisting, and surface damage.
- C. Stack materials on platforms or pallets, covered with suitable weather tight and ventilated covering. Do not store sheet metal flashing and trim materials in contact with other materials that might cause staining, denting, or other surface damage.

5.4.1.7 COORDINATION

- A. Coordinate installation of sheet metal flashing and trim with interfacing and adjoining construction to provide a leak proof, secure, and noncorrosive installation.

PRODUCTS

5.4.2.1 SHEET METALS

- A. Aluminum Sheet: ASTM B 209M, Alloy 3003, 3004, 3105, or 5005, Temper suitable for forming and structural performance required, but not less than H14, finished as follows:
 1. Anodized Finish: Apply the following coil-anodized finish:
 - a. Class I, Clear Anodic Finish: AA-M12C22A41 (Mechanical Finish: non-specular as-fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, clear coating but 0.025 mm or thicker) complying with AAMA 611.

5.4.2.2 UNDERLAYMENT MATERIALS

- A. Slip Sheet: Rosin-sized paper, minimum 0.16 kg/sq. m.

5.4.2.3 MISCELLANEOUS MATERIALS

- A. General: Provide materials and types of fasteners, solder, welding rods, protective coatings, separators, sealants, and other miscellaneous items as required for complete sheet metal flashing and trim installation.
- B. **Fasteners:** Wood screws, annular threaded nails, self-tapping screws, self-locking rivets and bolts, and other suitable fasteners designed to withstand design loads.
 - 1. Fasteners: Stainless steel.
 - 2. Fasteners for Flashing and Trim: Blind fasteners or self-drilling screws, gasketed, with hex washer head.
 - 3. Blind Fasteners: High-strength aluminum or stainless-steel rivets.
 - 4. Spikes and Ferrules: Same material as gutter; with spike with ferrule matching internal gutter width.
- C. **Sealing Tape:** Pressure-sensitive, 100 percent solids, polyisobutylene compound sealing tape with release-paper backing. Provide permanently elastic, non-sag, nontoxic, non-staining tape.
- D. **Elastomeric Sealant:** ASTM C 920, elastomeric polyurethane, polysulfide or silicone polymer sealant; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and remain watertight.
- E. **Butyl Sealant:** ASTM C 1311, single-component, solvent-release butyl rubber sealant, polyisobutylene plasticized, heavy bodied for hooked-type expansion joints with limited movement.
- F. Bituminous Coating: Cold-applied asphalt mastic, SSPC-Paint 12, compounded for 0.4 mm dry film thickness per coat. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.

5.4.2.4 MANUFACTURED SHEET METAL FLASHING AND TRIM

- A. Flashing: Fabricate from aluminum sheets to details indicated on Drawings and approved shop drawings. Thickness shall not be less than 1.00 mm.

5.4.2.5 FABRICATION, GENERAL

- A. General: Custom fabricate sheet metal flashing and trim to comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, metal, and other characteristics of item indicated. Shop fabricate items where practicable. Obtain field measurements for accurate fit before shop fabrication.
- B. Fabricate sheet metal flashing and trim in thickness or weight needed to comply with performance requirements, but not less than that specified for each application and metal.
- C. Fabricate sheet metal flashing and trim without excessive oil canning, buckling, and tool marks and true to line and levels indicated, with exposed edges folded back to form hems.
 - 1. Seams for Aluminum: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints for additional strength.
 - 2. Seams for Other Than Aluminum: Fabricate nonmoving seams in accessories with flat-lock seams. Tin edges to be seamed, form seams, and solder.

- D. Sealed Joints: Form non-expansion but movable joints in metal to accommodate elastomeric sealant to comply with SMACNA recommendations.
- E. Expansion Provisions: Where lapped or bayonet-type expansion provisions in the Work cannot be used, form expansion joints of intermeshing hooked flanges, not less than 25 mm deep, filled with elastomeric sealant concealed within joints.
- F. Conceal fasteners and expansion provisions where possible on exposed-to-view sheet metal flashing and trim, unless otherwise indicated.
- G. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal.
 - 1. Thickness: As recommended by SMACNA's "Architectural Sheet Metal Manual" for application but not less than thickness of metal being secured.
- H. Separate metal from non-compatible metal or corrosive substrates by coating concealed surfaces at locations of contact with asphalt mastic or other permanent separation as recommended by manufacturer.

5.4.2.6 FINISHES

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Aluminum finish is specified in Clause 2.1 of this Section.

EXECUTION

5.4.3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with the Installer present, to verify actual locations, dimensions and other conditions affecting performance of work.
 - 1. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.
 - 2. Proceed with installation only after unsatisfactory conditions have been corrected.

5.4.3.2 INSTALLATION, GENERAL

- A. General: Anchor sheet metal flashing and trim and other components of the Work securely in place, with provisions for thermal and structural movement. Use fasteners, solder, welding rods, protective coatings, separators, sealants, and other miscellaneous items as required to complete sheet metal flashing and trim system.
 - 1. Torch cutting of sheet metal flashing and trim is not permitted.
- B. **Metal Protection:** Where dissimilar metals will contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with bituminous coating or by other permanent separation as recommended by fabricator or manufacturers of dissimilar metals.

1. Coat side of uncoated aluminum sheet metal flashing and trim with bituminous coating where flashing and trim will contact wood, ferrous metal, or cementations construction.
 2. Underlayment: Where installing metal flashing directly on cementations or wood substrates, install a course of felt underlayment and cover with a slip sheet or install a course of polyethylene underlayment.
 3. Bed flanges in thick coat of asphalt roofing cement where required for waterproof performance.
- C. Install exposed sheet metal flashing and trim without excessive oil canning, buckling, and tool marks.
- D. Install sheet metal flashing and trim true to line and levels indicated. Provide uniform, neat seams with minimum exposure of solder, welds, and elastomeric sealant.
- E. Install sheet metal flashing and trim to fit substrates and to result in watertight performance. Verify shapes and dimensions of surfaces to be covered before fabricating sheet metal.
1. Space cleats not more than 300 mm apart. Anchor each cleat with two fasteners. Bend tabs over fasteners.
- F. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 3 m with no joints allowed within 600 mm of corner or intersection. Where lapped or bayonet-type expansion provisions cannot be used or would not be sufficiently watertight, form expansion joints of intermeshing hooked flanges, not less than 25 mm deep, filled with elastomeric sealant concealed within joints.
- G. Fasteners: Use fasteners of sizes that will penetrate substrate not less than 32 mm for nails and not less than 20 mm for wood screws.
1. Aluminum: Use stainless-steel fasteners.
- H. Seal joints with elastomeric sealant as required for watertight construction.
1. Where sealant-filled joints are used, embed hooked flanges of joint members not less than 25 mm into sealant. Form joints to completely conceal sealant. When ambient temperature at time of installation is moderate, between 4 and 21 deg. C, set joint members for 50 percent movement either way. Adjust setting proportionately for installation at higher ambient temperatures. Do not install sealant-type joints at temperatures below 4 deg. C.
 2. Prepare joints and apply sealants to comply with requirements in 7.0 Section "Joint Sealants."
- I. Aluminum Flashing: Rivet or weld joints in uncoated aluminum where necessary for strength.

5.4.3.3 ROOF FLASHING INSTALLATION

- A. General: Install sheet metal roof flashing and trim to comply with performance requirements, sheet metal manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners

where possible, set units true to line, and level as indicated. Install work with laps, joints, and seams that will be permanently watertight.

- B. **Counter flashing:** Coordinate installation of counter flashing with installation of base flashing. Insert counter flashing in reglets or receivers and fit tightly to base flashing. Extend counter flashing 100 mm over base flashing. Lap counter flashing joints a minimum of 100 mm and bed with elastomeric sealant.
 - 1. Secure in a waterproof manner by means of snap-in installation and sealant or lead wedges and sealant.
- C. **Roof-Penetration Flashing:** Coordinate installation of roof-penetration flashing with installation of roofing and other items penetrating roof. Install flashing as follows:
 - 1. Turn lead flashing down inside vent piping, being careful not to block vent piping with flashing.
 - 2. Seal with elastomeric sealant and clamp flashing to pipes penetrating roof except for lead flashing on vent piping.

5.4.3.4 **CLEANING AND PROTECTION**

- A. Clean exposed metal surfaces of substances that interfere with uniform oxidation and weathering.
- B. Clean and neutralize flux materials. Clean off excess solder and sealants.
- C. Remove temporary protective coverings and strippable films as sheet metal flashing and trim are installed. On completion of installation, clean finished surfaces, including removing unused fasteners, metal filings, pop rivet stems, and pieces of flashing. Maintain in a clean condition during construction.
- D. Replace sheet metal flashing and trim that have been damaged or that have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

5.5 - JOINT SEALANTS

GENERAL

5.5.1.1 RELATED DOCUMENTS

- A. Related Drawing and Detail.

5.5.1.2 SUMMARY

- A. This Section includes sealants for the applications indicated on Drawings and applications specified by reference to this Section.
- B. Related Sections include the following:
 - 1. Section "Unit Block Masonry Assemblies" for masonry control and expansion joint fillers and gaskets.
 - 2. 7.0, "Sheet Metal Flashing and Trim" for sealing joints related to flashing and sheet metal for roofing.
 - 3. 8.0 Section "Glazing" for glazing sealants.
 - 4. 9.0 Section "Gypsum Board Assemblies" for sealing perimeter joints of gypsum board assemblies to reduce sound transmission.
 - 5. 9.0 "Ceramic Tile" for sealing joints in ceramic tile.
 - 6. 9.0 Section "Acoustical Panel Ceilings" for sealing edge moldings at perimeters of acoustical ceilings.

5.5.1.3 DEFINITIONS

- A. **TRAFFICABLE SEALANT:** To qualify for traffic use under ASTM C 920 requirements, elastomeric sealants must demonstrate a shore A hardness of not less than 25 nor more than 50
- B. **LOW MODULUS:** Tensile strength of 310 kPa or less.
- C. **MEDIUM MODULUS:** Tensile strength of not less than 310 kPa or more than 517 kPa. Movement capabilities of $\pm 50\%$
- D. **HIGH MODULUS:** Tensile strength of more 517 kPa. Joint movement is limited to $\pm 25\%$ or less

5.5.1.4 PERFORMANCE REQUIREMENTS

- A. Provide joint sealants that have been produced and installed to establish and maintain airtight continuous seals, that are water resistant and cause no staining or deterioration of joint substrates.
- B. Sealant shall be compatible for adhesion with specified aluminum finishes, resin base paint, glass, stone, metal, ceramic tiles, anodized aluminum, galvanized steel and plastics such as polycarbonate and pvc etc.
- C. Sealant shall be capable of withstanding dynamic movement of $\pm 50\%$.
- D. Bond width of the sealant shall be minimum 10 mm.
- E. All exterior joints shall be filled with self-expanding "Compriband"
- F. Where required, use acoustical foam tape in conjunction with sealant.
- G. Sealant shall be non-chalking and non-cracking. Based on performance, the sealant shall be non-fire hazard.
- H. Sealants for joints that may be exposed to direct sun rays shall be UV-resistant.
- I. Fire-Resistive Joint Sealants: Provide joint sealants with fire-resistance ratings indicated, as determined per ASTM E 119, but not less than that equaling or exceeding the fire-resistance rating of the construction in which the joint occurs.

5.5.1.5 SUBMITTALS

- A. **Product Data:** For each joint-sealant product indicated.
- B. **Samples for Initial Selection:** Manufacturer's color charts consisting of strips of cured sealants showing the full range of colors available for each product exposed to view.
- C. **Samples for Verification:** For each type and color of joint sealant required. Install joint sealants in 13-mm- (1/2") wide joints formed between two 150-mm- (6") long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.
- D. **Product Certificates:** Signed by manufacturers of joint sealants certifying that products furnished comply with requirements and are suitable for the use indicated.
- E. **Installer Certificates:** Signed by product manufacturer certifying that Installer is approved, authorized, or licensed by manufacturer to install his products.
- F. **Installer Experience:** List of five projects (minimum) of a similar nature carried out successfully by the installer with the same product endorsed by the manufacturer's representative.
- G. **Qualification Data:** For firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects/Consultants and owners, and other information specified.
- H. **Preconstruction Field Test Reports:** Indicate which sealants and joint preparation methods resulted in optimum adhesion to joint substrates based on preconstruction testing specified in "Quality Assurance" Article.
- I. **Field Test Report Log:** For each elastomeric sealant application. Include information specified in "Field Quality Control" Article.
- J. **Product Test Reports:** From a qualified testing agency indicating sealants comply with requirements and are compatible with joint substrates, shims, joints sealant backings, secondary seals and miscellaneous materials, based on comprehensive testing of current product formulations.
- K. **Warranties:** Special warranties specified in this Section.

5.5.1.6 QUALITY ASSURANCE

- A. **Quality System:** Comply with ISO 9001/9002 Quality System as a minimum. Incorporate all the standard procedures supplied by the Consultant and the Employer.
- B. **Installer Qualifications:** An experienced installer who has specialized in installing joint sealants similar in material, design, and extent to those indicated for this Project and whose work has resulted in joint-sealant installations with a record of successful in-service performance.
- C. **Source Limitations:** Obtain each type of joint sealant through one source from a single manufacturer.
- D. **Product Testing:** Obtain test results for "Product Test Reports" Paragraph in "Submittals" Article from a qualified testing agency based on testing current sealant formulations within a 36-month period.
 - 1. Testing Agency Qualifications: An independent testing agency qualified according to ASTM C 1021 to conduct the testing indicated, as documented according to ASTM E 548.

2. Test elastomeric joint sealants for compliance with requirements specified by reference to ASTM C 920, and where applicable, to other standard test methods.
 3. Test elastomeric joint sealants according to SWRI's Sealant Validation Program for compliance with requirements specified by reference to ASTM C 920 for adhesion and cohesion under cyclic movement, adhesion-in peel, and indentation hardness.
 4. Test other joint sealants for compliance with requirements indicated by referencing standard specifications and test methods.
 5. Include test results performed on joint sealants after they have cured for 1 year.
- E. **Preconstruction Field-Adhesion Testing:** Before installing elastomeric sealants, field test their adhesion to joint substrates as follows:
1. Locate test joints where indicated or, if not indicated, as directed by Consultant.
 2. Conduct field tests for each application indicated below:
 - a. Each type of elastomeric sealant and joint substrate indicated.
 - b. Each type of non-elastomeric sealant and joint substrate indicated.
 3. Notify Consultant seven days in advance of dates and times when test joints will be erected.
 4. Arrange for tests to take place with joint sealant manufacturer's technical representative present.
 5. Test Method: Test joint sealants by hand-pull method described below:
 - a. Install joint sealants in 1500-mm- long joints using same materials and methods for joint preparation and joint-sealant installation required for the completed Work. Allow sealants to cure fully before testing.
 - b. Make knife cuts from one side of joint to the other, followed by two cuts approximately 50 mm long at sides of joint and meeting cross cut at one end. Place a mark 25 mm from cross-cut end of 50-mm piece.
 - c. Use fingers to grasp 50-mm piece of sealant between cross-cut end and 25-mm mark; pull firmly at a 90-degree angle or more in direction of side cuts while holding a ruler along side of sealant. Pull sealant out of joint to the distance recommended by sealant manufacturer for testing adhesive capability, but not less than that equaling specified maximum movement capability in extension; hold this position for 10 seconds.
 - d. For joints with dissimilar substrates, check adhesion to each substrate separately. Do this by extending cut along one side, checking adhesion to opposite side, and then repeating this procedure for opposite side.
 6. Report whether sealant in joint connected to pulled-out portion failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each type of product and joint substrate. For sealants that fail adhesively, retest until satisfactory adhesion is obtained.
 7. Evaluation of Preconstruction Field-Adhesion-Test Results: Sealants not evidencing adhesive failure from testing, in absence of other indications of noncompliance with requirements, will be considered satisfactory. Do not use sealants that fail to adhere to joint substrates during testing.
- F. **Mockups:** Before installing joint sealants, apply elastomeric sealants as follows to verify selections made under sample Submittals and to demonstrate aesthetic effects and qualities of materials and execution:

1. Joints in mockups of assemblies specified in other Sections that are indicated to receive elastomeric joint sealants, which are specified by reference to this Section.

5.5.1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials to Project site in original unopened containers or bundles with labels indicating manufacturer, product name and designation, color, expiration date, pot life, curing time, and mixing instructions for multi component materials.
- B. Store and handle materials in compliance with manufacturer's written instructions to prevent their deterioration or damage due to moisture, high or low temperatures, contaminants, or other causes.

5.5.1.8 PROJECT CONDITIONS

- A. **Environmental Limitations:** Do not proceed with installation of joint sealants under the following conditions:
 1. When ambient and substrate temperature conditions are outside limits permitted by joint sealant manufacturer.
 2. When ambient and substrate temperature conditions are outside limits permitted by joint sealant manufacturer or are below 4.4 deg C.
 3. When joint substrates are wet.
- B. **Joint-Width Conditions:** Do not proceed with installation of joint sealants where joint widths are less than those allowed by joint sealant manufacturer for applications indicated.
- C. **Joint-Substrate Conditions:** Do not proceed with installation of joint sealants until contaminants capable of interfering with adhesion are removed from joint substrates.

5.5.1.9 SEQUENCE AND SCHEDULING

- A. Sequence installation of joint sealants to occur not less than 21 or more than 30 days after completion of waterproofing, unless otherwise indicated.

5.5.1.10 WARRANTY

- A. **General Warranty:** Special warranties specified in this Article shall not deprive Employer of other rights Employer may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.
- B. **Special Installer's Warranty:** Written warranty, signed by Installer agreeing to repair or replace elastomeric joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.
 - 1. Warranty Period: Two years from date of Substantial Completion.
- C. **Special Manufacturer's Warranty:** Written warranty, signed by elastomeric sealant manufacturer agreeing to furnish elastomeric joint sealants to repair or replace those that do not comply with performance and other requirements specified in this Section within specified warranty period.
 - 1. Warranty Period: 10 years from date of Substantial Completion.
- D. Special warranties specified in this Article exclude deterioration or failure of elastomeric joint sealants from the following:
 - 1. Movement of the structure resulting in stresses on the sealant exceeding sealant manufacturer's written specifications for sealant elongation and compression caused by structural settlement or errors attributable to design or construction.
 - 2. Disintegration of joint substrates from natural causes exceeding design specifications.
 - 3. Mechanical damage caused by individuals, tools, or other outside agents.
 - 4. Changes in sealant appearance caused by accumulation of dirt or other atmospheric contaminants.

PRODUCTS

5.5.2.1 MATERIALS, GENERAL

- A. **Compatibility:** Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by sealant manufacturer based on testing and field experience.
- B. **Colors of Exposed Joint Sealants:** As selected by Consultant from manufacturer's full ranges for this characteristic.

5.5.2.2 SOLVENT-RELEASE-CURING JOINT SEALANTS

- A. **Acrylic Sealant:** Manufacturer's standard one-part, nonsag, solvent-release-curing acrylic terpolymer sealant complying with AAMA 808.3 or FS TT-S-00230 or both, with capability when tested for adhesion and cohesion under maximum cyclic movement per ASTM C 719, to withstand the following percentage change in joint width existing at time of application and remain adhered to joint substrates indicated for Project without failing cohesively:
 - 1. 12-1/2 percent movement in both extension and compression for a total of 25 percent.

5.5.2.3 ELASTOMERIC JOINT SEALANTS

- A. **Elastomeric Sealant Standard:** Comply with ASTM C 920 and other requirements indicated for each liquid-applied chemically curing sealant in the Elastomeric Joint-Sealant Schedule at the end of Part 3, including those referencing ASTM C 920 classifications for type, grade, class, and uses.
- B. **Additional Movement Capability:** Where additional movement capability is specified in the Elastomeric Joint-Sealant Schedule, provide products with the capability, when tested for adhesion and cohesion under maximum cyclic movement per ASTM C 719, to withstand the specified percentage change in the joint width existing at the time of installation and remain in compliance with other requirements of ASTM C 920 for uses indicated.
- C. **Stain-Test-Response Characteristics:** Where elastomeric sealants are specified in the Elastomeric Joint-Sealant Schedule to be non-staining to porous substrates, provide products that have undergone testing according to ASTM C 1248 and have not stained porous joint substrates indicated for Project.
- D. **Suitability for Contact with Food:** Where elastomeric sealants are indicated for joints that will come in repeated contact with food, provide products that comply with 21 CFR 177.2600.
- E. **Suitability for Immersion in Liquids.** Where elastomeric sealants are indicated for Use I for joints that will be continuously immersed in liquids, provide products that have undergone testing according to ASTM C 1247 and qualify for the length of exposure indicated by reference to ASTM C 920 for Class 1 or 2. Liquid used for testing sealants is deionized water, unless otherwise indicated.

5.5.2.4 ACOUSTICAL JOINT SEALANTS

- A. **Acoustical Sealant for Exposed and Concealed Joints:** For each product of this description indicated in the Acoustical Joint-Sealant Schedule at the end of Part 3, provide manufacturer's standard non-sag, paintable, non-staining latex sealant complying with ASTM C 834 and the following:
 - 1. Product effectively reduces airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E 90.

5.5.2.5 LATEX JOINT SEALANTS

- A. **Latex Sealant Standard:** Comply with ASTM C 834

5.5.2.6 JOINT-SEALANT BACKING

- A. **General:** Provide sealant backings of material and type that are non-staining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.
- B. **Cylindrical Sealant Backings:** ASTM C 1330, of type indicated below and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance:
 - 1. Proprietary, reticulated, closed-cell polymeric foam, nonoutgassing, with a density of 40 kg/cu. m and tensile strength of 241 kPa in

accordance with ASTM D 1623, and with water absorption less than 0.02 g/cc in accordance with ASTM C 1083.

- C. **Bond-Breaker Tape:** Polyethylene tape or other plastic tape recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint-filler materials or joint surfaces at back of joint where such adhesion would result in sealant failure. Provide self-adhesive tape where applicable.
- D. **Elastomeric Tubing Joint Backings:** Neoprene, butyl, EPDM, or silicone tubing complying with ASTM D 1056, nonabsorbent to water and gas, capable of remaining resilient at temperatures down to -32 deg C. Provide products with low compression set and of size and shape to provide a secondary seal, to control sealant depth, and otherwise contribute to optimum sealant performance.

5.5.2.7 MISCELLANEOUS MATERIALS

- A. **Primer:** Material recommended by joint sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.
- B. **Cleaners for Nonporous Surfaces:** Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way, and formulated to promote optimum adhesion of sealants with joint substrates.
- C. **Masking Tape:** Non-staining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

EXECUTION

5.5.3.1 EXAMINATION

- A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint-sealant performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

5.5.3.2 PREPARATION

- A. **Surface Cleaning of Joints:** Clean out joints immediately before installing joint sealants to comply with joint sealant manufacturer's written instructions and the following requirements:
 - 1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.
 - 2. Clean porous joint substrate surfaces by brushing, grinding, blast cleaning, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining from above cleaning operations by vacuuming or blowing out joints with oil-free compressed air. Porous joint surfaces include the following:
 - a) Concrete.

- b) Masonry.
 - c) Unglazed surfaces of ceramic tile.
 - 3. Remove laitance and form-release agents from concrete.
 - 4. Clean nonporous surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants.
 - a) Metal.
 - b) Glass.
 - c) Porcelain enamel.
 - d) Glazed surfaces of ceramic tile.
- B. **Joint Priming:** Prime joint substrates where recommended in writing by joint sealant manufacturer, based on preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.
- C. **Masking Tape:** Use masking tape where required to prevent contact of sealant with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

5.5.3.3 INSTALLATION OF JOINT SEALANTS

- A. **General:** Comply with joint sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.
- B. **Sealant Installation Standard:** Comply with recommendations of ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.
- C. **Acoustical Sealant Application Standard:** Comply with recommendations of ASTM C 919 for use of joint sealants in acoustical applications as applicable to materials, applications, and conditions indicated.
- D. Install sealant backings of type indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
 - 1. Do not leave gaps between ends of sealant backings.
 - 2. Do not stretch, twist, puncture, or tear sealant backings.
 - 3. Remove absorbent sealant backings that have become wet before sealant application and replace them with dry materials.
- E. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and back of joints.
- F. Install sealants by proven techniques to comply with the following and at the same time backings are installed:
 - 1. Place sealants so they directly contact and fully wet joint substrates.
 - 2. Completely fill recesses provided for each joint configuration.
 - 3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.
- G. **Tooling of Non-sag Sealants:** Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified

below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.

1. Remove excess sealants from surfaces adjacent to joint.
2. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.
3. Provide concave joint configuration per Figure 5A in ASTM C 1193, unless otherwise indicated.
4. Provide flush joint configuration, per Figure 5B in ASTM C 1193, where indicated.
5. Provide recessed joint configuration, per Figure 5C in ASTM C 1193, of recess depth and at locations indicated.
 - a) Use masking tape to protect adjacent surfaces of recessed tooled joints.

5.5.3.4 FIELD QUALITY CONTROL

A. Field-Adhesion Testing: Field-test joint-sealant adhesion to joint substrates as follows:

1. Extent of Testing: Test completed elastomeric sealant joints as follows:
 - a) Perform 10 tests for the first 300 m of joint length for each type of elastomeric sealant and joint substrate.
 - b) Perform one test for each 300 m of joint length thereafter or one test per each floor per elevation.
2. **Test Method:** Test joint sealants by hand-pull method described below:
 - a) Make knife cuts from one side of joint to the other, followed by two cuts approximately 50 mm long at sides of joint and meeting cross cut at one end. Place a mark 25 mm from cross-cut end of 50-mm piece.
 - b) Use fingers to grasp 50-mm piece of sealant between cross-cut end and 25-mm mark; pull firmly at a 90-degree angle or more in direction of side cuts while holding a ruler along side of sealant. Pull sealant out of joint to the distance recommended by sealant manufacturer for testing adhesive capability, but not less than that equaling specified maximum movement capability in extension; hold this position for 10 seconds.
 - c) For joints with dissimilar substrates, check adhesion to each substrate separately. Do this by extending cut along one side, checking adhesion to opposite side, and then repeating this procedure for opposite side.
3. Inspect joints for complete fill, for absence of voids, and for joint configuration complying with specified requirements. Record results in a field adhesion test log.
4. Inspect tested joints and report on the following:
 - a) Whether sealants in joints connected to pulled-out portion failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each type of product and joint substrate. Compare these results to determine if adhesion passes sealant manufacturer's field- adhesion hand-pull test criteria.
 - b) Whether sealants filled joint cavities and are free from voids.

- c) Whether sealant dimensions and configurations comply with specified requirements.
- 5. Record test results in a field adhesion test log. Include dates when sealants were installed, names of persons who installed sealants, test dates, test locations, whether joints were primed, adhesion results and percent elongations, sealant fill, sealant configuration, and sealant dimensions.
- 6. Repair sealants pulled from test area by applying new sealants following same procedures used to originally seal joints. Ensure that original sealant surfaces are clean and new sealant contacts original sealant.
- B. **Evaluation of Field-Test Results:** Sealants not evidencing adhesive failure from testing or noncompliance with other indicated requirements, will be considered satisfactory. Remove sealants that fail to adhere to joint substrates during testing or to comply with other requirements. Retest failed applications until test results prove sealants comply with indicated requirements.

5.5.3.5 SEALANT INSTALLATION SCHEDULE

- A. **General:** Unless otherwise indicated, install sealants at the following locations. For locations and applications not specified, install sealants of types recommended by the joint sealant manufacturer.
- B. **Exterior Joints:**
 - 1. Non-Traffic Joints: One-part non-sag urethane sealant.
 - 2. Joints Subject to Traffic: Multi-part pourable urethane sealant.
- C. **Interior Joints:**
 - 1. Joints Subject to Traffic: Multi-part pourable urethane sealant.
 - 2. Non-Traffic Joints:
 - a) Joints Subject to Movement of 10 to 25 Percent: One-part non-sag urethane sealant.
 - b) Joints Subject to Movement Under 10 Percent: Acrylic sealant.
 - 3. Tiled Areas and Areas Subject to Attack by Mildew: One-part mildew-resistant silicone sealant.
 - 4. Acoustical Rated Assemblies: Use acoustical sealant for sealing joints through and around acoustical rated assemblies.
 - 5. Paintable Wall Joints: Acrylic sealant.
 - 6. Sealants Subject to Contact with Food: Comply with requirements in Clause 2.3/D of this Section.
 - 7. Sealants Subject to Water Immersion: Comply with requirements in Clause 2.3/E of this Section.

5.5.3.6 CLEANING

- A. Clean off excess sealants or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

PROTECTION

- A. Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from the original work.

END OF SECTION

2. Doors and Windows

6.1- ALUMINIUM FRAMED ENTRANCES AND STOREFRONTS

GENERAL

6.1.1.1 RELATED DOCUMENTS

- A. Drawing and general provisions of the contracts, including general and supplementary Conditions.

6.1.1.2 SUMMARY

- A. This Section includes the following:
 - 1. Exterior manual-swing aluminum doors.
- B. Related Sections include the following:
 - 1. 8.0 Section "Door Hardware" for lock cylinders and closers.
 - 2. 8.0 Section "Glazing" for glazing requirements to the extent not specified in this Section.

6.1.1.3 PERFORMANCE REQUIREMENTS

- A. **General:** Provide aluminum-framed systems, including anchorage, capable of withstanding, without failure, the effects of the following:
 - 1. Structural loads.
 - 2. Thermal movements.
 - 3. Movements of supporting structure indicated on Drawings including, but not limited to, story drift and deflection from uniformly distributed and concentrated live loads.
 - 4. Dimensional tolerances of building frame and other adjacent construction.
 - 5. Failure includes the following:
 - a) Deflection exceeding specified limits.
 - b) Thermal stresses transferred to building structure.
 - c) Framing members transferring stresses, including those caused by thermal and structural movements, to glazing.
 - d) Glazing-to-glazing contact.
 - e) Noise or vibration created by wind and thermal and structural movements.
 - f) Loosening or weakening of fasteners, attachments, and other components.
 - g) Sealant failure.
 - h) Failure of operating units to function properly.
- B. **Structural Loads:**
 - 1. Wind Loads: Uniform Building Code (UBC) 1997 Edition, Exposure C, Basic Wind Speed 130 km/hr.
 - 2. Seismic Loads: Provide aluminum systems, including anchorage, capable of withstanding the effects of earthquake motions calculated according to requirements of Uniform Building Code (UBC), 1997 Edition, Zone 2A.
- C. **Deflection of Framing Members:**
 - 1. **Deflection Normal to Wall Plane:** Limited to 1/175 of clear span for spans up to 4.1 m and to 1/240 of clear span plus 6.35 mm (4/16") for spans greater than 4.1 m (3/16").
 - 2. **Deflection Parallel to Glazing Plane:** Limited to amount not exceeding that which reduces glazing bite to less than 75 percent of design dimension and that which reduces edge clearance between framing members and glazing or other fixed components directly below to less than 3.2 mm (2/16")

and clearance between members and operable units directly below to less than 1.5 mm (1/16").

- D. **Structural-Test Performance:** Provide aluminum systems tested according to ASTM E 330 as follows:
 - 1. When tested at positive and negative wind-load design pressures, systems do not evidence deflection exceeding specified limits.
 - 2. When tested at 150 percent of positive and negative wind-load design pressures, systems, including anchorage, do not evidence material failures, structural distress, and permanent deformation of main framing members exceeding 0.2 percent of span.
 - 3. Test Durations: As required by design wind velocity but not less than 10 seconds.
- E. **Thermal Movements:** Provide exterior aluminum systems that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures. Base Consulting calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
 - 1. **Temperature Change (Range):** 35 deg C, ambient; 65 deg C, material surfaces.
 - 2. **Test Performance:** No buckling; stress on glass; sealant failure; excess stress on framing, anchors, and fasteners; or reduction of performance when tested according to AAMA 501.5.
 - a) Test Ambient Temperature Range: plus 15 to 55 deg. C.
- F. **Air Infiltration:** Provide exterior aluminum systems with maximum air leakage through fixed glazing and framing areas of 0.03 L/s per sq. m of fixed wall area when tested according to ASTM E 283 at a minimum static-air-pressure difference of 300 Pa.
- G. **Water Penetration Under Static Pressure:** Provide exterior aluminum systems that do not evidence water penetration through fixed glazing and framing areas when tested according to ASTM E 331 at a minimum static-air-pressure difference of 20 percent of positive wind-load design pressure, but not less than 300 Pa.
- F. **Water Penetration Under Dynamic Pressure:** Provide exterior aluminum systems that do not evidence water leakage through fixed glazing and framing areas when tested according to AAMA 501.1 under dynamic pressure equal to 20 percent of positive wind-load design pressure, but not less than 300 Pa.
- G. **Sound Transmission:** Provide exterior aluminum-framed systems with fixed glazing and framing areas having minimum STC 30 according to ASTM E 413 and an OITC 26 according to ASTM E 1332, as determined by testing according to ASTM E 90.

6.1.1.4 SUBMITTALS

- A. **Product Data:** Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of product indicated.

- B. **Shop Drawings:** For aluminum-framed systems. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Include structural analysis data signed and sealed by the qualified professional Consultant responsible for their preparation.
 - 2. Include details of provisions for system expansion and contraction and for draining moisture occurring within the system to the exterior.
 - 3. For entrances, include hardware schedule and indicate operating hardware types, functions, quantities, and locations.
- C. **Samples for Initial Selection:** For units with factory-applied color finishes.
- D. **Samples for Verification:** For each type of exposed finish required, in manufacturer's standard sizes.
- E. **Fabrication Sample:** Of each vertical-to-horizontal intersection of systems, made from 300-mm (12") lengths of full-size components and showing details of the following:
 - 1. Joinery
 - 2. Anchorage
 - 3. Expansion provisions
 - 4. Glazing
 - 5. Flashing and drainage
- F. Welding certificates.
- G. **Qualification Data:** For Installer and testing agency.
- H. **Preconstruction Sealant Test Reports:** For structural-sealant-glazed systems, compatibility and adhesion test reports from sealant manufacturer indicating that materials forming joint substrates and joint-sealant backings have been tested for compatibility and adhesion with sealants. Include sealant manufacturer's interpretation of test results for sealant performance and recommendations for primers and substrate preparation needed to obtain adhesion.
- I. **Product Test Reports:** Based on evaluation of comprehensive tests performed by a qualified testing agency, for aluminum-framed systems.
- J. Field quality-control test and inspection reports.
- K. **Maintenance Data:** For aluminum-framed systems to include in maintenance manuals.
- L. **Warranties:** Special warranties specified in this Section.

6.1.1.5 QUALITY ASSURANCE

- A. **Quality System:** Comply with ISO 9001/9002 Quality System as a minimum. Incorporate all the standard procedures supplied by the Consultant and the Employer.
- B. **Installer Qualifications:** Capable of assuming Consultant responsibility and performing work of this Section and who is acceptable to manufacturer.
 - 1. Consultant Responsibility: Preparation of data for aluminum-framed systems including Shop Drawings based on testing and Consultant analysis of manufacturer's standard units in assemblies similar to those indicated for this Project and submission of reports of tests performed on manufacturer's standard assemblies.
- C. **Testing Agency Qualifications:** An independent agency qualified according to ASTM E 699 for testing indicated.
- D. **Product Options:** Information on Drawings and in Specifications establishes requirements for systems' aesthetic effects and performance characteristics.

Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction. Performance characteristics are indicated by criteria subject to verification by one or more methods including preconstruction testing, field testing, and in-service performance.

1. Do not modify intended aesthetic effects, as judged solely by Consultant, except with Consultant's approval. If modifications are proposed, submit comprehensive explanatory data to Consultant for review.
- E. **Welding:** Qualify procedures and personnel according to AWS D1.2, "Structural Welding Code-Aluminum."
- F. **Mockups:** Prior to installing aluminum entrances, construct one mockup for an exterior aluminum entrances to verify selections made under sample submittals and to demonstrate aesthetic effects as well as qualities of materials and execution. Build mockups to comply with the following requirements, using materials indicated for Work. Include class, glazing materials and spandrel panels.
 1. Locate mockups on-site in the location and of the size indicated on Drawings.
 2. Notify Consultant 7 days in advance of the dates and times when mockups will be constructed.
 3. Demonstrate the proposed range of aesthetic effects and workmanship.
 4. Obtain Consultant's approval of mockups before start of Work.
 5. Retain and maintain mockups during construction in an undisturbed conditions as a standard for judging the completed Work.
 - a) Approved mockups in an undisturbed condition at the time of Substantial Completion as judged solely by the Consultant may become part of the completed Work, otherwise dismantle mockup and install permanent works.

6.1.1.6 PROJECT CONDITIONS

- A. **Field Measurements:** Verify actual locations of structural supports for aluminum-framed systems by field measurements before fabrication and indicate measurements on Shop Drawings.

6.1.1.7 WARRANTY

- A. **Special Assembly Warranty:** Manufacturer's standard form in which manufacturer agrees to repair or replace components of aluminum-framed systems that do not comply with requirements or that deteriorate as defined in this Section within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a) Structural failures including, but not limited to, excessive deflection.
 - b) Noise or vibration caused by thermal movements.
 - c) Deterioration of metals, metal finishes, and other materials beyond normal weathering.
 - d) Water leakage through fixed glazing and framing areas.
 - e) Failure of operating components to function properly.
 - f) Warranty Period: Five years from date of Substantial Completion.
- B. **Special Finish Warranty:** Manufacturer's standard form in which manufacturer agrees to repair or replace components on which finishes fail within specified warranty period. Warranty does not include normal weathering.
 - 1. Warranty Period: 20 years from date of Substantial Completion.

PRODUCTS

6.1.2.1 MATERIALS

- A. **Aluminum:** Alloy and temper recommended by manufacturer for type of use and finish indicated, but not less than alloy and temper 6063 T5. Minimum wall thickness of extrusions for main ribs shall be 2.00 mm.
 - 1. Sheet and Plate: ASTM B 209M.
 - 2. Extruded Bars, Rods, Profiles, and Tubes: ASTM B 221M.
 - 3. Extruded Structural Pipe and Tubes: ASTM B 429.
 - 4. Structural Profiles: ASTM B 308/B 308M.
 - 5. Welding Rods and Bare Electrodes: AWS A5.10/A5.10M.

6.1.2.2 FRAMING SYSTEMS

- A. **Framing Members:** Manufacturer's standard extruded-aluminum framing members of thickness required and reinforced as required to support imposed loads.
- B. **Brackets and Reinforcements:** Manufacturer's standard high-strength aluminum with non-staining, nonferrous shims for aligning system components.
- C. **Fasteners and Accessories:** Manufacturer's standard corrosion-resistant, non-staining, non-bleeding fasteners and accessories compatible with adjacent materials.
 - 1. Where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration, use self-locking devices.
 - 2. Reinforce members as required to receive fastener threads.
 - 3. Use exposed fasteners with countersunk Phillips screw heads, finished to match framing system.

6.1.2.3 Weather-stripping

- A. **Compression Weather stripping:** Cellular elastomeric preformed gasket and sealing material of vulcanized rubber, EPDM or neoprene, to ASTM D 2000

6.1.2.4 GLAZING SYSTEMS

- A. **Glass Type:** As indicated on Drawings and specified in 8.0, Section "Glazing".
- B. **Glazing Material:** As specified in 8.0 Section "Glazing."
- C. **Bond-Breaker Tape:** Manufacturer's standard TFE-fluorocarbon or polyethylene material to which sealants will not develop adhesion.

6.1.2.5 DOORS

- A. **Doors:** Manufacturer's standard glazed doors, for manual swing operation.
 - 1. Door Construction: 44-mm (2") overall thickness unless otherwise indicated on Drawings, with minimum 5-mm (3/16"), extruded-aluminum tubular rail and stile members. Mechanically fasten corners with reinforcing brackets that are deep penetration and fillet welded or that incorporate concealed tie rods.
 - 2. Door Design: Wide stile; 127-mm (5") nominal width.
 - 3. Glazing Stops and Gaskets: Square, snap-on, extruded-aluminum stops and preformed gaskets.
 - 4. Provide non removable glazing stops on outside of door.

6.1.2.6 HARDWARE

- A. **General:** Provide heavy-duty hardware units indicated in sizes, number, and type recommended by manufacturer for swing doors indicated and fabricated from cast, wrought or extruded aluminum. Finish exposed parts to match door finish, unless otherwise indicated.
- B. **Pivot Hinges:**
 - 1. Standard: BHMA A156.4, Grade 1.
 - 2. Offset-Pivot Hinges: Provide top, bottom and intermediated offset pivots at each door leave.
- C. **Closers, General:** Comply with requirements of 8.0 Section "Door Hardware" and manufacturer's recommendations for closer size, depending on door size, exposure to weather, and anticipated frequency of use.
 - 1. Closing Cycle: Comply with requirements of authorities having jurisdiction.
 - 2. Opening Force: Comply with the following maximum opening-force requirements for locations indicated:
 - a) Exterior Doors: 15 lbf (67 N).
- D. **Hardware for Swing Doors:**
 - 1. Hinges: As specified.
 - 2. Door Pulls: Provide manufacturer's standard aluminum pull grips.
 - 3. Door Stops: Floor-or-wall-mounted door stop as appropriate, with integral rubber bumper complying with ANSI A 156.16, Grade 1.
 - 4. Keyed Cylinders: Mortise-type, 5-pin tumbler, stainless steel, inside cylinder units with cast aluminum face complying with ANSI A 156.5, Grade 1. Furnish 4 keys for each cylinder. Include cylinders in the master keying system.

5. Locks: Roller type, for installation in aluminum styles of width indicated, aluminum casing.
6. Closers: As specified in this Section and in 8.0, Section "Door Hardware".

6.1.2.7 ACCESSORY MATERIALS

- A. **Joint Sealants:** For installation at perimeter of aluminum-framed systems, as specified in 7.0 Section "Joint Sealants."
- B. **Bituminous Paint:** Cold-applied asphalt-mastic paint complying with SSPC-Paint 12 requirements except containing no asbestos, formulated for 0.75-mm (1/32") thickness per coat.

6.1.2.8 FABRICATION

- A. **General:** Fabricate components that, when assembled, will have accurately fitted joints with ends coped or mitered to produce hairline joints free of burrs and distortion. After fabrication, clearly mark components to identify their locations in Project according to Shop Drawings.
 1. Form aluminum shapes before finishing.
 2. Weld in concealed locations to greatest extent possible to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.
 3. **Framing Members, General:** Fabricate components that, when assembled, have the following characteristics:
 - a) Profiles that are sharp, straight, and free of defects or deformations.
 - b) Accurately fitted joints with ends coped or mitered.
 - c) Means to drain water passing joints, condensation occurring within framing members, and moisture migrating within the system to exterior.
 - d) Physical and thermal isolation of glazing from framing members.
 - e) Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.
 - f) Provisions for field replacement of glazing from exterior or interior.
 - g) Fasteners, anchors, and connection devices that are concealed from view to greatest extent possible.
- B. **Mechanically Glazed Framing Members:** Fabricate for flush glazing (without projecting stops).
- C. **Door Frames:** Reinforce as required to support loads imposed by door operation and for installing hardware.
 1. At exterior doors, provide compression weather stripping at fixed stops.
 2. At interior doors, provide silencers at stops to prevent metal-to-metal contact. Install three silencers on strike jamb of single-door frames and two silencers on head of frames for pairs of doors.
- D. **Doors:** Reinforce doors as required for installing hardware.
 1. At pairs of exterior doors, provide sliding weather stripping retained in adjustable strip mortised into door edge.
 2. At exterior doors, provide weather sweeps applied to door bottoms.

- E. **Hardware Installation:** Factory install hardware to the greatest extent possible. Cut, drill, and tap for factory-installed hardware before applying finishes.
 - 1. After fabrication, clearly mark components to identify their locations in Project according to Shop Drawings.
- F. **Forming:** Form shapes with sharp profiles, straight and free of defects or deformations, before finishing.
 - 1. Prepare components to receive concealed fasteners and anchor and connection devices.
 - 2. Fabricate components to drain water passing joints and condensation and moisture occurring or migrating within the system to the exterior.
- G. **Welding:** Weld components to comply with referenced AWS standard. Weld before finishing components to greatest extent possible. Weld in concealed locations to greatest extent possible to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.
- H. **Glazing Channels:** Provide minimum clearances for thickness and type of glass indicated according to FGMA's "Glazing Manual."
- I. **Metal Protection:** Where aluminum will contact dissimilar metals, protect against galvanic action by painting contact surfaces with primer or by applying sealant or tape recommended by manufacturer for this purpose. Where aluminum will contact concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.
- J. **Entrances:** Fabricate door framing in profiles indicated. Reinforce as required to support imposed loads. Factory assemble door and frame units and factory install hardware to greatest extent possible. Reinforce door and frame units as required for installing hardware indicated. Cut, drill, and tap for factory-installed hardware before finishing components.
- K. **Exterior Doors:** Provide compression weather stripping at fixed stops. At other locations, provide sliding weather stripping retained in adjustable strip mortised into door edge.

6.1.2.9 ALUMINUM FINISHES

- A. **General:** Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
- C. **High-Performance Organic Finish (3-Coat Fluoropolymer):** AA-C12C40R1x (Chemical Finish: cleaned with inhibited chemicals; Chemical Finish: conversion coating; Organic Coating: manufacturer's standard 3-coat, thermocured system consisting of specially formulated inhibitive primer, fluoropolymer color coat, and clear fluoropolymer topcoat, with both color coat and clear topcoat containing not less than 70 percent polyvinylidene fluoride resin by weight). Prepare, pretreat, and apply coating to exposed metal surfaces to comply with AAMA 2605 and with coating and resin manufacturers' written instructions.
 - 1. Color and Gloss: As selected by Consultant from manufacturer's full range.

EXECUTION

6.1.3.1 EXAMINATION

- A. Examine areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of work.
 - 1. Proceed with installation only after unsatisfactory conditions have been corrected.

6.1.3.2 INSTALLATION

- A. Install aluminum swing doors in accordance with manufacturer's recommendations and approved shop drawings.
- B. Install units plumb, level, and square, true to line or curvature as required, in alignment with work of other trades, free from waves, buckles, sags or other defects. Provide secure anchorage for all parts of work. Coordinate with related trades to ensure proper mating and connecting of the work.
- C. Isolate aluminum from contact with dissimilar metals and materials by applying on contact surfaces a heavy coat of approved alkali-resistant bituminous paint; or by separating surfaces with a non-absorptive tape or gasket.
- D. Install work in prepared openings. Conform with applicable requirements for assuring use of proper materials and procedures to prevent electrolytic deterioration.
- E. Comply with manufacturer's instructions and recommendations for installation of work. Shim and allow for movement resulting from changes in thermal conditions.
- F. Set frames level, plumb and in true alignment in accordance with approved shop drawings. Construct completely tight and waterproof assemblies. Provide proper support and anchor securely in place.
- G. Provide sealing as necessary to make work watertight and properly finished including joints between frames and adjoining construction.
- H. **Moving Parts:** There shall be no aluminum to aluminum contact between hardware parts or swing doors members which move relative to each other and remain in contact.
- I. **Hardware:** Install hardware to hardware manufacturer's instructions and installation templates.

6.1.3.3 FIELD QUALITY CONTROL

- A. **Testing Agency:** Engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.
- B. **Test Services:** Test aluminum swing doors as part of the assembly including them as specified in relevant Specifications Sections.

6.1.3.4 Adjusting

- A. Adjust operating swing doors and hardware to provide a tight fit at contact points and weather-stripping for smooth operation and weathertight closure.

6.1.3.5 Cleaning

- A. Clean aluminum surfaces promptly after installing units. Avoid damaging protective coatings and finishes. Remove excess glazing and sealing compounds, dirt and other substances.

- B. Lubricate hardware and the moving parts. Clean glass of pre-glazed units promptly after installing sliding glass door units.
- C. Wash and polish glass on both faces not more than 4 days prior to the date scheduled for final inspection. Comply with manufacturer's recommendations for final cleaning and maintenance.
- D. Remove and replace glass that is broken, chipped, cracked, abraded, or damaged in other ways during the construction period, including by natural causes, accidents and vandalism at no additional cost to the Employer.

6.1.3.6 Protection

- A. Institute and maintain protective and other precautions required through remainder of construction period to ensure that except for normal weathering aluminum.
- B. Aluminum swing doors units will be clean, neat and without damage or deterioration at time of Substantial Completion.

6.2 - ALUMINUM WINDOWS

GENERAL

2.11.2.1 RELATED DOCUMENTS

- A. Drawing and general provisions of the Contract, including general and supplementary Conditions.

2.11.2.2 SUMMARY

- A. This Section includes aluminum-framed windows
- B. Related Sections include the following:
 - 1. 8.0 Section "Aluminum Framed Entrances and Storefronts."
 - 2. 8.0 Section "Glazing" for glazing requirements for aluminum windows, including those specified to be factory glazed.

2.11.2.3 DEFINITIONS

- A. Structural test pressure, for uniform load structural test, is equivalent to 150 percent of design pressure.

2.11.2.4 PERFORMANCE REQUIREMENTS

- A. **General:** Provide aluminum windows capable of complying with performance requirements indicated, based on testing manufacturer's windows that are representative of those specified and that are of test size indicated below:
 - 1. Size indicated on Drawings.
- B. **Structural Performance:** Provide aluminum windows capable of withstanding the following, including wind loads based on passing AAMA/NWWDA 101/I.S.2, Uniform Load Structural Test, at basic wind speed indicated:
 - 2. Deflection: Design glass framing system to limit lateral deflections of glass edges to less than 1/175 of glass-edge length 19 mm, whichever is less, at design pressure based on structural computations.
 - 3. Basic Wind Speed: Determine wind loads and resulting design pressures applicable to Project according to the following, based on mean roof heights above grade as indicated on Drawings:
 - a) Uniform Building Code, 1997 Edition, Exposure C, Basic Wind Speed 130 km/hr
- C. **Air Infiltration:** Maximum rate not more than indicated when tested according to AAMA/NWWDA 101/I.S.2, Air Infiltration Test.
 - 1. Maximum Rate: 2 cu. m/h x sq. m of area at an inward test pressure of 300 Pa.
- D. **Water Resistance:** No water leakage as defined in AAMA/NWWDA referenced test methods at a water test pressure equaling that indicated, when tested according to AAMA/NWWDA 101/I.S.2, Water Resistance Test.
 - 1. Test Pressure: 20 percent of positive design pressure, but not more than 580 Pa.
- E. **Thermal Transmittance:** Provide aluminum windows with a whole-window U-value maximum indicated at 15-mph (24-km/h) exterior wind velocity and winter condition temperatures when tested according to AAMA 1503 and ASTM E 1423.

1. U-Value: shall not exceed U-value specified for glass insulating units specified in 8.0 Section "Glazing".
- F. **Sound Transmission Class:** Provide glazed windows rated for not less than 26 STC when tested for laboratory sound transmission loss according to ASTM E 90 and determined by ASTM E 413.
- G. **Thermal Movements:** Provide aluminum windows, including anchorage, that accommodate thermal movements of units resulting from the following maximum change (range) in ambient and surface temperatures without buckling, distortion, opening of joints, failure of joint sealants, damaging loads and stresses on glazing and connections, and other detrimental effects. Base Consultant calculation on actual surface temperatures of materials due to solar heat gain and nighttime-sky heat loss.
 1. Temperature Change (Range): 35 deg C, ambient; 65 deg C material surfaces.
- H. **Life-Cycle Testing:** Test according to AAMA 910 and comply with AAMA/WDMA 101/I.S.2.

2.11.2.5 SUBMITTALS

- A. **Product Data:** Include construction details, material descriptions, fabrication methods, dimensions of individual components and profiles, hardware, finishes, and operating instructions for each type of aluminum window indicated.
- B. **Shop Drawings:** Include plans, elevations, sections, details, hardware, attachments to other Work, operational clearances, and the following:
 1. Mullion details, including reinforcement and stiffeners.
 2. Joinery details.
 3. Expansion provisions.
 4. Flashing and drainage details.
 5. Weather-stripping details.
 6. Thermal-break details.
 7. Glazing details.
 8. For installed products indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional Consultant responsible for their preparation and used to determine the following:
 - a) Structural test pressures and design pressures from basic wind speeds indicated.
 - b) Deflection limitations of glass framing systems.
- C. **Samples for Initial Selection:** For units with factory-applied color finishes.
- D. **Samples for Verification:** For aluminum window components required, prepared on Samples of size indicated below.
 1. Main Framing Member: 300-mm- (12") long, full-size sections of extrusions with factory-applied color finish.
 2. Hardware: Full-size units with factory-applied finish.
 3. Weather Stripping: 300-mm- (12") long sections.
 4. Consultant reserves the right to require additional samples that show fabrication techniques, workmanship, and design of hardware and accessories.
- E. **Qualification Data:** For manufacturer, Installer, and testing agency.

1. **Installer Experience:** List of five projects (minimum) of a similar nature carried out successfully by the installer with the same product endorsed by the manufacturer's representative.
 2. **Field Quality-Control Test Reports:** From a qualified testing and inspecting agency engaged by Contractor.
- F. **Product Test Reports:** Based on evaluation of comprehensive tests performed within the last four years by a qualified testing agency, for each type, grade, and size of aluminum window. Test results based on use of down-sized test units will not be accepted.
- G. **Maintenance Data:** For operable window sash, operating hardware, weather stripping and finishes to include in maintenance manuals.

2.11.2.6 QUALITY ASSURANCE

- A. **Quality System:** Comply with ISO 9001/9002 Quality System as a minimum. Incorporate all the standard procedures supplied by the Consultant and the Employer.
- B. **Manufacturer Qualifications:** A firm experienced in manufacturing items specified in this section similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to manufacture required units.
- C. **Installer Qualifications:** An installer acceptable to aluminum window manufacturer for installation of units required for this Project.
1. A qualified firm specializing in performing the work of this Section with minimum three years documented experience and that is approved, authorized, or licensed by the product manufacturer to install his product and that is eligible to receive manufacturer's warranty. Include project names and addresses, names and addresses of Consultants and Employers, and other information specified
- D. **Testing Agency Qualifications:** An independent testing agency, acceptable to Consultant, with the experience and capability to conduct the testing indicated, as documented according to ASTM E 548.
- E. **Source Limitations:** Obtain aluminum windows through one source from a single manufacturer.
- F. **Fenestration Standard:** Comply with AAMA/WDMA 101/I.S.2, "Voluntary Specifications for Aluminum, Vinyl (PVC) and Wood Windows and Glass Doors," for minimum standards of performance, materials, components, accessories, and fabrication unless more stringent requirements are indicated.
- G. **Mockups:** Build mockups to verify selections made under sample Submittals and to demonstrate aesthetic effects and qualities of materials and execution.
1. Build mockup in building envelope wall in locations selected by Consultant.
 2. Build one mockup of each type of windows indicated on Drawings.
 3. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion as judged solely by the Consultant, otherwise dismantle mockups, remove site and install permanent works.
- H. **Pre-installation Conference:** Conduct conference at Project site to comply with requirements in 1.0 Section "Project Management and Coordination."

2.11.2.7 PROJECT CONDITIONS

- A. **Field Measurements:** Verify aluminum window openings by field measurements before fabrication and indicate measurements on Shop Drawings.

2.11.2.8 WARRANTY

- A. **Special Warranty:** Provide written warranty signed by Manufacturer and Contractor in which manufacturer agrees to repair or replace aluminum windows that fail in materials or workmanship within specified warranty period. Failures include, but are not limited to, the following:
1. Failure to meet performance requirements.
 2. Structural failures including excessive deflection.
 3. Water leakage, air infiltration, or condensation.
 4. Faulty operation of movable sash and hardware.
 5. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
 6. Insulating glass failure.
 7. Warranty Period: 5 years from date of Substantial Completion.
 8. Warranty Period for Metal Finishes: 20 years from date of Substantial Completion.

PRODUCTS

6.2.2.1 MATERIALS, GENERAL

- A. **Aluminum Extrusions:** Alloy and temper recommended by aluminum window manufacturer for strength, corrosion resistance, and application of required finish, but not less than 150-MPa ultimate tensile strength, not less than 110-MPa minimum yield strength, and not less than 2.00 mm (3/32") thickness at any location for the main frame and sash members.
- B. **Fasteners:** Aluminum, nonmagnetic stainless steel, epoxy adhesive, or other materials warranted by manufacturer to be non-corrosive and compatible with aluminum window members, trim, hardware, anchors, and other components
1. Reinforcement: Where fasteners screw-anchor into aluminum less than 3.2 mm (2/16") thick, reinforce interior with aluminum or nonmagnetic stainless steel to receive screw threads, or provide standard, non-corrosive, pressed-in, splined grommet nuts.
 2. Exposed Fasteners: Unless unavoidable for applying hardware, do not use exposed fasteners. For application of hardware, use fasteners that match finish of member or hardware being fastened, as appropriate.
- C. **Anchors, Clips, and Accessories:** Aluminum, nonmagnetic stainless steel, or zinc-coated steel or iron complying with ASTM B 633 for SC 3 severe service conditions; provide sufficient strength to withstand design pressure indicated.
- D. **Reinforcing Members:** Aluminum or nonmagnetic stainless steel, complying with ASTM B 456 for Type SC 3 severe service conditions, provide sufficient strength to withstand design pressure indicated.
- E. **Sliding-Type Weather Stripping:** Provide woven-pile weather stripping of wool, polypropylene, or nylon pile and resin-impregnated backing fabric. Comply with AAMA 701/702.
1. Sliding Weather Stripping: Wool, polypropylene, or nylon woven pile with nylon--fabric or aluminum-strip backing complying with AAMA 701/702 requirements.

- F. **Compression-Type Weather Stripping:** Provide compressible weather stripping designed for permanently resilient sealing under bumper or wiper action, and completely concealed when aluminum window is closed.
 - 1. Weather-Stripping Material: Dense elastomeric gaskets complying with ASTM C 864 fabricated from EPDM.
- G. **Replaceable Weather Seals:** Comply with AAMA 701/702.
- H. **Sealant:** For sealants required within fabricated windows, provide window manufacturer's standard, permanently elastic, non-shrinking, and non-migrating type recommended by sealant manufacturer for joint size and movement.

6.2.2.2 GLAZING

- A. **Glass and Glazing Materials:** Refer to 8.0 Section "Glazing" for glass units and glazing requirements applicable to glazed aluminum window units.
- B. **Glazing System:** Manufacturer's standard factory-glazing system that produces weather tight seal or as indicated in 8.0 Section "Glazing".

6.2.2.3 HARDWARE

- A. **General:** Provide manufacturer's standard hardware fabricated from aluminum, designed to smoothly operate, tightly close, and securely lock aluminum windows and sized to accommodate sash or ventilator weight and dimensions. Cadmium-plated hardware is not permitted. Do not use aluminum in frictional contact with other metals. Where exposed, provide extruded, cast, or wrought aluminum with clear anodized satin finish.
- B. **Hardware, General:** Comply with AAMA 902.
- C. **Sill Cap/Track:** Extruded-aluminum with finish matching that of window track of thickness, dimensions, and profile indicated; designed to comply with performance requirements indicated and to drain to the exterior.
- D. **Locks and Latches:** Designed to allow unobstructed movement of the sash across adjacent sash in direction indicated and operated from the inside only.
- E. **Roller Assemblies:** Low-friction design.
- F. **Four- or Six-Bar Friction Hinges:** Comply with AAMA 904.
 - 1. Locking mechanism and handles for manual operation.
 - 2. Friction Shoes: Provide friction shoes of nylon or other nonabrasive, non-staining, non-corrosive, durable material.
- G. **Limit Devices:** Provide limit devices designed to restrict sash or ventilator opening.
 - 1. Safety Devices: Limit clear opening to 150 mm (6") for ventilation; with custodial key release.
- H. **Horizontal-Sliding Windows:** Provide the following operating hardware:
 - 1. Sash Rollers: Stainless-steel, lubricated ball-bearing rollers with nylon tires.
 - 2. Sash Lock: Spring-loaded, snap-type lock at jambs; two per sash.
- I. **Projected Windows:** Provide the following operating hardware:
 - 1. Hinge: Five-knuckle butt hinge.
 - 2. Lock: Combination lever handle and cam-action lock with concealed pawl and keeper.
 - 3. Limit Device: Concealed friction adjustor, adjustable stay bar limit device; located on jamb of each ventilator.

6.2.2.4 FABRICATION

- A. **General:** Fabricate aluminum windows, in sizes indicated, that comply with AAMA/WDMA 101/I.S.2 for performance class and performance grade indicated. Include a complete system for assembling components and anchoring windows.
- B. Fabricate aluminum windows that are reglazable without dismantling sash or ventilator framing.
- C. **Thermally Improved Construction:** Fabricate aluminum windows with an integral, concealed, low-conductance thermal barrier; located between exterior materials and window members exposed on interior side; in a manner that eliminates direct metal-to-metal contact.
 - 1. Provide thermal-break construction that has been in use for not less than three years and has been tested to demonstrate resistance to thermal conductance and condensation and to show adequate strength and security of glass retention.
 - 2. Provide thermal barriers tested according to AAMA 505; determine the allowable design shear flow per the appendix in AAMA 505.
 - 3. Provide hardware with low conductivity for hardware bridging thermal breaks at frame or vent sash.
- D. **Weather Stripping:** Provide full-perimeter weather stripping for each operable sash and ventilator.
- E. **Weep Holes:** Provide weep holes and internal passages to conduct infiltrating water to exterior.
- F. **Mullions:** Provide mullions and cover plates as shown, matching window units, complete with anchors for support to structure and installation of window units. Allow for erection tolerances and provide for movement of window units due to thermal expansion and building deflections, as indicated. Provide mullions and cover plates capable of withstanding design loads of window units.
- G. **Sub-frames:** Provide sub-frames with anchors for window units as shown, of profile and dimensions indicated but not less than 1.6-mm- (2/32") thick extruded aluminum. Miter or cope corners, and weld and dress smooth with concealed mechanical joint fasteners. Finish to match window units. Provide subframes capable of withstanding design loads of window units.
- H. **Factory-Glazed Fabrication:** Glaze aluminum windows in the factory where practical and possible for applications indicated. Comply with requirements in 8.0 Section "Glazing" and with AAMA/WDMA 101/I.S.2.
- I. **Glazing Stops:** Provide snap-on glazing stops coordinated with 8.0 Section "Glazing" and glazing system indicated. Provide glazing stops to match sash and ventilator frames.

6.2.2.5 FINISHES

- A. **General:** Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
- C. **High-Performance Organic Finish (3-Coat Fluoropolymer):** AA-C12C40R1x (Chemical Finish: cleaned with inhibited chemicals; Chemical Finish: conversion coating; Organic Coating: manufacturer's standard 3-coat, thermocured system consisting of specially formulated inhibitive primer, fluoropolymer color coat, and clear fluoropolymer topcoat, with both color

coat and clear topcoat containing not less than 70 percent polyvinylidene fluoride resin by weight). Prepare, pretreat, and apply coating to exposed metal surfaces to comply with AAMA 2605 and with coating and resin manufacturers' written instructions.

- D. Color and Gloss: As selected by Consultant from manufacturer's full range.

EXECUTION

6.2.3.1 EXAMINATION

- A. Examine openings, substrates, structural support, anchorage, and conditions, with Installer present, for compliance with requirements for installation tolerances; rough opening dimensions; levelness of sill plate; coordination with wall flashings, vapor retarders, and other built-in components; operational clearances and other conditions affecting performance of work.
1. Masonry and Concrete Surfaces: Visibly dry and free of excess mortar, sand, and other construction debris.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

6.2.3.2 INSTALLATION

- A. **General:** Comply with manufacturer's written instructions for installing windows, hardware, accessories, and other components; Drawings; and Shop Drawings.
- B. Install windows level, plumb, square, true to line, without distortion or impeding thermal movement, anchored securely in place to structural support, and in proper relation to wall flashing and other adjacent construction.
- C. Set sill members in bed of sealant or with gaskets, as indicated, for weathertight construction.
- D. Install windows and components to drain condensation, water penetrating joints, and moisture migrating within windows to the exterior.
- E. Metal Protection: Separate aluminum and other corrodible surfaces from sources of corrosion or electrolytic action at points of contact with other materials by complying with requirements specified in "Dissimilar Materials" Paragraph in Appendix B in AAMA/WDMA 101/I.S.2.

6.2.3.3 ADJUSTING

- A. Adjust operating sashes and ventilators, screens, hardware, and accessories for a tight fit at contact points and weather stripping for smooth operation and weather-tight closure. Lubricate hardware and moving parts.

6.2.3.4 PROTECTION AND CLEANING

- A. Protect window surfaces from contact with contaminating substances resulting from construction operations. In addition, monitor window surfaces adjacent to and below exterior concrete and masonry surfaces during construction for presence of dirt, scum, alkaline deposits, stains, or other contaminants. If contaminating substances do contact window surfaces, remove contaminants immediately according to manufacturer's written recommendations.

- B. Clean aluminum surfaces immediately after installing windows. Avoid damaging protective coatings and finishes. Remove excess sealants, glazing materials, dirt, and other substances.
- C. Clean factory-glazed glass immediately after installing windows. Comply with manufacturer's written recommendations for final cleaning and maintenance. Remove nonpermanent labels and clean surfaces.
- D. Remove and replace glass that has been broken, chipped, cracked, abraded, or damaged during construction period.

6.3 - DOOR HARDWARE

PART 4 - GENERAL

6.3.1.1 RELATED DOCUMENTS

- A. Drawing and provisions of the contract, including General and supplementary Conditions.

6.3.1.2 SUMMARY

- A. This Section includes the following:
 - 1. Commercial door hardware for the following steel and wood doors:
 - a) Swinging doors.
 - b) Cylinders for doors specified in other Sections.
 - c) Electrified door hardware.
- B. Related Sections include the following:
 - 2. 8.0 Section "Custom Steel Doors and Frames" for astragals provided as part of a fire-rated labeled assembly and for door silencers provided as part of the time.
 - 3. 8.0 Section "Flush Wood Doors" for astragals provided as part of a fire-rated labeled assembly.
 - 4. 6.0 Section "Access Doors and Frames".
 - 5. 8.0 Section "Aluminum Framed Entrances and Storefronts".
 - 6. 8.4 Section "Sliding Automatic Entrance Doors" for entrance door hardware, except cylinders.
- C. Products furnished, but not installed, under this Section include the following. Coordinating, purchasing, delivering, and scheduling remain requirements of this Section.
 - 1. Cylinders for locks on aluminum and glass entrance doors.

6.3.1.3 SUBMITTALS

- A. **Product Data:** Include installation details, material descriptions, dimensions of individual components and profiles, and finishes.
- B. **Shop Drawings:** Details of electrified door hardware, indicating the following:
 - 1. Wiring Diagrams: Detail wiring for power, signal, and control systems and differentiate between manufacturer-installed and field-installed wiring. Include the following:
 - a) System schematic.
 - b) Point-to-point wiring diagram.
 - c) Riser diagram.
 - d) Elevation of each door.
 - e) Detail interface between electrified door hardware and fire other building systems.
- C. **Samples for Initial Selection:** Manufacturer's color charts consisting of units or sections of units showing the full range of colors, textures, and patterns available for each type of door hardware indicated.
- D. **Samples:** For exposed door hardware of each type indicated below, in specified finish, full size. Tag with full description for coordination with the Door Hardware Schedule. Submit samples before, or concurrent with, submission of the final Door Hardware Schedule.
 - 1. Door Hardware: Each piece of hardware indicated in hardware schedule or on Drawings.
 - 2. Samples will be returned to Contractor. Units that are acceptable and remain undamaged through submittal, review, and field

comparison process may, after final check of operation, be incorporated into the Work, within limitations of keying requirements.

- E. **Door Hardware Schedule:** Prepared by or under the supervision of supplier, detailing fabrication and assembly of door hardware, as well as procedures and diagrams. Coordinate the final Door Hardware Schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.

1. Format: Comply with scheduling sequence and vertical format in DHI's "Sequence and Format for the Hardware Schedule."
2. Organization: Organize the Door Hardware Schedule into door hardware sets indicating complete designations of every item required for each door or opening.
 - a) Organize door hardware sets in same order as in the Door Hardware Schedule at the end of Part 3.
3. Content: Include the following information:
 - a) Type, style, function, size, label, hand, and finish of each door hardware item.
 - b) Manufacturer of each item.
 - c) Fastenings and other pertinent information.
 - d) Location of each door hardware set, cross-referenced to Drawings, both on floor plans and in door and frame schedule.
 - e) Explanation of abbreviations, symbols, and codes contained in schedule.
 - f) Mounting locations for door hardware.
 - g) Door and frame sizes and materials.
 - h) Description of each electrified door hardware function, including location, sequence of operation, and interface with other building control systems.
 - i) Sequence of Operation: Include description of component functions that occur in the following situations: authorized person wants to enter; authorized person wants to exit; unauthorized person wants to enter; unauthorized person wants to exit.

F. **Submittal Sequence:**

1. Submit the final Door Hardware Schedule at earliest possible date, particularly where approval of the Door Hardware Schedule must precede fabrication of other work that is critical in the Project construction schedule. Include Product Data, Samples, Shop Drawings of other work affected by door hardware, and other information essential to the coordinated review of the Door Hardware Schedule.
2. Submit initial draft of final schedule along with essential Product Data to facilitate the fabrication of other work that is critical in the Project construction schedule. Submit the final Door Hardware Schedule after Samples, Product Data, coordination with Shop Drawings of other work, delivery schedules, and similar information has been completed and accepted.

- G. **Keying Schedule:** Prepared by or under the supervision of supplier, detailing Employer's final keying instructions for locks. Include schematic keying diagram and index each key set to unique door designations.
- H. **Product Certificates:** Signed by manufacturers of electrified door hardware certifying that products furnished comply with requirements.
 - 1. Certify that door hardware approved for use on types and sizes of labeled fire doors complies with listed fire door assemblies.
- I. **Qualification Data:** For firms and persons specified in "Quality Assurance" Article.
 - 1. Include lists of completed projects with project names and addresses of architects/Consultants and owners, and other information specified.
- J. **Product Test Reports:** Based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified testing agency, indicating current products comply with requirements.
- K. **Maintenance Data:** For each type of door hardware to include in maintenance manuals specified in 1.0 section.
- L. **Warranties:** Special warranties specified in this Section.

6.3.1.4 QUALITY ASSURANCE

- A. **Quality System:** Comply with ISO 9001/9002 Quality System as a minimum. Incorporate all the standard procedures supplied by the Consultant and the Employer.
- B. **Installer Qualifications:** A qualified firm specializing in performing the work of this Section and who has completed door hardware similar in material, design, and extent to that indicated for this Project with minimum three years documented experience and that is approved, authorized, or licensed by the product manufacturer to install his product and that is eligible to receive manufacturer's warranty. Include project names and addresses, names and addresses of Consultants and Employers, and other information specified
- C. **Supplier Qualifications:** A recognized architectural door hardware supplier, with warehousing facilities in the Project's vicinity, that has a record of successful in-service performance for supplying conventional and security door hardware similar in quantity, type, and quality to that indicated for this Project and that employs an experienced architectural hardware consultant (AHC) who is available to Employer, Consultant, and Contractor, at reasonable times during the course of the Work, for consultation. The supplier shall have access to adequate inventory of all hardware items to meet Project construction schedules and shall have the ability to submit samples, hardware data, templates, and hardware schedules in accordance with Project construction schedules.
 - 1. Require supplier to meet with Employer to finalize keying
 - 2. Electrified Door Hardware Supplier Qualifications: An experienced door hardware supplier who has completed projects with electrified door hardware similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful in-service performance, and who is acceptable to manufacturer of primary materials.

- a) **Consultant Responsibility:** Prepare data for electrified door hardware, including Shop Drawings, based on testing and Consultant analysis of manufacturer's standard units in assemblies similar to those indicated for this Project.
 - b) **Scheduling Responsibility:** Preparation of door hardware and keying schedules.
- D. **Architectural Hardware Consultant Qualifications:** A person who is currently certified by the Door and Hardware Institute as an Architectural Hardware Consultant and who is experienced in providing consulting services for door hardware installations that are comparable in material, design, and extent to that indicated for this Project.
 - 1. **Electrified Door Hardware Qualifications:** Experienced in providing consulting services for electrified door hardware installations.
- E. **Source Limitations:** Obtain each type and variety of door hardware from a single manufacturer, unless otherwise indicated.
 - 1. Provide electrified door hardware from same manufacturer as mechanical door hardware, unless otherwise indicated. Manufacturers that are listed to perform electrical modifications, by a testing and inspecting agency acceptable to authorities having jurisdiction, are acceptable.
- F. **Regulatory Requirements:** Comply with provisions of the following:
 - 2. **NFPA 101:** Comply with the following for means of egress doors:
 - a) **Latches, Locks, and Exit Devices:** Not more than 67 N to release the latch. Locks shall not require the use of a key, tool, or special knowledge for operation.
 - b) **Delayed-Egress Locks:** Lock releases within 15 seconds after applying a force not more than 67 N for not more than 3 seconds.
 - c) **Door Closers:** Not more than 133 N to set door in motion and not more than 67 N to open door to minimum required width.
 - d) **Thresholds:** Not more than 13 mm (1/2") high.
 - e) **Electrified Door Hardware:** Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction.
- G. **Fire-Rated Door Assemblies:** Provide door hardware for assemblies complying with NFPA 80, or any approved equal international standard, that are listed and labeled by a testing and inspecting agency acceptable to Consultant, for fire ratings indicated, based on testing according to NFPA 252.
 - 1. **Test Pressure:** Test at atmospheric pressure.
 - 2. **Labels:** All hardware components of fire resisting doors assemblies including, but not limited hinges, locks, bolts, door closers shall carry the identifying labels of an approved independent testing and inspection agency or laboratory, confirming their fire resistance rating. The rating of all door components shall be equal to the rating of the door assembly.

- H. **Door Closers on Fire Rated Doors:** Comply with requirements with specified in Clause 2.10 of this Section.
- I. **Keying Conference:** Conduct conference at Project site to comply with requirements in "Project Meetings." Incorporate keying conference decisions into final keying schedule after reviewing door hardware keying system including, but not limited to, the following:
 - 1. Function of building, flow of traffic, purpose of each area, degree of security required, and plans for future expansion.
 - 2. Preliminary key system schematic diagram.
 - 3. Requirements for key control system.
 - 4. Address for delivery of keys.
- J. **Pre-installation Conference:** Conduct conference at Project site to comply with requirements in 1.0 Section "Project Meetings." Review methods and procedures related to electrified door hardware including, but not limited to, the following:
 - 1. Inspect and discuss electrical roughing-in and other preparatory work performed by other trades.
 - 2. Review sequence of operation for each type of electrified door hardware.
 - 3. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
 - 4. Review required testing, inspecting, and certifying procedures.

6.3.1.5 DELIVERY, STORAGE, AND HANDLING

- A. Inventory door hardware on receipt and provide secure lock-up for door hardware delivered to Project site.
- B. Tag each item or package separately with identification related to the final Door Hardware Schedule, and include basic installation instructions with each item or package.
- C. Deliver keys to manufacturer of key control system.
- D. Deliver keys to Employer by registered mail or overnight package service.

6.3.1.6 COORDINATION

- A. Coordinate layout and installation of recessed pivots and closers with floor construction. Cast anchoring inserts into concrete. Concrete, reinforcement, and formwork requirements are specified in 3.0 Section "Cast-in-Place Concrete."
- B. **Templates:** Obtain and distribute to the parties involved templates for doors, frames, and other work specified to be factory prepared for installing door hardware. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing door hardware to comply with indicated requirements.

- C. **Electrical System Roughing-in:** Coordinate layout and installation of electrified door hardware with connections to power supplies and fire alarm system and detection devices and any other building system as indicated on Drawings.

6.3.1.7 WARRANTY

- A. **General Warranty:** Special warranties specified in this Article shall not deprive Employer of other rights Employer may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.
- B. **Special Warranty:** Written warranty, executed by manufacturer agreeing to repair or replace components of door hardware that fail in materials or workmanship within specified warranty period. Failures include, but are not limited to, the following:
 - 1. Structural failures including excessive deflection, cracking, or breakage.
 - 2. Faulty operation of operators and door hardware.
 - 3. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
- A. **Warranty Period:** Three years from date of Substantial Completion, unless otherwise indicated.
- B. **Warranty Period for Electromagnetic and delayed-Egress Locks:** Five years from date of Substantial Completion.
- C. **Warranty Period for Manual Closers:** 10 years from date of Substantial Completion.
- D. **Warranty Period for Concealed Floor Closers:** Five years from date of Substantial Completion.

6.3.1.8 MAINTENANCE SERVICE

- A. **Maintenance Tools and Instructions:** Furnish a complete set of specialized tools and maintenance instructions as needed for Employer's continued adjustment, maintenance, and removal and replacement of door hardware.
- B. **Maintenance Service:** Beginning at Substantial Completion, provide six months' full maintenance by skilled employees of door hardware Installer. Include quarterly preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper door hardware operation. Provide parts and supplies as used in the manufacture and installation of original products.

PRODUCTS

6.3.2.1 SCHEDULED DOOR HARDWARE

- A. **General:** Provide door hardware for each door to comply with requirements in this Section, and the Door and Hardware sets Schedule annexed at the end of Part 3.
1. **Door Hardware Sets:** Provide quantity, item, size, finish or color indicated, and products complying with BHMA standard referenced.
 2. **Sequence of Operation:** Provide electrified door hardware function, sequence of operation, and interface with other building control systems indicated.
- B. **Designations:** Requirements for design, grade, function, finish, size, and other distinctive qualities of each type of door hardware are indicated in the Door and Hardware sets Schedule at the end of Part 3. Products are identified by using door hardware designations, as follows:
1. International hardware manufactures have to establish their compliance with these specifications and with international fire codes for fire rated hardware.
 2. **References to BHMA Standards:** Provide products complying with these standards and requirements for description, quality, and function.

6.3.2.2 HINGES AND PIVOTS

- A. **Standards:** Comply with the following:
1. **Butts and Hinges:** BHMA A156.1.
 2. **Template Hinge Dimensions:** BHMA A156.7.
 3. **Self-Closing Hinges and Pivots:** BHMA A156.17.
 4. **Pivots:** BHMA A156.4.
- B. **Size:** Provide the following minimum sizes, unless otherwise indicated, with hinge widths sized for door thickness and clearances required:

Maximum Door Size (mm)	Hinge Height (mm)	Metal Thickness (mm)	Heavy Weight Kg
		Standard Weight Kg	
800 by 2125 by 35	88 (3½")	3.1	-
900 by 2125 by 35	100 (4")	3.3	-
900 by 2285 by 38	113 (4½")	3.4	4.6
1050 by 2285 by 38	113 (4½")	3.4	4.6
1200 by 3050 by 38	125 (5")	3.7	4.8

C. **Template Requirements:** Except for hinges and pivots to be installed entirely (both leaves) into wood doors and frames, provide only template-produced units.

D. **Hinge Weight:** Unless otherwise indicated, provide the following:

1. Entrance Doors: Heavy-weight hinges.
2. Doors with Closers: Antifriction-bearing hinges.
3. Interior Doors: Standard-weight hinges.

E. **Hinge Base Metal:** Unless otherwise indicated, provide the following:

1. Exterior Hinges: Stainless steel alloy 316, with stainless-steel pin
2. Interior Hinges: Stainless steel alloy 304, with stainless-steel pin.
3. Hinges for Fire-Rated Assemblies: Stainless steel alloy 304, with stainless-steel pin.

F. **Hinge Options:** Comply with the following where indicated in the Door Hardware Schedule or on Drawings:

1. Maximum Security Pin: Fix pin in hinge barrel after it is inserted.
2. Non-removable Pins: Provide set screw in hinge barrel that, when tightened into a groove in hinge pin, prevents removal of pin while door is closed; for the following applications:
 - a) Out-swinging exterior doors.

3. Corners: 4-mm (5/32") radius.

G. **Hinges, General:** Shall be full mortise, template, of concealed ball bearing, 5 knuckles, suitable for high frequency applications and of life time warranty.

6.3.2.3 LOCKS AND LATCHES

A. **Standards:** Comply with the following:

1. Mortise Locks and Latches: BHMA A156.13.
2. Interconnected Locks and Latches: BHMA A156.12.
3. Auxiliary Locks: BHMA A156.5.
4. Push-Button Combination Locks: BHMA A156.2.
5. Electromagnetic Locks: BHMA A156.23.
6. Delayed-Egress Locks: BHMA A156.24.
7. Exit Locks: BHMA A156.5.

B. **Mortise Locks:** Stamped steel case with stainless steel parts; BHMA Grade 1; Series 1000. Provide mortise locks for exterior doors, throughout the job, except for toilets. All lock shall be ADA compliant Marine grade mortise locks shall be provided in the exterior and in non air conditioned areas. Provide ten years product warranty for performance and finish.

C. **Mortise Lock:** Shall be types produced for extra-heavy-duty applications. Lock lever shall be of anti-vandalism design.

D. Where threaded bars are used to assemble the two pieces of lock spindle, minimum inner diameter of threading bar shall be 6 mm (1/4").

E. **Interconnected Locks:** BHMA Grade 1; Series 5000.

F. **Auxiliary Locks:** BHMA Grade 1.

G. **Push-Button Combination Locks:** BHMA Grade 1 for cylindrical locks and Grade 2 for mortise locks.

H. **Certified Products:** Provide door hardware listed in the following BHMA directories:

1. Mechanical Locks and Latches: BHMA's "Directory of Certified Locks & Latches."

I. **Lock Trim:** Comply with the following: All trims to have returns. Trims shall be ADA compliant. Trim shall be stainless steel BHMA-630

1. Lever: Wrought, forged, or cast.
2. Escutcheon (Rose): Wrought, forged, or cast.

3. Dummy Trim: Match lock trim and escutcheons.
 4. Lockset Designs: Provide the lockset design designated below or, if sets are provided by another manufacturer, provide designs that match those designated:
- J. **Lock Functions:** Function numbers and descriptions indicated in the Door Hardware Schedule comply with the following:
1. Mortise Locks: BHMA A156.13.
 2. Interconnected Locks: BHMA A156.12.
- K. **Lock Features:** Comply with testing requirements for length of bolts to comply with labeled fire door requirements, and as follows:
1. Mortise Locks: Minimum 19-mm (3/4") latchbolt throw.
 2. Deadbolts: Minimum 25-mm (1") bolt throw.
 3. Pairs of Doors: 16-mm (3/4") minimum throw of latch.
 4. Fire-Rated Doors: Comply with UL requirements for throw of bolts and latches on rated fire openings.
 5. Heavy duty anti friction tongue.
 6. Non handed auxiliary guard latch.
 7. Adjustable stainless steel armor front.
 8. Seven pin interchangeable core cylinder.
 9. Corrosion protected steel case.
- L. **Rabbeted Doors:** Provide special rabbeted front and strike on locksets for rabbeted meeting stiles.
- M. **Backset:** 70 mm, (3") unless otherwise indicated.
- N. **Lock Function:** Provide lock functions as described below, but not limited to
1. F-04 Office lock, with faceplate button depressed function.
 2. Classroom function for stores
 3. F-13 Corridor lock.
 4. Provide classroom dead bolts for main doors of toilets and janitors rooms

Additional lock function will be required as per function of various rooms.

- O. Locks shall have double buttons in face plate. For Office Locks the handle will rotate only when bottom button is depressed or turning key for outside cylinder. For other locks, the bottom button in face plate shall also retract the latch.
- P. These requirements for mortise locks shall remain applicable in all respects for wood doors, steel doors and minimum doors.

6.3.2.4 DOOR BOLTS

A. **Standards:** Comply with the following:

1. Surface Bolts: BHMA A156.16.
2. Manual Flush Bolts: BHMA A156.16.

B. **Surface Bolts:** BHMA Grade 1.

1. Flush Bolt Heads: Minimum of 13-mm- (1/2") diameter rods of brass, bronze, or stainless steel with minimum 300-mm- (24") long rod for doors up to 2100 mm in height. Provide longer rods as necessary for doors exceeding 2100 mm (7'-0").

C. **Flush Bolts:** BHMA Grade 1, designed for mortising into door edge.

D. **Bolt Throw:** Comply with testing requirements for length of bolts to comply with labeled fire door requirements, and as follows:

1. Half-Round Surface Bolts: Minimum 22-mm (1") throw.
2. Interlocking Surface Bolts: Minimum 24-mm (1") throw.
3. Fire-Rated Surface Bolts: Minimum 25-mm (1") throw; listed and labeled for fire-rated doors.
4. Dutch-Door Bolts: Minimum 19-mm (3/4") throw.
5. Mortise Flush Bolts: Minimum 19-mm (3/4") throw.

6.3.2.5 EXIT DEVICES

A. **Standard:** BHMA A156.3.

1. BHMA Grade: Grade 1.

B. **Certified Products:** Provide exit devices listed in BHMA's "Directory of Certified Exit Devices."

C. **Panic Exit Devices:** Listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for panic protection, based on testing according to UL 305.

D. **Panic Exit Devices:** For non-fire rated doors are to be as specified in Sub-Clause but with facility to hold latchbolts in retracted position so that the doors may be used as push/pull. Dogging is to be accomplished by a hex key cylinder installed on the body of touch bar devices or a hexagonal key in the hinge and lock cases of cross bar devices

E. **Fire Exit Devices:** Complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire and panic protection, based on testing according to UL 305 and NFPA 252.

F. **Dummy Push Bar:** Nonfunctioning push bar matching functional push bar.

1. Operation: Rigid.

G. **Outside Trim:** Lever with cylinder or Pull with cylinder; unless otherwise indicated material and finish to match locksets, unless otherwise indicated.

1. Match design for locksets and latchsets, unless otherwise indicated.

H. **Through Bolts:** For exit devices and trim on metal doors and non-fire-rated wood doors.

I. Fire and panic exit devices shall be of concealed latches. No exposed latches shall be accepted.

6.3.2.6 CYLINDERS AND KEYING

A. **Standards:** Comply with the following:

1. Cylinders: BHMA A156.5.
2. Key Control System: BHMA A156.5.

B. **Cylinder Grade:** BHMA Grade 1 or Grade 1A.

C. **Cylinders:** Manufacturer's standard tumbler type, constructed from brass or bronze, stainless steel, or nickel silver, and complying with the following:

1. Number of Pins: Seven.
2. Mortise Type: Threaded cylinders with rings and straight- or clover-type cam.
3. Rim Type: Cylinders with back plate, flat-type vertical or horizontal tailpiece, and raised trim ring.

D. **Permanent Cores:** Manufacturer's standard; finish face to match lockset; complying with the following:

1. Interchangeable Cores: Core insert, removable by use of a special key, and usable with other manufacturers' cylinders.
2. Removable Cores: Core insert, removable by use of a special key, and for use with only the core manufacturer's cylinder and door hardware.

E. **Construction Keying:** Comply with the following:

1. Construction Master Keys: Provide cylinders with feature that permits voiding of construction keys without cylinder removal. Provide 10 construction master keys.
2. Construction Cores: Provide construction cores that are replaceable by permanent cores. Provide 4 constructions master keys for Employer/Consultant use.
 - a) Replace construction cores with permanent cores, as directed by Employer.
 - b) Furnish permanent cores to Employer for installation.

F. **Keying System:** Unless otherwise indicated, provide a factory-registered keying system complying with the following requirements:

1. Master Key System: Cylinders are operated by a change key and a master key.

G. **Keys:** Provide stainless steel keys complying with the following:

1. Stamping: Permanently inscribe each key with a visual key control number and include the following notation:
 - a) Notation: Information to be furnished by Employer.
2. Quantity: In addition to one extra blank key for each lock, provide the following:
 - a) Cylinder Change Keys: Three.
 - b) Master Keys: Five.

H. **Key Control System:** BHMA Grade 1 system, including key-holding hooks, labels, two sets of key tags with self-locking key holders, key-gathering envelopes, and temporary and permanent markers. Contain system in metal cabinet with baked-enamel finish.

1. Wall-Mounted Cabinet: Cabinet with hinged-panel door equipped with key-holding panels and pin-tumbler cylinder door lock.
2. Capacity: Able to hold keys for 150 percent of the number of locks.
3. Cross-Index System: Set up by key control manufacturer, complying with the following:
 - a) Card Index: Furnish four sets of index cards for recording key information. Include three receipt forms for each key-holding hook.

6.3.2.7 STRIKES

A. **Standards:** Comply with the following:

1. Strikes for Mortise Locks and Latches: BHMA A156.13.
2. Strikes for Interconnected Locks and Latches: BHMA A156.12.
3. Strikes for Auxiliary Deadlocks: BHMA A156.5.
4. Dustproof Strikes: BHMA A156.16.

B. **Strikes:** Provide manufacturer's standard strike with strike box for each latch or lock bolt, with curved lip extended to protect frame, finished to match door hardware set, unless otherwise indicated, and as follows:

1. Flat-Lip Strikes: For locks with three-piece antifriction latchbolts, as recommended by manufacturer.
2. Extra-Long-Lip Strikes: For locks used on frames with applied wood casing trim.
3. Aluminum-Frame Strike Box: Provide manufacturer's special strike box fabricated for aluminum framing.
4. Provide recess type top strikes for bolts locking into head frames, unless otherwise indicated.

5. Provide dust-proof strikes for foot bolts, except where special threshold construction provides non recessed strike for bolt.

C. Dustproof Strikes: BHMA Grade 1.

6.3.2.8 CARD READER

A. Proximity Reader with Keypad:

1. Technology: Wiengand proximity system compatible with building security system.
2. Housing: Weather resistant ABS plastic housing. Color as selected by Consultant from manufacturer's full line.
3. Key Pad: 12 button key pad for entry of Personal Identification Number (PIN) in addition to proximity card.
4. Display Status: 3 LED status display and controllable beeper to indicate reader operation and status.
5. Tamper Detection: Mechanical tamper switch to send signal to security room if reader is completely removed from wall in addition to detecting when reader has been separated from its back plate.
6. Provide all mounting plates, cables, programs and other items required to make card reader work with building security system.

6.3.2.9 OPERATING TRIM

A. Standard: Comply with BHMA A156.6.

B. Door handles shall have returns in direction of door, straight handles shall not be accepted.

C. Handles shall be with round (rose) cover plates.

D. **Materials:** Fabricate from stainless steel, unless otherwise indicated.

E. **Push-Pull Design:** As indicated on Drawings.

6.3.2.10 ACCESSORIES FOR PAIRS OF DOORS

A. Standards: Comply with the following:

1. Coordinators: BHMA A156.3.

B. **Carry-Open Bars:** Provide carry-open bars for inactive leaves of pairs of doors, unless automatic or self-latching bolts are used.

C. Do not use security astragals. Use split adjustable astragals or concealed side mounted.

6.3.2.11 CLOSERS

A. Closers, General-unless otherwise indicated, provide closers on all fire-rated doors, exterior doors, toilet and locker room doors, sound-retardant doors, corridor doors, doors between heated/cooled and unheated / uncooled areas, elevator equipment room doors, and other door as required. Closer shall be tested for 10 million cycles and will withstand 57 degree ambient temperature and will be provided with all weather hydraulic fluid. Closer will be equipped with the function of variable back check and delayed action. Closer will be provided with ten years warranty and warranty against leaks.

Closer will be non banded. Closer will be provided with adjustable with speed and hold open facility. Concealed door closer will be completely and components will minimize tempering and vandalism.

1. Size of Units: Unless otherwise indicated, comply with the manufacturer's recommendation for size of door control unit depending on size of door, exposure to weather and drafts, and anticipated frequency of use.
 2. Arms: Provide parallel arms for all overhead closers, unless otherwise indicated. Provide closer unit one size larger than recommended for use with standard arms.
 3. Closing Cycle: Comply with requirements of authorities having jurisdiction or the Americans with Disabilities Act (ADA), "Accessibility Guidelines for Buildings and Facilities (ADAAG)", whichever are most stringent
 4. Opening Force: Comply with the following maximum opening-force requirements for locations indicated:
 - a) Exterior Doors: 67 N.
 - b) Interior Doors: 22.2N.
 5. Construction: Provide marine-grade construction for closers in non-air conditioned areas and in door swimming pool areas, consisting of nonferrous and stainless steel components.
- B. **Aluminum Entrance Doors:** Provide concealed door closer. Standards: Comply with the following:
1. Closers: BHMA A156.4.
 2. Closer Holder Release Devices: BHMA A156.15.
- C. **Surface Closers:** BHMA Grade 1.
- D. **Concealed Closers:** BHMA Grade 1.
- E. **Certified Products:** Provide door closers listed in BHMA's "Directory of Certified Door Closers".
- F. **Door Closers on Fire Rated Doors:** Shall be type that closes the door and positively latch the door.
- G. **Hold-Open Closers/Detectors:** Coordinate and interface integral smoke detector and closer device with fire alarm system. Fire rated doors with closers of hold open facility shall release automatically in case of fire based on signal from the fire alarm system (electric release door closer). System of release device for double leaf fire rated doors shall be adjustable so as the inactive leaf shall close prior to the active leaf and that active leave shall positively latch to the inactive leaf at final closing position (electric release door closers and door coordinator).
- H. **Flush Floor Plates:** Provide finish cover plates for floor closers unless thresholds are indicated. Match door hardware finish, unless otherwise indicated.
- I. **Recessed Floor Plates:** Provide recessed floor plates with insert of floor finish material for floor closers, unless thresholds are indicated. Provide extended closer spindle to accommodate thickness of floor finish.
-

- J. Weather Comply with manufacturer's written recommendation of exposure to weather. Provide factory-sized closers, adjustable to meet field conditions and requirements for opening force.
- K. **Grade:** Door closers shall be from types tested for 10 millions cycles of operation and sized for door leaves of minimum weight of 200 kilogram per leaf for both steel doors and external doors.

6.3.2.12 PROTECTIVE TRIM UNITS

- A. **Standard:** Comply with BHMA A156.6.
- B. **Materials:** Fabricate protection plates from the following to match requirement indicate:
 - 1. Stainless Steel: beveled top and 2 sides.
- C. **Protection Plates, General:**
 - 1. Fabricate edge trim of stainless steel to fit door thickness in standard lengths or to match height of protection plates.
- D. **Kick Plates:** beveled top and two side edges (B3E). Provide two kick plates for toilet doors. Kick plate will ensure that the door bottom is protected.
 - 1. Metal Plates: Stainless steel, 3.00 mm (2/16") thick
- E. **Armor Plates:** 3 mm (2/16") thick, 914 mm (36") high by full width of door less clearance for stops on door frame.
- F. **Fasteners:** Provide manufacturer's standard exposed fasteners for door trim units consisting of either machine or self-tapping screws.
- G. Furnish protection plates sized 38 mm (1.5") less than door width on push side and 13 mm (1/2") less than door width on pull side, by height specified in Door Hardware Schedule.

6.3.2.13 STOPS AND HOLDERS

- A. **Standards:** Comply with the following:
 - 1. Stops and Bumpers: BHMA A156.16.
 - 2. Mechanical Door Holders: BHMA A156.16.
 - 3. Electromagnetic Door Holders: BHMA A156.15.
 - 4. Combination Overhead Holders and Stops: BHMA A156.8.
 - 5. Door Silencers: BHMA A156.16.
- B. **Stops and Bumpers:** BHMA Grade 1.
- C. **Mechanical Door Holders:** BHMA Grade 1.
- D. **Combination Floor and Wall Stops and Holders:** BHMA Grade 1.
- E. **Combination Overhead Stops and Holders:** BHMA Grade 1.

- F. **Electromagnetic Door Holders for Labeled Fire Door Assemblies:** Coordinate with fire detectors and interface with fire alarm system.
- G. **Floor Stops:** For doors, unless wall or other type stops are scheduled or indicated. Do not mount floor stops where they will impede traffic.
 - a) Where floor or wall stops are not appropriate, provide overhead holders.
- H. **Silencers for Wood Door Frames:** BHMA Grade 1; neoprene or rubber, minimum 16 by 19 mm; (1/2" ~ 3/4") fabricated for drilled-in application to frame.
- I. **Silencers for Metal Door Frames:** BHMA Grade 1; neoprene or rubber, minimum diameter 13 mm; (1/2") fabricated for drilled-in application to frame.

6.3.2.14 DOOR GASKETING

- A. **Standard:** Comply with BHMA A156.22.
- B. **General:** Provide continuous weather-strip gasketing on exterior doors and provide smoke, light, or sound gasketing on interior doors where indicated or scheduled. Provide non-corrosive fasteners for exterior applications and elsewhere as indicated.
 - 1. Perimeter Gasketing: Apply to head and jamb, forming seal between door and frame.
 - 2. Meeting Stile Gasketing: Fasten to meeting stiles, forming seal when doors are closed.
 - 3. Door Bottoms: Apply to bottom of door, forming seal with threshold when door is closed.
- C. **Air Leakage:** Not to exceed 0.000774 cu. m/s per m (0.0000209 cft / s per 3'-0") of crack length for gasketing other than for smoke control, as tested according to ASTM E 283.
- D. **Smoke-Labeled Gasketing:** Assemblies complying with NFPA 105 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for smoke-control ratings indicated, based on testing according to UL 1784.
 - 1. Provide smoke-labeled gasketing on 20-minute-rated doors and on smoke-labeled doors.
- E. **Fire-Labeled Gasketing:** Assemblies complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated, based on testing according to UL 10B or NFPA 252.
- F. **Sound-Rated Gasketing:** Assemblies that are listed and labeled by a testing and inspecting agency, for sound ratings indicated, based on testing according to ASTM E 1408.

- G. **Replaceable Seal Strips:** Provide only those units where resilient or flexible seal strips are easily replaceable and readily available from stocks maintained by manufacturer.
- H. **Gasketing Materials:** Comply with ASTM D 2000 and AAMA 701/702.
- I. **Weather-stripping and Seal Types:** Unless otherwise indicated, provide the following, or approved equal:
1. Door Shoes: Extruded aluminum, with vinyl seal and integral rain drip.
 2. Rain Drips: Extruded aluminum. Unless noted otherwise, provide rain drips for all exterior doors.
 3. Automatic Door Bottoms: Extruded aluminum with neoprene insert for doors to achieve STC of 47 or better, as indicated in the hardware schedule.
 4. Meeting Stile Seals (Astragal Seals): Extruded anodized aluminum, with silicon seal.
 5. Weather-stripping, Smoke Seals, and Sound Retarding Gaskets: Compression-type self-adhesive silicone gasket applied to door stops, white color.
 6. Security Astragals: Cam operated automatic security astragal.

6.3.2.15 THRESHOLDS

- A. **General:** Unless otherwise indicated, provide standard metal threshold units of type, size, and profile as shown or scheduled. Comply with ANSI/BHMA A156.21.
1. Material: Extruded aluminum, non-slip finish, except as otherwise specified.
 2. Exterior Hinged Doors: Provide units not less than 100 mm (4") wide, and not more than 12-mm- (1/2") high, with beveled edges providing a floor level change with a slope of not more than 1:2, formed to accommodate change in floor elevation where indicated, fabricated to accommodate door hardware and to fit door frames, and as follows:
 - a) For in-swinging doors provide units with interlocking lip and interior drain channel; include hook on bottom edge of door and drain pan.
 - b) For out-swinging doors provide rabbeted type units with replaceable weather-strip insert in stop. Provide threshold with thermal break when mentioned in the hardware schedule

- B. **Exterior Thresholds:** ANSI/BHMA A156.21, extruded aluminum. Provide flat saddle type or interlocking type with resilient insert as shown.
- C. **Threshold for Aluminum Entrance Doors:** Manufacturer's standard threshold with cutouts coordinated for operating hardware, with anchors and jamb clips, and not more than 12-mm-(1/2") high, with beveled edges providing a floor level change with a slope of not more than 1:2, formed to accommodate change in floor elevation where indicated.
- D. **Threshold for Doors with Exit Devices:** Extruded aluminum latching type, with replaceable vinyl inserts.
- E. **Interior Thresholds:** Extruded aluminum flat saddle type with smooth surface.

6.3.2.16 MISCELLANEOUS DOOR HARDWARE

- A. **Standard:** Comply with the following:
 - 1. Auxiliary Hardware: BHMA A156.16.
 - 2. Exit Alarms: BHMA A156.5.
- B. **Auxiliary Hardware:** BHMA Grade 1, unless otherwise indicated.
- C. **Boxed Power Supplies:** Modular unit in NEMA ICS 6, Type 4 enclosure; filtered and regulated; voltage rating and type matching requirements of door hardware served; and listed and labeled for use with fire alarm systems.

6.3.2.17 FABRICATION

- A. **Manufacturer's Nameplate:** Do not provide manufacturers' products that have manufacturer's name or trade name displayed in a visible location (omit removable nameplates) except in conjunction with required fire-rated labels and as otherwise approved by Consultant.
 - 1. Manufacturer's identification will be permitted on rim of lock cylinders only.
- B. **Base Metals:** Produce door hardware units of base metal specified, fabricated by forming method indicated, using manufacturer's standard metal alloy, composition, temper, and hardness. Furnish metals of a quality equal to or greater than that of specified door hardware units and BHMA A156.18 for finishes. Do not furnish manufacturer's standard materials or forming methods if different from specified standard.
- C. **Fasteners:** Provide door hardware manufactured to comply with published templates generally prepared for machine, wood, and sheet metal screws. Provide screws according to commercially recognized industry standards for application intended. Provide Phillips flat-head screws with finished heads to match surface of door hardware, unless otherwise indicated.
 - 1. Concealed Fasteners: For door hardware units that are exposed when door is closed, except for units already specified with concealed

fasteners. Do not use through bolts for installation where bolt head or nut on opposite face is exposed unless it is the only means of securely attaching the door hardware. Where through bolts are used on hollow door and frame construction, provide sleeves for each through bolt.

2. Steel Machine or Wood Screws: For the following fire-rated applications:
 - a) Mortise hinges to doors.
 - b) Strike plates to frames.
 - c) Closers to doors and frames.
3. Steel Through Bolts: For the following fire-rated applications, unless door blocking is provided:
 - a) Surface hinges to doors.
 - b) Closers to doors and frames.
 - c) Surface-mounted exit devices.
4. Spacers: For through bolting of hollow metal doors.
5. Fasteners for Wood Doors: Comply with requirements of DHI WDHS.2, "Recommended Fasteners for Wood Doors."

6.3.2.18 **Base Metal**

A. Base Metal for hardware and door furniture shall be as follows:

1. Exterior Units: Stainless Steel alloy 316
2. Interior Units: Stainless Steel alloy 304

6.3.2.19 **FINISHES**

- A. **Standard:** Comply with BHMA A156.18.
- B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- C. **Appearance of Finished Work:** Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
- D. **BHMA Designations:** Comply with base material and finish requirements indicated by the following:

1. BHMA 630: Satin stainless steel, over stainless-steel base metal.

EXECUTION

6.3.2.20 EXAMINATION

- A. Examine doors and frames, with Installer present, for compliance with requirements for installation tolerances, labeled fire door assembly construction, wall and floor construction, and other conditions affecting performance.
- B. Examine roughing-in for electrical power systems to verify actual locations of wiring connections before electrified door hardware installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

6.3.2.21 PREPARATION

- A. **Steel Doors and Frames:** Comply with DHI A115 series.
 1. Surface-Applied Door Hardware: Drill and tap doors and frames according to SDI 107.
- B. **Wood Doors:** Comply with DHI A115-W series.

6.3.2.22 INSTALLATION

- A. **Mounting Heights:** Mount door hardware units at heights indicated in following applicable publications, unless specifically indicated or required to comply with governing regulations:
 1. Custom Steel Doors and Frames: DHI's "Recommended Locations for Builders' Hardware for Custom Steel Doors and Frames."
 2. Wood Doors: DHI WDHS.3, "Recommended Locations for Architectural Hardware for Wood Flush Doors."
- B. Install each door hardware item to comply with manufacturer's written instructions. Where cutting and fitting are required to install door hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation of surface protective trim units with finishing work specified in 9.0 Sections. Do not install surface-mounted items until finishes have been completed on substrates involved.
 1. Set units level, plumb, and true to line and location. Adjust and reinforce attachment substrates as necessary for proper installation and operation.
 2. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors according to industry standards.

- C. **Key Control System:** Place keys on markers and hooks in key control system cabinet, as determined by final keying schedule.
- D. **Thresholds:** Set thresholds for exterior and acoustical doors in full bed of sealant complying with requirements specified in 7.0 Section "Joint Sealants."

6.3.2.23 **Adjusting**

- A. **Initial Adjustment:** Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended. Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.
 - 1. Door Closers: Adjust sweep period so that, from an open position of 70 degrees, the door will take at least 3 seconds to move to a point 75 mm (3") from the latch, measured to the leading edge of the door.
- B. **Six-Month Adjustment:** Approximately six months after date of Substantial Completion, Installer shall perform the following:
 - 1. Examine and readjust each item of door hardware as necessary to ensure function of doors, door hardware, and electrified door hardware.
 - 2. Consult with and instruct Employer's personnel on recommended maintenance procedures.
 - 3. Replace door hardware items that have deteriorated or failed due to faulty design, materials, or installation of door hardware units.

6.3.2.24 **CLEANING AND PROTECTION**

- A. Clean adjacent surfaces soiled by door hardware installation.
- B. Clean operating items as necessary to restore proper function and finish.
- C. Provide final protection and maintain conditions that ensure door hardware is without damage or deterioration at time of Substantial Completion.

6.3.2.25 **DEMONSTRATION**

Engage a factory-authorized service representative to train Employer's maintenance personnel to adjust, operate, and maintain door hardware and door hardware finishes.

6.4 – GLAZED ALUMINUM CURTAIN WALL

6.4.1. Section Includes:

- A. Aluminum framing system.
- B. Glass Panels
- C. Other accessories including integral fire stops at floor slabs and Perimeter sealant.

6.4.2. REFERENCES

- A. AAMA - American Architectural Manufacturer Association

AAMA Metal Curtain Wall, Window, Store Front and Entrance -Guide
Specifications Manual

AAMA Aluminum Curtain Wall Design Guide Manual

AAMA Curtain Wall Manual #10 - Care and Handling of Architectural
Aluminum from Shop to Site

AAMA Series No. 11 - Design Wind loads for Buildings and Boundary
Layer Wind Tunnel Testing

AAMA 501 Methods of Test for Metal Curtain Walls

AAMA 603.8 Performance Requirements and Test Procedures for Pigmented
Organic Coatings on Extruded Aluminum

AAMA 605.2 Specification for High Performance Organic Coatings on
Architectural Extrusions and Panels

AAMA 606.1 Specifications and Inspection Methods for Integral Color Anodic
Finishes for Architectural Aluminum

AAMA 607.1 Specifications and Inspection Methods for Clear Anodic Finishes for
Architectural Aluminum

AAMA 608.1 Specification and Inspection Methods for Electrolytically Deposited
Color Anodic Finishes for Architectural Aluminum

AAMA T1R A1 Sound Control for Aluminum Curtain Walls and Windows

AAMA FC-1 Field Check of Metal Curtain Walls for Water Leakage

- B. ASTM - American Society of Testing and Materials

ANSI/ASTM A36 Structural Steel

ANSI/ASTM A386 Zinc Coating (Hot Dip) on Assembled Steel Products

ANSI/ASTM A446 Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip
Process, Structural (Physical) Quality.

ANSI/ASTM B209 Aluminum and Aluminum-Alloy Sheet and Plate

ANSI/ASTM B221 Aluminum-Alloy Extruded Bar, Rod, Wire, Shape, and Tube

ANSI/ASTM E283 Rate of Air Leakage through Exterior Windows, Curtain
Walls, and Doors

ANSI/ASTM E330 Structural Performance of Exterior Windows, Curtain Walls, and
Doors by Uniform Static Air Pressure Difference

ANSI/ASTM E331 Test Method for Water Penetration of Exterior Windows,
Curtain Walls, and Doors by Uniform Static Air Pressure
Difference

ASTM E413 Classification for Determination of Sound Transmission Class

- B. SSPC - Steel Structures Painting Council

SP-10 Near-White Blast Cleaning

PS-12.00 Guide for Selecting Zinc-Rich Painting Systems

6.4.3. SYSTEM DESCRIPTION

A. Glazed aluminum curtain wall system includes PVDF3 coated aluminum sections with self-supporting framing, shop fabricated, factory pre-finished, vision double glazing glass, glass spandrel infill; related flashings, anchorage and attachment devices.

6.4.4. 1.04 PERFORMANCE REQUIREMENTS

- A. General: Provide glazed aluminum curtain wall system that has the following capabilities based on pre-construction testing:
1. Withstand loads and thermal and structural movement requirements indicated without failure. Failure includes the following:
 - a. Air infiltration and water penetration not exceeding the specified limits.
 - b. Framing members transferring stresses, including those caused by thermal and structural movement, to glazing units.
 - B. Glazing: Glazing shall be physically and thermally isolated from framing members.
 - C. System is reglazable from interior, except spandrel glazing are reglazable from exterior.
 - D. Wind Loads: Provide glazed aluminum curtain wall system, including anchorage, capable of withstanding wind-load inward and outward design pressures calculated according to requirements of the Saudi Code for loading and Saudi Code of Structural Steel works.
 - E. Design and size components to withstand seismic loads and sway displacement when wind loads effect maximum overturning moment.
 - F. Limit deflection of framing members in a direction normal to wall plane to 1/175 of clear span or 19 mm whichever is smaller; with full recovery of glazing materials. Where system affects gypsum board or plaster surfaces, limit deflection of framing members in a direction normal to wall plane to 1/360 of clear span or 19 mm maximum, whichever is smaller.
 - G. System to accommodate, without damage to system, components or deterioration of seals; movement within system; movement between system and perimeter framing components; dynamic loading and release of loads; deflection of structural support framing, shortening of building concrete structural columns, creep of concrete structural members and a mid-span slab edge deflection of 1/175 of clear span, 19 mm maximum.
 - H. Test Performance: Provide glazed aluminum curtain wall system that does not evidence material failures, structural distress, or permanent deformation of main framing members exceeding 0.2 percent of clear span when tested according to ASTM E330 and achieving the following:
 1. Test Pressure: 150 percent of inward and outward wind-load design pressure.
 2. Duration: As required by design wind velocity; fastest 1 mile of wind for relevant exposure category.
 - I. Average Thermal Conductance: Provide double glazed aluminum curtain wall system with average U-value 2 W/m²C.
 - J. Sound Attenuation Through Wall system (Exterior to Interior): > STC 37, measured according to ASTM E413.
 - K. Air infiltration through Assembly: Limit air infiltration to 0.3 L/s/sq. m of fixed wall area when tested according to ANSI/ASTM E283 at a static-air-pressure difference of 299 Pa.
 - L. Water Leakage: None, when measured in accordance with ASTM E331.

- M. System to provide for expansion and contraction within system components caused by a cycling temperature range of 95 degrees C over a 12 hour period without causing detrimental effect to system components.
- N. Drain water entering joints, condensation occurring in glazing channels, or migrating moisture occurring within system, to the exterior by a weep drainage network.
- O. Maintain system components from dust and moisture during assembly, after transport to site, during and after installation.
- P. Reinforce curtain wall system to accommodate window washing guide rails. Provide anchors sufficiently rigid to resist loads caused by equipment platform, without damage to wall system.
- Q. Not Permitted: Vibration harmonics, wind whistles, noises caused by thermal movement, thermal movement transmitted to other building elements, loosening, weakening, or fracturing of attachments or components of system.

6.4.5. SUBMITTALS

- A. Design calculations by professional engineer
- B. Shop Drawings: Indicate system dimensions, framed opening requirements and tolerances, anticipated deflection under load, affected related Work, weep drainage network, expansion and contraction joint location and details, and field welding required.
- C. Product Data:
 - 1. Provide component dimensions, describe components within assembly, anchorage and fasteners, glass and infill, internal drainage details and water flow diagrams.
 - 2. Product Data: Provide framing member structural and physical characteristics, dimensional limitations, and special installation requirements.
 - 3. Type and properties of glass and method of fixation.
- D. Submit 2 samples 300 x 300 mm in size illustrating prefinished aluminum surface, specified glass units, insulated infill panels, glazing materials illustrating edge and corner.
- E. Test Reports: Submit substantiating engineering data, test results of previous tests which purport to meet performance criteria, and other supportive data.
- F. Manufacturer's Installation Instructions: Indicate special installation procedures, instruction and other recommendations.
- G. Properties of PVDF3 finish, indicating durability of coating considering the project site weather.

6.4.6. QUALITY ASSURANCE

- A. Drawings and Specifications: Plans, elevations and details as shown on Drawings and the requirements specified in this section, indicate design concept. The approved manufacturer shall be responsible for complete curtain wall system design based on the system performance requirements specified in this section.
- B. Applicable Standards: Perform Work in accordance with the following:
 - 1. AAMA - Metal Curtain Wall, Window, Store Front and Entrance - Guide Specifications Manual.
 - 2. AAMA - Aluminum Curtain Wall Design Guide Manual.

6.4.7. MANUFACTURER AND INSTALLER QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing aluminum curtain wall systems with minimum 10 years documented experience.
- B. Installer for Total System: Company authorized by system manufacturer and approved by The Engineer.
- C. Design structural support framing components under direct supervision of a Professional Engineer experienced in design of this work.

6.4.8. MOCKUP

- A. Provide a floor-to-floor mock-up including intermediate mullion, corner mullion, sill, vision glass light, and infill panel. Assemble to illustrate component assembly including glazing materials, weep drainage system, attachments, anchors, and perimeter sealant.
- B. Mockup may not remain as part of the Work.

6.4.9. DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect and handle products to site in strict accordance with manufacturer's instructions.
- B. Protect prefinished aluminum surfaces. Do not use adhesive papers or sprayed coatings which bond when exposed to sunlight or weather.

6.4.10. WARRANTY

- A. Provide five year for the glazed curtain wall system. Warranty shall include coverage for complete system for failure to meet specified requirements.

PRODUCTS

6.4.11. MATERIALS AND ACCESSORIES

- A. Aluminum: Alloy and temper shall be as recommended by manufacturer for type of use and finish indicated and complying with the following requirements:
 - 1. Sheet and Plate: ASTM B209
 - 2. Extruded Bars, Rods, Shapes, and Tubes: ASTM B221
 - 3. Extruded Structural Pipe and Tube: ASTM B429
 - 4. Welding Rods and Bare Electrodes: AWS A5.10
 - 5. Aluminum Coating PVDF 3.
- B. Steel Reinforcement:
 - 1. ASTM A36 for structural shapes, plates and bars.
 - 2. ASTM A611 for cold-rolled sheet and strip.
 - 3. ASTM A570 for hot-rolled sheet and strip.
- C. Glazing: Double glazing as specified in item 2.03
- D. Glazing Gasket: Manufacturer standard sealed-corner pressure-glazing system of resilient elastomeric glazing gaskets, setting blocks, and shims or spacers; in hardness as recommended by manufacturer.
- E. Glazing Sealant: As recommended by manufacturer for the intended application.
- F. Fasteners: Stainless steel.
- G. Touch-Up Primer for Galvanized Steel Surfaces: Zinc rich type.

6.4.12.COMPONENTS

A. Mullion Profile: Manufacturer standard aluminum extrusions, matching stops and pressure plate of sufficient size and strength to provide bite on glass and infill panels; drainage holes; deflector plates and internal flashings to accommodate internal weep drainage system; internal mullion baffles to eliminate "stack effect" air movement within internal spaces.

B. Reinforced Mullion: Where required, provide profile of extruded or sheet aluminum cladding with internal reinforcement of shaped steel structural section.

C. Operable Windows: Heavy Commercial grade, complying with the requirements specified in of AAMA 101 as well as Section 08520 - ALUMINUM WINDOWS.

D. Infill Panel: Internally reinforced, glazing units, color to match vision glass, structurally sufficient to support wall fin radiation saddles with glass fiber insulation core and aluminum backing.

E. Column Covers: Aluminum with backing, thickness as recommended by manufacturer to ensure flat surface, finish as selected to match curtain wall mullion sections.

F. Flashings: Aluminum, thickness as recommended by manufacturer to ensure flat surface, finish as selected to match curtain wall mullion sections where exposed, secured with concealed fastening method.

G. Louver Screening: Provide bird screen at exhaust and insect screen at intake air louver inside surface.

6.4.13.GLASS AND GLAZING MATERIALS

A. Refer to the requirements in the following table:

Single Glazing :- 6mm

Colour	mm	Blue
Thickness	mm	6
Light Factors		
LT	%	57
LRe	%	6
LRi	%	6
Energy Factors		
T	%	44
Re	%	5
Ri	%	5
A	%	51
Solar factor g		0.57
Shading Coefficient SC		0.65
U-Value	W/(m2.K)	5.7

Double Glazing : 6 (12) 6 mm

External Pane		Blue
Low E coating	Face	3
Light factors		
LT	%	49
LRe	%	8
LRi	%	10
Energy Factors		
T	%	30
Re	%	9
Ri	%	18
A1		56
A2	%	8
Solar factor g		0.40
Shading coefficient SC		0.46
U-value (Air gap)	W/(m2.K)	1.8
STC		≥37

The thickness and gap of glass mentioned above is minimum only. It may vary as indicated in drawings or as directed by Engineer.

6.4.14.SEALANT MATERIALS

- A. Sealant and Backing Materials: Comply with the requirements of Section SEALANTS for perimeter sealants.
- B. Structural Glazing Sealant: Silicone-based, high performance sealant, type and grade as recommended by manufacturer for the intended application.

6.4.15.FABRICATION

- A. Fabricate curtain wall components with minimum clearances and shim spacing around perimeter of assembly, yet enabling installation and dynamic movement of perimeter seal.
- B. Accurately fit and secure joints and corners. Make joints flush, hairline, and weatherproof.
- C. Prepare components to receive anchor devices. Fabricate anchors in factory.
- D. Arrange fasteners and attachments to ensure concealment from view.
- E. Where required, reinforce interior horizontal head rail to receive drapery track brackets and attachments.
- F. Reinforce framing members for external imposed loads.

6.4.16.2.06 FINISHES

- A. Exposed aluminum surfaces shall have PVDF3 finish.
- B. Concealed Steel Items: Galvanized in accordance with ANSI/ASTM A386 to 610 gm/sq m).
- C. Apply one coat of bituminous paint to concealed aluminum and steel surfaces in contact with cementitious or dissimilar materials.

EXECUTION**6.4.17.3.01 EXAMINATION**

- A. Verify site opening conditions.
- B. Verify dimensions, tolerances, and method of attachment with other work.
- C. Verify wall openings and adjoining air and vapor seal materials are ready to receive work of this Section.

6.4.18.3.02 INSTALLATION

- A. Install curtain wall system in strict accordance with manufacturer's instructions as well as the following standard:
 - 1. AAMA - Metal Curtain Wall, Window, Store Front and Entrance - Guide Specifications Manual.
 - 2. AAMA - Aluminum Curtain Wall Design Guide Manual.
- B. Attach to structure to permit sufficient adjustment to accommodate construction tolerances and other irregularities.
- C. Provide alignment attachments and shims to permanently fasten system to building structure.
- D. Align assembly plumb and level, free of warp or twist. Maintain assembly dimensional tolerances, aligning with adjacent work.
- E. Provide thermal isolation where components penetrate or disrupt building insulation.
- F. Where required, install sill flashings.
- G. Coordinate installation of fire and air stop insulation at each floor slab edge.
- H. Coordinate attachment and seal of perimeter air and vapor barrier materials.
- I. Pack fibrous insulation in shim spaces at perimeter of assembly to maintain continuity of thermal barrier.
- J. Install operating sash in accordance with Drawings.
- K. Install louvers, associated flashings, blank-off plates and screening. Fit blank-off plates tight to ductwork.
- L. Install glass and infill panels in accordance with Section 08800 - GLAZING.
- M. Install perimeter sealant to method required to achieve performance criteria, backing materials, and installation criteria in accordance with Section 07900 - SEALANTS.

6.4.19.3.03 TOLERANCES

- A. Maximum Variation from Plumb: 1.5 mm/m non-cumulative or 12 mm/30 m), whichever is less.
- B. Maximum Misalignment of Two Adjoining Members Abutting in Plane: 0.8 mm.

6.4.20.3.04 FIELD QUALITY CONTROL

- A. Inspection will monitor quality of installation and glazing.
- B. Air Infiltration: Test areas of installed system for compliance with system performance requirements according to ASTM E783.
- C. Repair or remove defected and damaged work that does not meet requirements or that is damaged by testing; replace to conform to specified requirements.

6.4.21.3.05 ADJUSTING AND CLEANING

- A. Adjust operating sash for smooth operation.
- B. Remove protective material from prefinished aluminum surfaces and system components.
- C. Wash down surfaces with a solution of mild detergent in warm water, applied with soft, clean wiping cloths. Take care to remove dirt from corners. Wipe surfaces clean.
- D. Remove excess sealant by moderate use of mineral spirits or other solvent acceptable to sealant manufacturer.

6.4.22.PROTECTION OF FINISHED WORK

- A. After work completion provide final protection and maintain conditions, in a manner acceptable to Manufacturer, Installer and the Engineer, that ensure glazed aluminum curtain wall system is without damage or deterioration at time of Substantial Completion.

6.6 – Automatic Platform Gate

General Compliance and standards

APG Operational Cycles: doors will be subject to heavy and intensive use. They should have the capacity to make 1000 to 1500 cycles of opening and closing daily. The motor must be certified by an independent laboratory of 10,000,000 cycles of opening and closing with a 2 year warranty without the need for repair.

High Performance BLDC Motor: type high performance three coil-brushless motor of 24V and 10.000.000 minimum cycles, with Certificates according to standards UNE-EN 16005:2013 > 10,000,000 cycles.

Door Stops Machined: Door stops machined in steel and anti-noise rubbers in the area of contact with the carrier

Transmission Toothing Belt: Transmission toothing belt for connection to the belt fitting. Toothing belt coupling located with independent carrier in the center of the sliding blade made of 4-5 mm steel to keep centre of gravity of traction.

Motor Certificate IP-65 Protection Rating: Certificate IP-65 Protection rating according to IEC 60529 Standards

APG Certificate IP-55 Protection Rating: Certificate IP-55 Protection rating according to IEC 60529:1989/12:2013 APG - Automatic Platform Gate for BRT and Railway Applications

Maximum Thrust force: Maximum Thrust force according to European Standards **less than 220N**

CE Certificate: CE Certificate in Low Voltage Directive UNE EN 61000 2004/108/CE, Machinery Directive 2006/42/CE, RoHS 2002/95/CE

Minimum Functional BRT Doors: Minimum functional BRT doors installation of 2000 PDS doors worldwide. **Experience in PSD/APG installations accrediting, with BRT-AT installations in 7 different cities and countries as a minimum.**

Local experience: Local experience must be from 250-500 BRT doors installations in Pakistan.

Vendor and manufacturer should have sufficient experience in all types of PSDs and APG.

Suitable for Outdoors Application: All equipment should be suitable for outdoors Application (IP-55).

Working Temperature Range: Working temperature range should be from 50°C to - 25°C,

Humidity Tolerance: Humidity tolerance should be relative humidity of 85% non-condensing.

SCADA Compatibility: All doors should be linked to central control station by SCADA for faults, alarms and maintenance issues.

Vehicle detection system through reflective photoelectric/Ultrasonic sensors of **adjustable range** type WBE000TA02, compact body, and long range adjustable to a maximum distance of 2 m. Type IP-67 rated for demanding and intensive applications. Receiver equipped with two-segment diodes. This can be done independently of the color or background. It incorporates the ability to place two sensors very close or facing each other without interfering with each other. Adjustable long range reflectivity. Consume of 50 mA or less. Operation at 24V DC.

Modular Based Device: The incorporation of new devices is done without the need to change installed devices and can be expanded simply by incorporating more communication cards and reprogramming the main board.

Power Backup: System should be capable of Self-contained Power backup system for 200 cycles (Opening and Closing)

General Compliances Standardization:

- Quality Management System ISO 9001:2015
- Environmental Management System ISO 14001:2015
- Directive 2006/95/EC:
 - EN 60335-2-103:2005 + A11:2010 in connection with
 - EN 60335-1:2012 + A11:2014 + AC:2014
- Directive 2004/108/EC:
 - EN 61000-6-3:2007 + A1:2012
 - EN 61000-3-2:2014
 - EN 61000-3-3:2013
 - EN 61000-6-1:2007
 - EN 61000-4-2:2010
 - EN 61000-4-3:2007 + A1:2008 + A2:2011
 - EN 61000-4-4:2013
 - EN 61000-4-5:2015
 - EN 61000-4-6:2014

- EN 61000-4-8:2011
- EN 61000-4-11:2015
- EMC2004/108/CE
- 92/58/CEE
- 3006/42/CE
- **Relating to the APG Body:**
 - IEC 60529 1984/A2:2013 IP-55
- **Relating to the security:**
 - EN 16005:2013
- **Relating to the motor:**
 - EN 60529 IP65.
 - Certificate 10.000.000 of cycles UNE-EN 16005:2013
- **Relating to wiring:**
 - EN 60754-1:2014
 - EN 60754-2:2014
- **Relating to glazing:**
 - EN 12600:2003
- **Relating to profiles:**
 - DIN 50049, DIN 17162
 - ASTM A 480
 - ISO 7599:2011

APG - AUTOMATIC PLATFORM GATE

- Automatic Platform Gates APGs SCREEN SYSTEM for BRT-AT of one (01) lateral - opening door leaf or two (02) center-opening door leaves which includes:
- Body made in stainless steel AISI 304 or AIS 316, surface finish according to ASTM A 480 No 4 mate or No 8 brilliant mirror.
- Security tempered laminated glass 44/2 colorless and perimetral serigraphy.
- The APG-AT system can be used for different bus typologies and bus formats. The system can be optionally managed through the SCADA management system, which allows to control the APG door operation defined by the authorities right from the station itself and/or from the central control.

- The APG Module inner structure manufactured with a high resistance Steel and powder coated finished.
- Accessible APG cover manufactured with pneumatic shock absorbers for easy access. Antivandal safety locks to ensure the APG cover is not opened and only handled by authorized and qualified technical staff trained by the system manufacturer.
- Control module and independent motor interconnected in between to ensure proper operation and functioning.
- Concealed system for the moving door leaf reinforced screws and machined steel plate of 4-5 mm. High performance PA66-GF10 wheels.
- Toothed belt coupling located with independent carrier in the center of the sliding door made of 4-5 mm steel to keep Centre of gravity of traction.
- Adjustable tension pulley, machined with galvanized electrolytic UNE EN ISO 2081 or 1015
- Drills to install the fixations set of the APG chassis module to allow its correct installation in case the floor is not leveled. Fixation template to facilitate drilling and the installation of the screws in the correct position which are fixed from floor to the module.
- During opening and closing of the door, the light signal will flashes green and red respectively. When the door is open for passenger boarding / disembarking, it lights solid green. When the door is closed it lights up in solid red. Operation with LEDs that indicate to the users the arrival of the bus and passengers can access to it. It allows the reduction of energy consumption compared to traditional light signals. Integrated in the module itself and preventing it from being manipulated.

Automatic Platform Gate for BRT system (Components):

- Microprocessor
- Function card: Electronic.
- Programming Unit.
- All cabling till termination with SCADA equipment.
- 24 VDC motor. Brushless, maintenance-free.
- Transmission: Toothed Belt.

- Working temperature: -25 °C / 50 °C
- Relative Humidity: 85%, non-condensing
- Power supply: AC 110 - 220 V, 50/60 Hz.
- Maximum consumption: <150W.
- Standby power consumption: 10 W
- Consumption at medium speeds: <100 W.
- Fuse: F3A 250V.
- Adjustable opening speed: 150 ~ 460 mm / s 1 leaf 260 ~ 920 mm / s 2 leaves
- Adjustable closing speed: 130 - 460 mm / s
- Closing force: 1500 N.
- Braking speed: 200 - 600 mm / s
- Hold open time: 0-9 s.
- Opening Width: Adjustable.
- Braking Distance: Adjustable
- Anti-crushing: Closing force <50N
- Static force: Adjustable 90-150 N
- Frequency of use: Continuous.
- Provision of manual operating system in-case of failure of automatic system with each door
- Connection to PC: through RJ45 connector
- Power backup system for 200 cycles (Opening and Closing)
- Certificate 10,000,000 cycles.
- Motor IP-65 rating according to IEC 60529

Maximum weight per door leaf

60 Kg.

Dimensions:

Clear passage width: 1 door leaf 600 – 1200 mm.
2 door leaves 1200 – 2400 mm.

FRAMES AND PROFILES FOR APG

- Vertical profiles with rounded edges dimensions 55 x 46 mm
- Horizontal profiles dimensions 63 x 42 mm
- Registrable front and back cover for easy installation and maintenance of the installed equipment.
- EPDM vertical joint between the door leaves to guarantee it is not the material wasted and avoid scratches.
- The APG module is manufactured with cold mechanized bends with no welds in order to prevent the deterioration or oxidation because of climate conditions in outside installations.

ELECTRONIC OF COMMUNICATION, CONTROL AND DIAGNOSIS OF THE APG BRT SYSTEM

Door operator control and communication devices allow the synchronization of the doors and peripheral devices.

- The main or control operator has a main Multifunction board type CMS (Control Management System WBE000GE12) that allows synchronization between door operators and secondary doors. This card executes the actions of the devices and sends them to the communication cards.
- Card type CMS (WBE000GE13) installed in all slaves operators which allows communication between the main and secondary doors of the platform.
- Flat shielded wire MECPLCAG90 type IDC FLAT WIRE 10 ways for connection of control and communication cards.
- UTP type wire and RJ-45 connector for connection of the operators.
- The programming of the control card allows programming different opening / closing commands according to the type of Bus and doors to be synchronized.
- The control and communication system is ready to assign any of the functions type RF, AT, DI. MX.
- Equipment interconnected by means of a high-performance CAN bus. The Equipment CAN bus transmits data at a speed of 125 Kbps and can be increased up to 1 Mbps. The Master CMS can forward the data received via CAN to the internet and deliver it by this means to others stations or remote control system.

- The configuration of the CAN bus chosen for BRTs responds in a standard way to ISO 11898-2, also called high speed CAN, although it can also be configured according to ISO 11899-3 or CAN of low speed tolerant to failures.

- Main characteristics of CAN bus are:

- CAN bus is able to manage different messages priorities.
- All times involved in the communication process are deterministic.
- Flexible configuration of the whole communication system.
- Is possible to use broadcasting reception of the messages.
- System very strong regarding data coherence.
- Multi-master system is also allowed.
- CAN bus is able to signalize and correct transmission errors.
- Automatic managing of incorrect or misleading frames.
- CAN bus can distinguish between temporary node errors, and autonomous disconnection of erroneous nodes.

- To upgrade the CMS software, the program "STM32ST-LINK Utility.exe" is used.

- The CAN cable used in your installations is a cable designed for this standard (BUS CAN 1x2x0,5 * 20AWG (SHIELDED) c(UL)us E236660 CMX 75°C RoHS), as well as the correct installation of the two termination resistors of $120\Omega \pm 5\%$, and that the measurement of the resistance at any point between CAN_H line and CAN_L with a multimeter is $60 \pm 15\%$ (corresponding to the parallel value of the two termination resistors of 120Ω bus located at the end of the line).

Vehicle Detection System through reflective photoelectric/Ultrasonic sensors of **adjustable range** type WBE000TA02, compact body, and long range adjustable to a maximum distance of 2 m. Type IP-67 rated for demanding and intensive applications. Receiver equipped with two-segment diodes. This can be done independently of the colour or background. It incorporates the ability to place two sensors very close or facing each other without interfering with each other. Adjustable long range reflectivity. Consume of 50 mA or less. Operation at 24V DC.

- The incorporation of new devices is done without the need to change installed devices, and can be expanded simply by incorporating more communication cards and reprogramming the main board.

- It incorporates software in the main card that allows the management of the doors and the installed safety devices.

- The system allows the migration of technology to any of the activation and control systems RF, AT, DI, MX.
- The PCGRUL-01 allows the operation of the indicative traffic light of open and closed doors.
- The system allows the incorporation of a monitoring, control, tracking system and SCADA supervision that can be done locally or remotely, this will be done online and in real time.
- Electronic Control Cards that incorporate a system to visualize the functioning of the devices through LED diodes that show in real time the operation of these, if they are active or need to be replaced.
- The control board CMS allows the recording of informative messages that facilitate the user to use the BRT system. You can enter two messages in two different languages.
- Scalable APG system with the possibility of incorporating new devices.
- It incorporates an opening device capable of making an emergency intervention of all the doors simultaneously
- Incorporates the possibility of placing an opening device in each of the doors of the platform
- The sound signal can be programmed and deactivated according to the need of the sound operation. It has programmed volume control.
- The system keeps the doors closed and locked without the need to install an additional lock. The thrust forces are higher than 1500 Newtons.
- Allows the inclusion of linear LED light signals, colored lamps, etc
- The system allows the programming of door closing without possibility of reopening and with an alert through an acoustic and luminous alarm.
- Operators have a control module interconnected to a control module of the motor.
- APG electronics ready for the integration of a people counting system for bus access and exits
- Scalable system BRT SCREEN SYSTEM, with the option of integrating various visual control devices, CCTV, SCADA, bus monitoring, etc.
- The system integrates a SCADA that incorporates online status of doors, maintenance notification, number of door life cycles, time of arrival and stop of the buses in the station, peripheral device failures, and information regarding arrival / departures of buses.

SCADA (REMOTE MONITORING AND CONTROL SYSTEM OF BRT-AT SYSTEM)

System of Remote Supervision, Control and Data Acquisition facilitate real-time feedback with field devices and controls the process automatically. It provides all the information generated in the production process (supervision, quality control, production control, data storage, etc.) and allows its management and intervention.

Includes:

- Application software for local or remote stations
- Connection to a local or remote PC to a central server.
- On Line Monitoring of the doors operation.
- Remote intervention of security opening of one or group of doors.
- Monitoring of peripheral devices
- HMI Human-Machine Interface located in the station.
- Operating cycle counter, maintenance alert and control settings
- Allows the sending of an audible alert of use or emergency.
- Operation history for assessment of usage statistics.
- BRTSCDIS1 HMI device touch panel 17 "TFT-LED True Flat where an easy-to-learn functional scheme is incorporated. Includes OS Windows 7
- Main control PC for integration with other devices of the monitoring system and connected to supervisory HMIs.
- PC touch panel 17 "TFT-LED True Flat BRTSCCCC01 with an OS Windows 7 Professional 64 bits for visualization of maintenance alarms, situation of the emergency opening push button, positioning sensors, signal lights, etc.
- Communication module WBE000GE07 between the HMI and the door operator AG90 / 200.
- UTP type cable and RJ-45 connector for interconnection of devices. Maximum distance of 100 mt.
- SCADA working environment, adaptable to the particular application intended to develop. Open architecture system (able to adapt according to the needs of the owner). Easy communication both with the user and central control equipment.

UPS (UNINTERRUPTIBLE POWER SUPPLY)

UPS, uninterruptible power supply backup system for APGs and SCADA installed in each of the stations.

Specifications: According to indications of the manufacturer of APGs fulfilling the needs of load for each station.

WARRANTY:

All system has two years of limited warranty against any manufacturing failure.

SPECIAL TERMS AND CONDITIONS

Daily Opening and Closing Cycles of APG: APG doors will be subject to heavy and intensive use. They should have the capacity to make **1000 to 1500 cycles** of opening and closing daily. The motor must be certified by an independent laboratory of 10,000,000 cycles of opening and closing with a **7 year warranty** motor.

European Origin: The APG doors will be from Europe and CE marked with sufficient technical assistance and original spare parts. The import of all equipment/components will be varified through shipping documents.

The supplier must guarantee the existence of the components and spare parts of the doors in at least 5% of the number of units to be placed.

FAT(Factory Acceptance Test): The supplier will be responsible for FAT at the factory premises for atleast TWO persons(One Consultant & One Client)including all exenses(boarding/lodging/travelling expenses/air tickets-both ways)

END OF SECTION

6.6 - MIRRORS

GENERAL

6.6.1. RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

6.6.2. SUMMARY

A. Section includes the following types of silvered flat glass mirrors:

1. Annealed monolithic glass mirrors.

B. Related Sections include the following:

1. Division 1 Section "Architectural Products Submittals and Substitutions" for requirements regarding submittals and substitutions of architectural products.
2. Division 1 Sections for contractual requirements.
3. Division 10 Section "Toilet and Bath Accessories".

6.6.3. SUBMITTALS

A. Product Data: For each type of product indicated.

1. Mirrors. Include description of materials and process used to produce each type of silvered flat glass mirror specified that indicates sources of glass, glass coating components, edge sealer, and quality-control provisions.

B. Shop Drawings: Include mirror elevations, edge details, mirror hardware, and attachments to other work.

C. Samples: For each type of the following products:

1. Mirrors: 300 mm square, including edge treatment on two adjoining edges.
2. Mirror Clips: Full size.

D. Qualification Data: For qualified Installer.

E. Product Certificates: For each type of mirror and mirror mastic, from manufacturer.

F. Preconstruction Test Reports: From mirror manufacturer indicating that mirror mastic was tested for compatibility and adhesion with mirror backing paint and substrates on which mirrors are installed.

G. Maintenance Data: For mirrors to include in maintenance manuals.

H. Warranty: Sample copy of manufacturer's proposed warranty complying with specified requirements, and stating obligations, remedies, limitations, and exclusions of warranty.

6.6.4. QUALITY ASSURANCE

A. Installer Qualifications: A qualified installer who employs glass installers for this Project who are certified under the National Glass Association's Certified Glass Installer Program.

B. Source Limitations for Mirrors: Obtain mirrors from single source from single manufacturer.

C. Source Limitations for Mirror Accessories: Obtain mirror glazing accessories from single source.

D. Glazing Publications: Comply with the following published recommendations:

1. GANA's "Glazing Manual" unless more stringent requirements are indicated. Refer to this publication for definitions of glass and glazing terms not otherwise defined in this Section or in referenced standards.
2. GANA Mirror Division's "Mirrors, Handle with Extreme Care: Tips for the Professional on the Care and Handling of Mirrors."
- E. Preconstruction Mirror Mastic Compatibility Test: Submit mirror mastic products to mirror manufacturer for testing to determine compatibility of mastic with mirror backing paint and substrates on which mirrors are installed.

6.6.5. DELIVERY, STORAGE, AND HANDLING

- A. Protect mirrors according to mirror manufacturer's written instructions and as needed to prevent damage to mirrors from moisture, condensation, temperature changes, direct exposure to sun, or other causes.
- B. Comply with mirror manufacturer's written instructions for shipping, storing, and handling mirrors as needed to prevent deterioration of silvering, damage to edges, and abrasion of glass surfaces and applied coatings. Store indoors.

6.6.6. PROJECT CONDITIONS

- A. Environmental Limitations: Do not install mirrors until ambient temperature and humidity conditions are maintained at levels indicated for final occupancy.

6.6.7. WARRANTY

- A. Mirrors Warranty: Provide complete warranty in which Manufacturer, Contractor and

Installer are jointly and severally responsible and agree to repair or replace without limitations, all or any part of the mirrors specified in this section which fails or becomes defective in materials or workmanship within specified warranty period.

1. Defects: Deterioration of mirrors is defined as defects developed from normal use that are not attributed to mirror breakage or to maintaining and cleaning mirrors contrary to manufacturer's written instructions. Defects include discoloration, black spots, and clouding of the silver film.

1. Warranty Period: Five years from date of Substantial Completion.

PRODUCTS

6.6.8. SILVERED FLAT GLASS MIRRORS

- A. Glass Mirrors, General: ASTM C 1503.
Clear Glass: Mirror Glazing Quality.
Nominal Thickness: 6.0 mm.

6.6.9. MISCELLANEOUS MATERIALS

- A. Setting Blocks: Elastomeric material with a Shore, Type A durometer hardness of 85, plus or minus 5.
- B. Edge Sealer: Coating compatible with glass coating and approved by mirror manufacturer for use in protecting against silver deterioration at mirrored glass edges.

C. Mirror Mastic: An adhesive setting compound, asbestos-free, produced specifically for setting mirrors and certified by both mirror manufacturer and mastic manufacturer as compatible with glass coating and substrates on which mirrors will be installed.

6.6.10. MIRROR HARDWARE

A. Mirror Bottom Clips: One Piece continuous fixed type 25 mm high brass nickel plated, as shown on detail.

B. Mirror Top Clips: One Piece adjustable type, 30 mm high brass nickel plated with 16 mm counter sunk screw and slot, as shown on detail.

C. Fasteners: Fabricated of same basic metal and alloy as fastened metal and matching it in finished color and texture where fasteners are exposed.

D. Anchors and Inserts: Provide devices as required for mirror hardware installation. Provide toothed or lead-shield expansion-bolt devices for drilled-in-place anchors. Provide galvanized anchors and inserts for applications on inside face of exterior walls and where indicated.

6.6.11. FABRICATION

A. Mirror Sizes: To suit Project conditions, cut mirrors to final sizes and shapes.

B. Cutouts: Fabricate cutouts for notches and holes in mirrors without marring visible surfaces.

Locate and size cutouts so they fit closely around penetrations in mirrors.

C. Mirror Edge Treatment: Beveled polished edge of width shown.

1. Seal edges of mirrors with edge sealer after edge treatment to prevent chemical or atmospheric penetration of glass coating.

2. Require mirror manufacturer to perform edge treatment and sealing in factory immediately after cutting to final sizes.

EXECUTION

6.6.12. EXAMINATION

A. Examine substrates, over which mirrors are to be mounted, with Installer present, for compliance with installation tolerances, substrate preparation, and other conditions affecting performance of the Work.

B. Verify compatibility with and suitability of substrates, including compatibility of mirror mastic with existing finishes or primers.

C. Proceed with installation only after unsatisfactory conditions have been corrected and surfaces are dry.

6.6.13. PREPARATION

Comply with mastic manufacturer's written installation instructions for preparation of substrates, including coating substrates with mastic manufacturer's special bond coating where applicable.

6.6.14. INSTALLATION

A. General: Install mirrors to comply with mirror manufacturer's written instructions and with referenced GANA publications. Mount mirrors accurately in place in a manner that avoids distorting reflected images.

B. Provide a minimum air space of 3 mm between back of mirrors and mounting surface for air circulation between back of mirrors and face of mounting surface.

C. Wall-Mounted Mirrors: Install mirrors with mastic and mirror hardware. Attach mirror hardware securely to mounting surfaces with mechanical fasteners installed with anchors or inserts as applicable. Install fasteners so heads do not impose point loads on backs of mirrors.

1. Mirror Clips: Place a felt or plastic pad between mirror and each clip to prevent spalling of mirror edges. Locate clips where indicated.

2. Install mastic as follows:

a. Apply barrier coat to mirror backing where approved in writing by manufacturers of mirrors and backing material.

b. Apply mastic to comply with mastic manufacturer's written instructions for coverage and to allow air circulation between back of mirrors and face of mounting surface.

c. After mastic is applied, align mirrors and press into place while maintaining a minimum air space of 3 mm between back of mirrors and mounting surface.

6.6.15. CLEANING AND PROTECTION

A. Protect mirrors from breakage and contaminating substances resulting from construction operations.

B. Do not permit edges of mirrors to be exposed to standing water.

C. Maintain environmental conditions that will prevent mirrors from being exposed to moisture from condensation or other sources for continuous periods of time.

D. Wash exposed surface of mirrors not more than four days before date scheduled for inspections that establish date of Substantial Completion. Wash mirrors as recommended in writing by mirror manufacturer.

END OF SECTION

6.7 - GLASS AND GLAZING

GENERAL

6.7.1. DESCRIPTION

A. Furnish labor, materials and equipment to supply and install glass in different types of windows and doors.

6.7.2. SUBMITTALS

A. Samples:

1. 300 x 300 mm (12 x 12 IN), of each specified type, class and thickness.
2. Sample of translucent ceramic fit pattern.

B. Project close-out information

1. Guarantee

6.7.3. JOB CONDITIONS

Do not proceed with installation under adverse weather conditions, or when temperature are below or above manufacturer's recommended limitations.

6.7.4. STORAGE AND HANDLING:

A. Store glazing in cases within building in a dry, well-ventilated area to avoid cyclic wetting and drying and damage from moisture.

B. Store glazing out of case vertically with interweaving or pacing between the individual lights

C. Protect glazing from welding operation, wind-blown objects, and run-off over alkaline materials.

D. Handle glazing carefully to prevent edge damage.

6.7.5. GUARANTEE

Written 5 year guarantee signed by installer to cover weather tightness of installation including air and water integrity. Guarantee structural adequacy of units and hardware, sealants and caulking within and around perimeter of installation.

PRODUCTS

6.7.6. MATERIALS

A. Glass materials.

1. Comply with specified standards
2. Manufacturer or fabricator is responsible for determining if any of these materials should be heat strengthened or fully tempered and provide accordingly.

B. Tinted glass for aluminum windows & doors

1. Tinted tempered float glass 6 or 8, 10 or 12 mm thick as produced by Pilkington or similar.

2. The following performance:

- a- Visible light transmittance 71%
- b- Outdoor reflectance (%) 7%
- c- Total solar energy transmittance 33%
- d- Shading Coefficient 0.58%

C. Clear glass for windows and doors

- 1. Clear tempered float glass, 6 mm, 8 mm or 10 mm thick ASTM C1048.

D. Glazing compounds:

- 1. Non-sag, non-stain type.
- 2. Pigmented to match frame units not requiring painting.
- 3. Compatible with adjacent surfaces.
- 4. For use in setting glass: One part polyurethane or silicone sealant, F.S. TTS-00230C (2), Type II, class A or two-part polyurethane sealant, F.S. TT-S- 00227E, Type II, class A.
- 5. Sealant tape: Performed butyl 1 rubber sealant tape or ribbon having a continuous neoprene rubber shim.
- 6. Gaskets: Polyvinyl chloride or neoprene, extruded, flexible, of profile and hardness required to receive glass and provide a watertight installation.

D. Setting blocks and spacers: Neoprene, compatible with sealants used.

- 1. Setting blocks: 70 - 90 urometer
- 2. Spacers: 40-50 urometer
- 3. Compressible filler stock: closed-cell jacketed rod stock of synthetic rubber or plastic foam.

E. Shims clips, springs, angles, beads, attachment screws and other miscellaneous items: As indicated or required.

EXECUTION

6.7.7. INSPECTION

Examine framing or glazing channel surfaces, backing, stop design, and conditions under which glazing is to be performed.

6.7.8. INSTALLATION

- A. Do not install glass with edge damage.
- B. Contractor is responsible for correct glass size for each opening, within tolerances and dimensions established.
- C. Comply with combined recommendation of material manufacturers, except where more stringent requirements are shown or specified.
- D. Install sealants as recommended by sealant manufacturer.
 - A. E. Install setting blocks in adhesive.
- F. Provide spacers inside and out, of proper size and spacing, for all glass sizes larger than 1270 united mm, expect where gaskets are used for glazing. Provide 3.175 mm minimum bite of spacers on glass. Use thickness equal to sealant width. Use preshimmed tape, if tape is used.
- G. Miter cut and bond gasket ends together at corner. Do not stretch gaskets.
- H. Immediately after installation, attach crossed streamers to framing held away from glass. Do not apply anything to surfaces to glass.
- I. Remove, and replace damaged glass and provide new acceptable materials.

6.7.9. CLEANING AND PROTECTION

A. Maintain glass reasonably clean during construction, so that it will not be damaged by corrosive action and will not contribute to deterioration of other materials.

B. Wash and polish, glass on both faces not more than 7 days prior to Engineers acceptance of work in each area. Comply with glass manufacturer's recommendation.

END OF SECTION

3. FINISHES

7.1. UNIT PAVERS

GENERAL

7.1.1 RELATED DOCUMENTS

- A. Drawing and general provision of the contract, including condition of Contract and other Details.

7.1.2 SUMMARY

- A. This Section includes the following:
 - 1. Concrete pavers set in aggregate setting bed.
- B. Related Sections include the following:
 - 1. 2.0 Section "Earthwork" for compacted sub grade and sub base course, if any, under unit pavers.

7.1.2.1 SUBMITTALS

- A. **Product Data:** For the following:
 - 1. Concrete pavers.
- B. **Samples for Initial Selection:** Manufacturer's color charts consisting of units or sections of units showing the full range of colors, textures, and patterns available for each type of unit paver indicated.
 - 1. Include similar samples of material for joints and accessories involving color selection.
- C. **Samples for Verification:** Full-size units of each type of unit paver indicated; in sets for each color, texture, and pattern specified, showing the full range of variations expected in these characteristics.
 - 1. Provide samples with joints grouted and cured, showing the full range of colors to be expected in the completed Work.
- D. **Qualification Data:** For firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects/Consultants and owners, and other information specified.

7.1.2.2 QUALITY ASSURANCE

- A. **Installer Qualifications:** An experienced installer who has completed unit paver installations similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.
- B. **Source Limitations:** Obtain each type of unit paver, joint material, and setting material from one source with resources to provide materials and products of consistent quality in appearance and physical properties.
- C. **Mockups:** Before installing unit pavers, build mockups for each form and pattern of unit pavers 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 the completed Work, including same base construction, special features for expansion joints, and contiguous work as indicated:

1. Build mockups in the location and of the size indicated or, if not indicated, as directed by the Consultant.
2. Notify the Consultant 7 days in advance of dates and times when mockups will be constructed.
3. Demonstrate the proposed range of aesthetic effects and workmanship.
4. Obtain the Consultant's approval of mockups before starting unit paver installation.
5. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
6. Demolish and remove mockups when directed.
7. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

7.1.2.3 DELIVERY, STORAGE, AND HANDLING

- A. Protect unit pavers and aggregate during storage and construction against soiling or contamination from earth and other materials.
 1. Cover pavers with plastic or use other packaging materials that will prevent rust marks from steel strapping.

PRODUCTS

7.1.2.1 COLORS AND TEXTURES

- A. **Colors and Textures:** As shown on drawings and as selected by the Consultant from the manufacturer's full range.

7.1.2.2 UNIT PAVERS

- A. **Concrete Pavers:** Solid, interlocking paving units, ASTM C 936, made from normal-weight aggregates in sizes and shapes indicated. Interlocking Paving should be installed on 30-50 mm thick sand setting bed over 250 mm thick sub-base. The minimum thickness of concrete pavers shall be 60mm. Concrete pavers shall be tested for compressive strength, abrasion resistance, absorption and dimensional tolerance. The test results shall comply with the requirements specified in ASTM C 936.

7.1.2.3 ACCESSORIES

- A. **Precast Concrete Edge Restraints:** Precast concrete curbing, made from normal-weight aggregate, in shapes and sizes indicated.

7.1.2.4 AGGREGATE SETTING-BED MATERIALS

- A. **Graded Aggregate for Sub base:** Sound crushed stone or gravel complying with ASTM D 448 for Size No. 57.
- B. **Graded Aggregate for Sub base:** ASTM D 2940, sub base material.
- C. **Graded Aggregate for Base:** Sound crushed stone or gravel complying with ASTM D 448 for Size No. 8.
- D. **Graded Aggregate for Base:** ASTM D 2940, base material.
- E. **Geotextile:** Woven or nonwoven geotextile manufactured from polyester or polypropylene fibers, with a permeability rating 10 times greater than that of

soil on which paving is founded and an apparent opening size small enough to prevent passage of fines from leveling course into graded aggregate of base course below.

- F. **Sand for Leveling Course:** Sound, sharp, washed natural sand or crushed stone complying with gradation requirements of ASTM C 33 for fine aggregate.
- G. **Stone Screenings for Leveling Course:** Sound stone screenings complying with ASTM D 448 for Size No. 10.
- H. **Sand for Joints:** Fine, sharp, washed natural sand or crushed stone with 100 percent passing 1.18 mm sieve and no more than 10 percent passing 0.075 mm sieve.
 - 1. Provide sand of color needed to produce required joint color.

EXECUTION

7.1.3.1 EXAMINATION

- A. Examine areas indicated to receive paving, with the Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.
 - 1. Where pavers are to be installed over waterproofing, examine waterproofing installation, with the waterproofing Installer present, for protection from paving operations. Examine areas where waterproofing system is turned up or flashed against vertical surfaces and horizontal waterproofing. Proceed with installation only after protection is in place.

7.1.3.2 PREPARATION

- A. Vacuum clean concrete substrates to remove dirt, dust, debris, and loose particles.
- B. Remove substances, from concrete substrates, that could impair mortar bond, including curing and sealing compounds, form oil, and laitance.
- C. Proof-roll prepared sub grade surface to check for unstable areas and areas requiring additional compaction. Proceed with unit paver installation only after deficient sub grades have been corrected and are ready to receive sub base for unit pavers.

7.1.3.3 INSTALLATION, GENERAL

- A. Do not use unit pavers with chips, cracks, voids, discolorations, and other defects that might be visible or cause staining in finished work.
- B. Mix pavers from several pallets or cubes, as they are placed, to produce uniform blend of colors and textures.
- C. Cut unit pavers with motor-driven masonry saw equipment to provide clean, sharp, unchipped edges. Cut units to provide pattern indicated and to fit adjoining work neatly. Use full units without cutting where possible. Hammer cutting is not acceptable.
 - 1. For concrete pavers, a block splitter may be used.
- D. **Joint Pattern:** Herringbone.
- E. **Pavers over Waterproofing:** Exercise care in placing pavers and setting materials over waterproofing so protection materials are not displaced and waterproofing is not punctured or otherwise damaged. Carefully replace

protection materials that become displaced and arrange for repair of damaged waterproofing before covering with paving.

1. Provide joint filler, at waterproofing that is turned up on vertical surfaces; or, if not indicated, provide temporary filler or protection until paver installation is complete.
- F. Tolerances: Do not exceed 0.8 mm unit-to-unit offset from flush (lippage) nor 3 mm in 3 m from level, or indicated slope, for finished surface of paving.

7.1.3.4 **AGGREGATE SETTING-BED PAVER APPLICATIONS**

- A. Compact soil sub grade uniformly to at least 95 percent of ASTM D 1557 laboratory density.
- B. Place geotextile over prepared sub grade, overlapping ends and edges at least 300 mm.
- C. Place aggregate sub base in thickness indicated. Compact by tamping with plate vibrator and screed to depth required to allow setting of pavers.
- D. Place aggregate sub base over compacted sub grade. Provide compacted thickness indicated. Compact sub base to 100 percent of ASTM D 1557 maximum laboratory density and screed to depth required to allow setting of pavers.
- E. Place geotextile over compacted base course, overlapping ends and edges at least 300 mm.
- F. Place leveling course and screed to a thickness of 25 to 38 mm, taking care that moisture content remains constant and density is loose and constant until pavers are set and compacted.
- G. Treat leveling base with soil sterilizer to inhibit growth of grass and weeds.
- H. Set pavers with a minimum joint width of 1.6 mm and a maximum of 3 mm, being careful not to disturb leveling base. If pavers have spacer bars, place pavers hand tight against spacer bars. Use string lines to keep straight lines. Fill gaps between units that exceed 10 mm with pieces cut to fit from full-size unit pavers.
 1. When installation is performed with mechanical equipment, use only unit pavers with spacer bars on sides of each unit.
- I. Vibrate pavers into leveling course with a low-amplitude plate vibrator capable of a 16- to 22 kN compaction force at 80 to 90 Hz. Perform at least three passes across paving with vibrator. Vibrate under the following conditions:
 1. After edge pavers are installed and there is a completed surface or before surface is exposed to rain.
 2. Before ending each day's work, fully compact installed concrete pavers to within 900 mm of the laying face. Cover open layers with non-staining plastic sheets overlapped 1200 mm on each side of the laying face to protect it from rain.
- J. Spread dry sand and fill joints immediately after vibrating pavers into leveling course. Vibrate pavers and add sand until joints are completely filled, then remove excess sand. Leave a slight surplus of sand on the surface for joint filling.
- K. Do not allow traffic on installed pavers until sand has been vibrated into joints.
- L. Repeat joint-filling process 30 days later.

7.1.3.5 REPAIR

- A. Remove and replace unit pavers that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units as intended. Provide new units to match adjoining units and install in same manner as original units, with same joint treatment and with no evidence of replacement.

7.2. GYPSUM BOARD ASSEMBLIES

GENERAL

7.2.1. RELATED DOCUMENTS

- A. Drawing and general provisions of the contract, including general and supplementary Conditions.

7.2.2. SUMMARY

- A. This Section includes the following:
 - 1. Suspended gypsum board ceilings.
 - 2. Gypsum board walls and partitions.
 - 3. Recessed Lighting enclosure.
 - 4. Partition Closers.
 - 5. Framed steelwork encasement.
- B. **Related Sections:** The following Sections contain requirements that relate to this Section:
 - 1. 5.0 Section "Metal Fabrication".
 - 2. 6.0 Section "Rough Carpentry" for wood framing and furring, and gypsum sheathing applied over wood framing.
 - 3. 5.0 Section "Custom Steel Doors and Frames" for steel door to be installed in gypsum board walls or partitions.

7.2.3. DEFINITIONS

- A. **Gypsum Board Construction Terminology:** Refer to ASTM C 11 and GA-505 for definitions of terms for gypsum board assemblies not defined in this Section or in other referenced standards.

7.2.4. ASSEMBLY PERFORMANCE REQUIREMENTS

- A. **Fire Resistance Characteristics:** Provide interior gypsum board assemblies with fire-resistance ratings indicated.

7.2.5. SUBMITTALS

- A. **Product Data:** For each type of product specified.
- B. **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 the Consultant.
- C. **Shop Drawings:** Showing locations, fabrication, and installation of control and expansion joints including plans, elevations, sections, details of components, and attachments to other units of Work.
- D. **Samples:** For the following products:
 - 1. Trim Accessories: Full-size sample in 300-mm-(12") long length for each trim accessory indicated.
 - 2. Access panel framing and hardware
- E. **Product Certificates:** Signed by manufacturers of gypsum board assembly components certifying that their products comply with specified requirements.
- F. **Installer Certificates:** Signed by the product manufacturer certifying that the Installer is approved, authorized, or licensed by the manufacturer to install his products.
- G. **Installer Experience:** List of five projects (minimum) of a similar nature carried out successfully by the installer with the same product endorsed by the manufacturer's representative.

7.2.6. QUALITY ASSURANCE

- A. **Quality System:** Comply with ISO 9001/9002 Quality System as a minimum. Incorporate all the standard procedures supplied by the Consultant and the Employer.
- B. **Installer Qualifications:** A qualified firm specializing in performing the work of this Section with minimum three years documented experience and that is approved, authorized, or licensed by the product manufacturer to install his product and that is eligible to receive manufacturer's warranty. Include project names and addresses, names and addresses of Consultants and Employers, and other information specified
- C. **Single-Source Responsibility for Gypsum Boards and Steel Framing:** Obtain each type of gypsum board and other panel products and steel framing from a single manufacturer.
- D. **Single-Source Responsibility for Finishing Materials:** Obtain finishing materials from either the same manufacturer that supplies gypsum board and other panel products or from a manufacturer acceptable to the gypsum board manufacturer.

- E. **Fire-Test-Response Characteristics:** Where fire-resistance-rated gypsum board assemblies are indicated, provide gypsum board assemblies that comply with the following requirements:
 - 1. Gypsum board assemblies indicated are identical to assemblies tested for fire resistance according to ASTM E 119 or BS 476 Part 20-24 by an independent testing and inspecting agency acceptable to the Consultant.
 - 2. Deflection and Firestop Track: Top runner provided in fire-resistance-rated assemblies indicated is labeled and listed by UL, Warnock Hersey, or another testing and inspecting agency acceptable to the Consultant.
- F. **Mockups:** Prior to finishing gypsum board assemblies, construct mockups of at least 9 sq. m in surface area to demonstrate aesthetic effects of finishes as well as qualities of materials and execution. Simulate finished lighting conditions for review of in-place unit of Work.
 - 1. Construct mockups for each of the following applications:
 - a) Ceiling surfaces indicated to receive emulsion paint finishes.
 - 2. Build mockups to comply with the following requirements, using materials indicated for final unit of Work.
 - a) Locate mockups on site in the location and of the size indicated or, if not indicated, as directed by the Consultant.
 - b) Notify the Consultant one week in advance of the dates and times when mockups will be constructed.
 - c) Demonstrate the proposed range of aesthetic effects and workmanship.
 - d) Obtain the Consultant's approval of mockups before start of final unit of Work.
 - e) Retain and maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
 - f) Approved mockups in an undisturbed condition at the time of Substantial Completion may become part of the completed Work.

7.2.7. Delivery, storage and handling

- A. Deliver materials in original packages, containers, or bundles bearing brand name and identification of manufacturer or supplier.
- B. Store materials inside under cover and keep them dry and protected against damage from weather, direct sunlight, surface contamination, corrosion, construction traffic, and other causes. Neatly stack gypsum panels flat to prevent sagging.
- C. Handle steel framing materials in a manner not to cause bending or denting of sections.

7.2.8. PROJECT CONDITIONS

- A. **Environmental Conditions, General:** Establish and maintain environmental conditions for applying and finishing gypsum board to comply with ASTM C 840 requirements or gypsum board manufacturer's recommendations, whichever are more stringent.
- B. **Room Temperatures:** Maintain room temperature at not less than 4 deg. C.
- C. **Ventilation:** Ventilate building spaces as required to dry joint treatment materials. Avoid drafts during hot, dry weather to prevent finishing materials from drying too rapidly.

PRODUCTS

7.2.9. STEEL FRAMING COMPONENTS FOR SUSPENDED CEILINGS

- A. **General:** Provide components complying with ASTM C 754 for conditions indicated.
- B. **Post-installed Anchors in Concrete:** Anchors of type indicated below, fabricated from corrosion-resistant materials, with holes or loops for attaching hanger wires, and with capability to sustain, without failure, a load equal to 5 times that imposed by ceiling construction, as determined by testing according to ASTM E 488 conducted by a qualified independent testing agency.
 - 1. Expansion anchor.
- C. **Wire Ties:** ASTM A 641M, Class 1 zinc coating, soft temper, 1.6 mm thick.
- D. **Hanger Rods:** Mild steel and zinc coated or protected with rust-inhibitive paint.
- E. **Flat Hangers:** Mild steel and zinc coated or protected with rust-inhibitive paint.
- F. **Angle-Type Hangers:** Angles with legs not less than 22.2 mm (3/4") wide, formed from 1.6-mm- (2/32") thick galvanized steel sheet complying with ASTM A 653M, Z 180 coating designation, with bolted connections and 8 mm (1/2") diameter bolts.
- G. **Channels:** Cold-rolled steel, 1.5 mm (2/32") minimum thickness of base (uncoated) metal and 11.1 mm wide flanges, and as follows:
 - 1. Carrying Channels: 38 mm (1.5") deep, 70 kg/100 m (70 kg/328 Rft), unless otherwise indicated.
 - 2. Furring Channels: 19 mm (3/4") deep, 45 kg/100 m (45 kg/328 Rft), unless otherwise indicated.
 - 3. Finish: ASTM A 653M, Z 180 hot-dip galvanized coating.

7.2.10. STEEL FRAMING FOR WALLS AND PARTITIONS

- A. **General:** Provide steel framing members complying with the following requirements:
 - 1. Protective Coating: ASTM A 653M, Z180 hot-dip galvanized corrosion resistant coating.
- B. **Steel Studs and Runners:** ASTM C 645, with flange edges of studs bent back 90 degrees and doubled over to form 5 mm (1/4") wide minimum lip (return), and complying with the following requirements for minimum thickness of base (uncoated) metal and for depth:
 - 1. Thickness: 0.84 mm (1/32") as follows:
 - a) For head runner, sill runner, jamb, and cripple studs at door and other openings.
 - b) Where indicated.
 - 2. Depth: As required to obtain thickness indicated on Drawings.
- C. **Deflection Track:** Manufacturer's standard top runner designed to prevent cracking of gypsum board applied to interior partitions resulting from deflection of the structure above fabricated from steel sheet complying with ASTM A 653M or ASTM A 568M. Thickness as indicated for studs, and width to accommodate depth of studs, and of the following configuration:
 - 1. Top Runner with Compressible Flanges: 64 mm (2.5") deep flanges with V-shaped offsets that compress when pressure is applied from construction above.

2. Top Runner with Slotted Flanges: 64 mm (2.5") deep flanges with slots 25 mm (1") o.c.
 3. Top runner with 64 mm (2.5") deep flanges that either have V-shaped offsets that compress when pressure is applied from construction above or have slots 25 mm (1") o.c. that allow fasteners attached to studs through the slots to accommodate structural movement by slipping.
- D. **Deflection and Firestop Track for Fire Rated Assemblies:** Top runner designed to allow partition heads to expand and contract with movement of structure above while maintaining continuity of the assembly. Comply with requirements of ASTM C 645 except configuration, of thickness indicated for studs and width to accommodate depth of studs indicated with flanges offset at midpoint to accommodate gypsum board thickness.
1. Offset Configuration: Shadow-line design with offset projecting out from depth of stud.
 2. Offset Configuration: Reveal design with offset recessing in from depth of stud.
- E. **Steel Rigid Furring Channels:** ASTM C 645, hat shaped, depth and minimum thickness of base (uncoated) metal as follows:
1. Thickness: 0.84 mm (1/32") , unless otherwise indicated.
 2. Depth: 22.2 mm (1").
- F. **Furring Brackets:** Serrated-arm type, adjustable, fabricated from corrosion-resistant steel sheet complying with ASTM C 645, minimum thickness of base (uncoated) metal of 0.84 mm (1/32"), designed for screw attachment to steel studs and steel rigid furring channels used for furring.
- G. **Steel Resilient Furring Channels:** Manufacturer's standard product designed to reduce sound transmission, fabricated from steel sheet complying with ASTM A 653M or ASTM A 568M to form 13 mm (1/2") deep channel of the following configuration:
1. Single-Leg Configuration: Asymmetric-shaped channel with face connected to a single flange by a single-slotted leg (web).
 2. Double-Leg Configuration: Hat-shaped channel with 38 mm (1.5") wide face connected to flanges by double-slotted or expanded-metal legs (webs).
- H. **Z-Furring Members:** Manufacturer's standard Z-shaped furring members with slotted or nonslotted web, fabricated from steel sheet complying with ASTM A 653M or ASTM A 568M; with a minimum base metal (uncoated) thickness of 0.45 mm, face flange of 31.8 mm, wall-attachment flange of 22.2 mm, (1") and of depth required to fit insulation thickness indicated.
- I. **Steel Channel Bridging:** Cold-rolled steel, 1.5 mm (1/16") minimum thickness of base (uncoated) metal and 11.1 mm wide flanges, 38 mm (1.5") deep, 45 kg/100 m, (45 kg / 328 Rft.) unless otherwise indicated.
- J. **Steel Flat Strap and Backing Plate:** Steel sheet for blocking and bracing complying with ASTM A 653M or ASTM A 568M, length and width as indicated, and with a minimum base metal (uncoated) thickness as follows:
1. Thickness: 1.5 mm (1/16") where indicated.
- 7.2.2.1 **Fasteners for Metal Framing:** Provide fasteners of type, material, size, corrosion resistance, holding power, and other properties required to fasten steel framing and furring members securely to substrates involved; complying

with the recommendations of gypsum board manufacturers for applications indicated.

7.2.11. GYPSUM BOARD PRODUCTS

- A. **General:** Provide gypsum board of types indicated in maximum lengths available that will minimize end-to-end butt joints in each area indicated to receive gypsum board application.
 - 1. Widths: Provide gypsum board in widths of 1200 mm (48").
 - 2. Composition: The mix for manufacture of gypsum boards shall incorporate reinforcing noncombustible glass fibers.
- B. **Gypsum Wallboard:** ASTM C 36 and as follows:
 - 1. Type: Regular, unless otherwise indicated for lining.
 - 2. Type: Type X where required for fire-resistance-rated assemblies.
 - 3. Type: Sag-resistant type for ceiling surfaces.
 - 4. Edges: Tapered.
 - 5. Thickness: 13 mm, (1/2") unless otherwise indicated and unless higher thickness is recommended by manufacturer to obtain fire performance rating specified.
- C. **Water-Resistant Gypsum Backing Board:** ASTM C 630 and as follows:
 - 1. Type: Regular, unless otherwise indicated.
 - 2. Type: Type X where required for fire-resistance-rated assemblies and where indicated.
 - 3. Type: Sag-resistant type for ceiling surfaces.
 - 4. Thickness: 13 mm, (1/2") unless otherwise indicated and unless higher thickness is recommended by manufacturer to obtain fire performance rating specified.
 - 5. Use for application in wet areas and where indicated on Drawings or specified.

7.2.12. TRIM ACCESSORIES

- A. **Accessories for Interior Installation:** Cornerbead, edge trim, and control joints complying with ASTM C 1047 and requirements indicated below:
 - 1. Material: Formed metal or plastic, with metal complying with the following requirement:
 - a) Steel sheet zinc coated by hot-dip, G60 (Z180) coating intensity.
 - 2. Shapes indicated below by reference to Fig. 1 designations in ASTM C 1047:
 - a) Cornerbead on outside corners, unless otherwise indicated.
 - b) LC-bead with both face and back flanges; face flange formed to receive joint compound. Use LC-beads for edge trim, unless otherwise indicated.
 - c) L-bead with face flange only; face flange formed to receive joint compound. Use L-bead where indicated.
 - d) U-bead with face and back flanges; face flange formed to be left without application of joint compound. Use U-bead where indicated.
 - e) One-piece control joint formed with V-shaped slot and removable strip covering slot opening.

7.2.13. JOINT TREATMENT MATERIALS

- A. **General:** Provide joint treatment materials complying with ASTM C 475 and the recommendations of both the manufacturers of sheet products and of joint treatment materials for each application indicated.
- B. **Joint Tape for Gypsum Board:** Use open-weave, glass-fiber reinforcing tape, 50 mm (2") wide with compatible joint compound where recommended by the manufacturer of gypsum board and joint treatment materials for application indicated.
- C. **Drying-Type Joint Compounds for Gypsum Board:** Factory-packaged vinyl-based products complying with the following requirements for formulation and intended use.
 - 1. Ready-Mixed Formulation: Factory-mixed product.
 - a) All-purpose compound formulated for both taping and topping compounds.

7.2.14. ACOUSTICAL SEALANT

- A. **Acoustical Sealant for Exposed and Concealed Joints:** Manufacturer's standard nonsag, paintable, nonstaining latex sealant complying with ASTM C 834 and the following requirements:
 - 1. Product is effective in reducing airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E 90.
- B. **Acoustical Sealant for Concealed Joints:** Manufacturer's standard nondrying, nonhardening, nonskinning, nonstaining, gunnable, synthetic-rubber sealant recommended for sealing interior concealed joints to reduce transmission of airborne sound.

7.2.15. MISCELLANEOUS MATERIALS

- A. **General:** Provide auxiliary materials for gypsum board construction that comply with referenced standards and recommendations of gypsum board manufacturer.
- B. Steel drill screws complying with ASTM C 1002 for the following applications:
 - 1. Fastening gypsum board to steel members less than 0.84 mm thick.
- C. Steel drill screws complying with ASTM C 954 for fastening gypsum board to steel members from 0.84 to 2.84 mm (1/32" to 4/32") thick.
- D. Steel drill screws of size and type recommended by unit manufacturer for fastening cementations boards.
- E. **Foam Gaskets:** Closed-cell vinyl foam adhesive-backed strips that allow fastener penetration without foam displacement, 3.2 mm (2/16") thick, in width to suit metal stud size indicated.
- F. **Sound-Attenuation Blankets:** Un-faced mineral-fiber blanket insulation produced by combining mineral fibers of type described below with thermosetting resins to comply with ASTM C 665 for Type I (blankets without membrane facing).
 - 1. Mineral-Fiber Type: Fibers manufactured from glass, slag wool, or rock wool.
 - 2. Blanket is to be 40 mm (1.5") thick, 60 kg/m³ (60 kg/35.28 cft) intensity, minimum.
 - 3. Where ceiling plenum is used for air condition return, use sound blanket with foil scrim facing and set with facing at upper side in the as-installed position.
- G. **Core Material:** Material indicated below, of thickness and width to fill inner cavity of gypsum board wall or partition.

1. Un-faced Mineral-Fiber Blanket Insulation: Un-faced mineral-fiber blanket insulation produced by combining mineral fibers of type described below with thermosetting resins to comply with ASTM C 665 for Type I (blankets without membrane facing).
 - a) Mineral-Fiber Type: Fibers manufactured from glass, slag wool, or rock wool.
 - b) Intensity: As recommended by manufacturer to attain performance specified.
 2. Manufacturer's standard pre-packed mineral fiber insulation quilts to be snugly fitted in vertical studs.
 - a) Mineral-Fiber Type: Fibers manufactured from glass, slag wool, or rock wool.
 - b) Intensity: As recommended by manufacturer to attain performance specified.
- H. **Vapor Retarder Tape:** Pressure-sensitive tape of type recommended by vapor retarder manufacturer for sealing joints and penetrations in vapor retarder. Use at warm side of open-to-air assemblies.

7.2.16. RECESSED LIGHTING ENCLOSURE

- A. Shall be constructed from 13.00 mm (1/2") thick plasterboards, moisture-resistant type, fixed to galvanized steel furring channels not less than 0.84 mm (1/32") thick with galvanized steel plasterboard screws
- B. Lighting Enclosure shall also comprise stainless steel, alloy 304, grille of polished mirror finish loosely laid on stainless steel T-section supports of material and finish matching that of the adjoining suspended ceiling. Comply with applicable requirements of 5.0 Section "Metal Fabrications" for manufacture of grilles.
- C. Inner surfaces of plasterboards are to receive smooth acrylic emulsion paint finish of White color, as specified in 9.0, Section "Painting".

7.2.17. PARTITIONS CLOSERS

- A. **Partition Closers:** Are nonload-bearing gypsum boards short solid partitions used to close the gaps between masonry walls and partitions and aluminum used in building elevations.
- B. **Fire Rating:** Partition closer is to be of the same fire resisting rating as of the masonry wall or partition to which it is fixed.

7.2.18. FRAMED STEELWORK ENCASEMENT

- A. **System:**
 1. Fire rated gypsum boards as specified fixed to lightweight framework connected to structural steel work with manufacturer's standard clips.
 2. Manufacturer's standard patent system that is tested and list for fire protection ratings indicated on Drawings and recommended by manufacturers for steel sections and applications indicated.
 3. **Framework:** Fabricated from galvanized steel sheets, not less than 180 gm/m² zinc coating intensity. Clips and fasteners or anchors are to be from galvanized steel of same minimum zinc coating intensity.
 4. **Joints:** Tape and finish using manufacture's jointing compounds used in laboratory fire testing of the system.
 5. Where necessary, use moisture resistant fire rated gypsum boards.
 6. **Fire Protections Rating:** As indicated on Fire Drawings.
 7. Use of Frameless steelwork encasement is not acceptable.

EXECUTION

7.2.19. EXAMINATION

Examine substrates to which gypsum board assemblies attach or abut, installed hollow metal frames, cast-in-anchors, and structural framing, with the Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of assemblies specified in this Section. Do not proceed with installation until unsatisfactory conditions have been corrected.

7.2.20. PREPARATION

- A. **Ceiling Anchorages:** Coordinate installation of ceiling suspension systems with installation of overhead structural assemblies to ensure that inserts and other provisions for anchorages to building structure have been installed to receive ceiling hangers that will develop their full strength and at spacing required to support ceilings.
- B. Before sprayed-on fireproofing is applied, attach offset anchor plates or ceiling runners (tracks) to surfaces indicated to receive sprayed-on fireproofing. Where offset anchor plates are required, provide continuous units fastened to building structure not more than 600 mm (24") o.c.
- C. After sprayed-on fireproofing has been applied, remove only as much fireproofing as needed to complete installation of gypsum board assemblies without reducing thickness of fireproofing below that is required to obtain fire-resistance rating indicated. Protect remaining fireproofing from damage.

7.2.21. INSTALLING STEEL FRAMING, GENERAL

- A. **Steel Framing Installation Standard:** Install steel framing to comply with ASTM C 754 and with ASTM C 840 requirements that apply to framing installation.
- B. Install supplementary framing, blocking, and bracing at terminations in gypsum board assemblies to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, or similar construction. Comply with details indicated and with recommendations of gypsum board manufacturer or, if none available, with United States Gypsum Co.'s "Gypsum Construction Handbook."
- C. Isolate steel framing from building structure at locations indicated to prevent transfer of loading imposed by structural movement.
 - 1. Where building structure abuts ceiling perimeter or penetrates ceiling.
 - 2. Where lining abut structure, except at floor.
 - a) Provide cushioned-type joints as detailed to attain lateral support and avoid axial loading.
 - 3. Do not bridge building control and expansion joints with steel framing or furring members. Independently frame both sides of joints with framing or furring members as indicated.

7.2.22. INSTALLING STEEL FRAMING FOR SUSPENDED CEILINGS

- A. Suspend ceiling hangers from building structural members and as follows:

1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structural or ceiling suspension system. Splay hangers only where required to miss obstructions and offset resulting horizontal forces by bracing, counter-splaying, or other equally effective means.
2. Where width of ducts and other construction within ceiling plenum produces hanger spacing's that interfere with the location of hangers required to support standard suspension system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards.
3. Secure wire hangers by looping and wire-tying, either directly to structures or to inserts, eye-screws, or other devices and fasteners that are secure and appropriate for substrate, and in a manner that will not cause them to deteriorate or otherwise fail.
4. Secure flat, angle, and rod hangers to structure, including intermediate framing members, by attaching to inserts, eye-screws, or other devices and fasteners that are secure and appropriate for structure as well as for type of hanger involved, and in a manner that will not cause them to deteriorate or otherwise fail.
5. Do not support ceilings directly from permanent metal forms. Furnish cast-in-place hanger inserts that extend through forms.
6. Do not attach hangers to steel deck tabs.
7. Do not attach hangers to steel roof deck. Attach hangers to structural members.
8. Do not connect or suspend steel framing from ducts, pipes, or conduit.
- B. Sway-brace suspended steel framing with hangers used for support.
- C. Install suspended steel framing components in sizes and at spacing's recommended by manufacturer, but not less than that required by the referenced steel framing installation standard.
 1. Wire Hangers: 1200 mm (48") o.c.
 2. Carrying Channels (Main Runners): 1200 mm (48") o.c.
 3. Furring Channels (Furring Members): 400 mm (16") o.c.
- D. **Installation Tolerances:** Install steel framing components for suspended ceilings so that cross-furring or grid suspension members are level to within 3 mm (2/16") in 3.6 m (12'-0") as measured both lengthwise on each member and transversely between parallel members.
- E. Wire-tie or clip furring members to main runners and to other structural supports as indicated.

7.2.23. INSTALLING STEEL FRAMING FOR WALLS AND PARTITIONS

- A. Install runners (tracks) at floors, ceilings, and structural walls and columns where gypsum board stud assemblies abut other construction.
 1. Where studs are installed directly against exterior walls, install asphalt felt strips or foam gaskets between studs and wall.
 2. Additional Runners and Furring: Where fittings, equipment or accessories are to be hung to gypsum board walls or partitions, provide additional runners or furring of suitable section and wall thickness installed at locations so as to receive fasteners of fittings, equipment or accessories. Coordinate with Drawings or shop drawings indicating work items to be hung to gypsum board walls or partitions.

- B. **Installation Tolerances:** Install each steel framing and furring member so that fastening surfaces do not vary more than 3 mm (2/16") from the plane formed by the faces of adjacent framing.
- C. Extend partition framing full height from structural floors to structural supports or substrates above suspended ceilings, except where partitions are indicated to terminate at suspended ceilings. Continue framing over frames for doors and openings and frame around ducts penetrating partitions above ceiling to provide support for gypsum board.
 - 1. Cut studs 13 mm (2/16") short of full height to provide perimeter relief.
 - 2. For fire-resistance-rated partitions that extend to the underside of floor/roof slabs and decks or other continuous solid structural surfaces to obtain ratings, install framing around structural and other members extending below floor/roof slabs and decks, as needed, to support gypsum board closures needed to make partitions continuous from floor to underside of solid structure.
- D. Install steel studs and furring in sizes and at spacing's indicated.
 - 1. Single-Layer Construction: Space studs 400 mm (16") o.c., unless otherwise indicated.
 - 2. Multilayer Construction: Space studs 600 mm (24") o.c., unless otherwise indicated.
- E. Install steel studs so that flanges point in the same direction and leading edge or end of each gypsum board panel can be attached to open (unsupported) edges of stud flanges first.
- F. Frame door openings to comply with GA-219, and with applicable published recommendations of the gypsum board manufacturer, unless otherwise indicated. Attach vertical studs at jambs with screws either directly to frames or to jamb anchor clips on door frames; install runner track section (for cripple studs) at head and secure to jamb studs.
 - 1. Install 2 studs at each jamb, unless otherwise indicated.
 - 2. Install cripple studs at head adjacent to each jamb stud, with a minimum 13 mm (1/2") clearance from jamb stud to allow for installation of control joint.
 - 3. Extend jamb studs through suspended ceilings and attach to underside of floor or roof structure above.
- G. Frame openings other than door openings to comply with details indicated or, if none indicated, as required for door openings. Install framing below sills of openings to match framing required above door heads.
- H. Install insulation to manufacturer's standard details approved by the Consultant.
- I. Install polyethylene vapor retarder where indicated to comply with the following requirements:
 - 1. Extend vapor retarder to extremities of areas to be protected from vapor transmission. Secure in place with mechanical fasteners or adhesives. Extend vapor retarder to cover miscellaneous voids in insulated substrates, including those filled with loose mineral-fiber insulation.
 - 2. Seal vertical joints in vapor retarders over framing by lapping not less than 2 wall studs. Fasten vapor retarders to framing at top, end, and bottom edges, at perimeter of wall openings, and at lap joints; space fasteners 400 mm (16") o.c.

3. Seal joints in vapor retarders caused by pipes, conduits, electrical boxes, and similar items penetrating vapor retarders with vapor retarder tape.
4. Repair any tears or punctures in vapor retarder immediately before concealing it with the installation of gypsum board or other construction.

7.2.24. APPLYING AND FINISHING GYPSUM BOARD, GENERAL

- A. **Gypsum Board Application and Finishing Standards:** Install and finish gypsum panels to comply with ASTM C 840 and GA-216.
- B. Install sound-attenuation blankets, where indicated, prior to installing gypsum panels unless blankets are readily installed after panels have been installed on one side.
- C. Install ceiling board panels across framing to minimize the number of abutting end joints and to avoid abutting end joints in the central area of each ceiling. Stagger abutting end joints of adjacent panel's not less than one framing member.
- D. Install gypsum panels with face side out. Do not install imperfect, damaged, or damp panels. Butt panels together for a light contact at edges and ends with not more than 1.5 mm of open space between panels. Do not force into place.
- E. Locate both edge or end joints over supports, except in ceiling applications where intermediate supports or gypsum board back-blocking is provided behind end joints. Do not place tapered edges against cut edges or ends. Stagger vertical joints on opposite sides of partitions. Avoid joints other than control joints at corners of framed openings where possible.
- F. Attach gypsum panels to steel studs so that leading edge or end of each panel is attached to open (unsupported) edges of stud flanges first.
- G. Attach gypsum panels to framing provided at openings and cutouts.
- H. Form control and expansion joints at locations indicated and as detailed, with space between edges of adjoining gypsum panels, as well as supporting framing behind gypsum panels.
- I. Cover both faces of steel stud partition framing with gypsum panels in concealed spaces (above ceilings, etc.), except in chases that are braced internally.
 1. Except where concealed application is indicated or required for sound, fire, air, or smoke ratings, coverage may be accomplished with scraps of not less than 0.7 sq. m (7.50 Sft) in area.
 2. Fit gypsum panels around ducts, pipes, and conduits.
 3. Where partitions intersect open concrete coffers, concrete joists, and other structural members projecting below underside of floor/roof slabs and decks, cut gypsum panels to fit profile formed by coffers, joists, and other structural members; allow 6.5 to 9.5 mm wide joints to install sealant.
- J. Isolate perimeter of nonload-bearing gypsum board partitions at structural abutments, except floors, as detailed. Provide 6.5 to 13 mm (1/4" ~ 1/2") wide spaces at these locations and trim edges with U-bead edge trim where edges of gypsum panels are exposed. Seal joints between edges and abutting structural surfaces with acoustical sealant.

- K. Space fasteners in gypsum panels according to referenced gypsum board application and finishing standard and manufacturer's recommendations.
 - 1. Space screws a maximum of 300 mm (12") o.c. for vertical applications.
 - 2. Space screws a maximum of 200 mm (8") o.c. for ceilings.
- L. Space fasteners in panels that are tile substrates a maximum of 200 mm (8") o.c.

7.2.25. GYPSUM BOARD APPLICATION METHODS

- A. **Single-Layer Application:** Install gypsum wallboard panels as follows:
 - 1. On ceilings, apply gypsum panels prior to wall/partition board application to the greatest extent possible and at right angles to framing, unless otherwise indicated.
 - 2. On partitions/walls, unless otherwise indicated, and provide panel lengths that will minimize end joints.
 - 3. On partitions/walls, apply gypsum panels horizontally (perpendicular to framing), unless parallel application is required for fire-resistance-rated assemblies. Use maximum-length panels to minimize end joints.
 - a) Stagger abutting end joints not less than one framing member in alternate courses of board.
 - b) At stairwells and other high walls, install panels horizontally.
- B. **Multilayer Application on Partitions/Walls:** Apply gypsum board indicated for base layers and gypsum wallboard face layers vertically (parallel to framing) with joints of base layers located over stud or furring member and face-layer joints offset at least one stud or furring member with base-layer joints. Stagger joints on opposite sides of partitions.
 - 1. On Z-furring members, apply base layer vertically (parallel to framing) and face layer either vertically (parallel to framing) or horizontally (perpendicular to framing) with vertical joints offset at least one furring member. Locate edge joints of base layer over furring members.
- C. **Single-Layer Fastening Methods:** Apply gypsum panels to supports as follows:
 - 1. Fasten with screws.

7.2.26. INSTALLING TRIM ACCESSORIES

- A. **General:** For trim accessories with back flanges, fasten to framing with the same fasteners used to fasten gypsum board. Otherwise, fasten trim accessories according to accessory manufacturer's directions for type, length, and spacing of fasteners.
- B. Install corner-bead at external corners.
- C. Install edge trim where edge of gypsum panels would otherwise be exposed. Provide edge trim type with face flange formed to receive joint compound, except where other types are indicated.

1. Install LC-bead where gypsum panels are tightly abutted to other construction and back flange can be attached to framing or supporting substrate.
 2. Install L-bead where edge trim can only be installed after gypsum panels are installed.
 3. Install U-bead where indicated.
 4. Install aluminum trim and other accessories where indicated.
- D. Install control joints at locations indicated.
- E. Install control joints according to ASTM C 840 and manufacturer's recommendations and in specific locations approved by the Consultant for visual effect.

7.2.27. FINISHING GYPSUM BOARD ASSEMBLIES

- A. **General:** Treat gypsum board joints, interior angles, and flanges of cornerbead, edge trim, control joints, penetrations, fastener heads, surface defects, and elsewhere as required to prepare gypsum board surfaces for decoration.
- B. Apply joint tape over gypsum board joints, except those with trim accessories having flanges not requiring tape.
- C. Apply joint tape over gypsum board joints and to flanges of trim accessories as recommended by the trim accessory manufacturer.
- D. **Levels of Gypsum Board Finish:** Provide the following levels of gypsum board finish per GA-214.
1. Level 5.
- E. Use one of the following joint compound combinations as applicable to the finish levels specified.
- F. Where Level 5 gypsum board finish is indicated, embed tape in joint compound and apply first, fill (second), and finish (third) coats of joint compound over joints, angles, fastener heads, and accessories; and apply a thin, uniform skim coat of joint compound over entire surface. For skim coat, use joint compound specified for third coat, or a product specially formulated for this purpose and acceptable to the gypsum board manufacturer. Touch up and sand between coats and after last coat as needed to produce a surface free of visual defects, tool marks, and ridges and ready for decoration.

7.2.3.1 FIELD QUALITY CONTROL

- A. **Above-Ceiling Observation:** The Consultant will conduct an above-ceiling observation prior to installation of gypsum board ceilings and report any deficiencies in the Work observed. Do not proceed with installation of gypsum board to ceiling support framing until deficiencies have been corrected.
1. Notify the Consultant one week in advance of the date and the time when the Project, or part of the Project, will be ready for an above-ceiling observation.
 2. Prior to notifying the Consultant, complete the following in areas to receive gypsum board ceilings:

- a) Installation of 80 percent of lighting fixtures, powered for operation.
- b) Installation, insulation, and leak and pressure testing of water piping systems.
- c) Installation of air duct systems.
- d) Installation of air devices.
- e) Installation of mechanical system control air tubing.
- f) Installation of ceiling support framing.

7.2.3.2 **CLEANING AND PROTECTION**

- A. Promptly remove any residual joint compound from adjacent surfaces.
- B. Provide final protection and maintain conditions, in a manner acceptable to the Installer, that ensure that gypsum board assemblies are without damage or deterioration at the time of Substantial Completion.

7.3 PORTLAND CEMENT PLASTER

PART 5 - GENERAL

7.3.1.1 RELATED DOCUMENTS

- A. Drawing and general provisions of the contract, including general and supplementary conditions.

7.3.1.2 SUMMARY

- A. This Section includes the following:
 - 1. Portland cement plaster.
 - 2. Metal Lath suspended ceiling.
- B. Related Sections: The following Sections contain requirements that relate to this Section:
 - 1. 6.0 Section "Rough Carpentry".
 - 2. 9.0 Section "Ceramic Tiles" for plaster base coat to be applied to receive ceramic wall tiles.

7.3.1.3 SUBMITTALS

- A. **Product Data:** For each product specified.
- B. **Samples for Initial Selection:** manufacturer's color charts consisting of actual units or sections of units at least 300 mm (12") square showing the full range of colors, textures, and patterns available for each type of finish indicated.
 - 1. Where finish involves normal color and texture variations, include Sample sets composed of 2 or more units showing the full range of variations expected.
 - 2. Include similar Samples of material for joints and accessories involving color selection.
- C. **Shop Drawings:** Submit shop drawings for suspended metal lath ceilings including layout and details of ceilings installation
- D. **Material Certificates:** certificate signed by manufacturer for each kind of plaster aggregate certifying that materials comply with requirements.

7.3.1.4 QUALITY ASSURANCE

- A. **Quality System:** Comply with ISO 9001/9002 Quality System as a minimum. Incorporate all the standard procedures supplied by the Consultant and the Employer.
- B. **Mockups:** Prior to installing plaster work, construct panels for each type of finish and application required to verify selections made under Sample submittals and to demonstrate aesthetic effects as well as qualities of materials and execution. Build mockups to comply with the following requirements, using materials indicated for final unit of Work.
 - 1. Locate mockups on-site in the location and of the size indicated or, if not indicated, as directed by Consultant.
 - 2. Erect mockups 1200 by 1200 mm (48" x 48") by full thickness in presence of Consultant using materials, including lath, support system, and control joints, indicated for final Work.

3. Notify Consultant 7 days in advance of the dates and times when mockups will be constructed.
4. Demonstrate the proposed range of aesthetic effects and workmanship.
5. Obtain Consultant's approval of mockups before start of plaster Work.
6. Retain and maintain mockups during construction in an undisturbed condition as a standard for judging the completed Portland cement plaster Work.
7. When directed demolish mockups, remove rubbles from site and replace with permanent works.

7.3.1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver cementations materials to Project site in original packages, containers, or bundles, labeled with manufacturer's name, product brand name, and lot number.
- B. Store materials indoor, under cover, and dry, protected from weather, direct sunlight, surface contamination, aging, corrosion, and damage from construction traffic and other causes.

7.3.1.6 PROJECT CONDITIONS

- A. **Environmental Requirements, General:** Comply with requirements of referenced plaster application standards and recommendations of plaster manufacturer for environmental conditions before, during, and after plaster application.
- B. **Warm-Weather Requirements:** Protect plaster against uneven and excessive evaporation and from strong flows of dry air, both natural and artificial. Apply and cure plaster as required by climatic and job conditions to prevent dry out during cure period. Provide suitable coverings, moist curing, barriers to deflect sunlight and wind, or combinations of these, as required.
- C. **Exterior Plaster Work:** Do not apply plaster when ambient temperature is below 4 deg C.
- D. **Interior Plaster Work:** Maintain at least 10 deg C temperatures in areas to be plastered for at least 48 hours before, during, and after application.
- E. **Ventilation:** Provide natural or mechanical means of ventilation to properly dry interior spaces after Portland cement plaster has cured.
- F. Protect contiguous work from soiling and moisture deterioration caused by plastering. Provide temporary covering and other provisions necessary to minimize harmful spattering of plaster on other work.

PART 6 - PRODUCTS

7.3.2.1 METAL SUPPORTS FOR SUSPENDED CEILINGS

- A. **General:** Size metal ceiling supports to comply with ASTM C 1063, unless otherwise indicated.
- B. **Post installed Anchors in Concrete:** Anchors of type indicated below, fabricated from corrosion-resistant materials, with holes or loops for attaching hanger wires; and with capability to sustain, without failure, a load equal to 5 times that imposed by ceiling construction, as determined by testing according to ASTM E 488 conducted by a qualified independent testing agency.
 1. Chemical anchor.
- C. **Wire for Hangers and Ties:** ASTM A 641M, Class 1 zinc coating, soft temper.

- D. **Rod Hangers:** Mild steel, zinc coated.
- E. **Flat Hangers:** Mild steel, zinc coated or protected with rust-inhibitive paint.
- F. **Channels:** Cold-rolled steel, minimum 1.5-mm- (1/16") thick base (uncoated) metal and 11.1-mm- wide flanges, and as follows:
 - 1. Carrying Channels: Based on design calculations but not less than 38 mm (1.5") deep, 0.7 kg/m.
- G. **Finish:** ASTM A 653M, Z180 hot-dip galvanized coating for framing where indicated.

7.3.2.2 LATH

- A. **Expanded-Metal Lath:** Comply with ASTM C 847 for material, type, configuration, and other characteristics indicated below.
 - 1. Material: Fabricate expanded-metal lath from sheet metal conforming to the following:
 - a) Galvanized Steel: Structural-quality, zinc-coated (galvanized) steel sheet complying with ASTM A 653M, Z275 minimum coating designation, unless otherwise indicated.
 - b) Form: Coil.
 - c) Special Pieces: For internal corners.
 - 2. Diamond-Mesh Lath for Plaster Background: Comply with the following requirements:
 - a) Configuration: Flat.
 - i) Weight: 1.1 kg/sq. m.
 - 3. Rib Lath for Suspended Ceilings: Comply with the following requirements:
 - a) Configuration: Flat, rib depth of not over 3 mm (2/16").
 - i) Weight: 1.8 kg/sq. m.

7.3.2.3 ACCESSORIES

- A. **General:** Comply with material provisions of ASTM C 1063 and the requirements indicated below; coordinate depth of accessories with thicknesses and number of plaster coats required.
 - 1. Galvanized Steel Components (for internal plaster): Fabricated from zinc-coated (galvanized) steel sheet complying with ASTM A 653M, Z90 minimum coating designation.
- B. **Metal Corner Reinforcement:** Expanded, large-mesh, diamond-metal lath fabricated from zinc-alloy or welded-wire mesh fabricated from 1.2-mm-diameter, zinc-coated (galvanized) wire and specially formed to reinforce external corners of Portland cement plaster on exterior exposures while allowing full plaster encasement.
- C. **Cornerbeads:** Small nose cornerbeads fabricated from the following metal, with expanded flanges of large-mesh diamond-metal lath allowing full plaster encasement.
- D. **Casing Beads:** Square-edged style, with expanded flanges.
- E. **Curved Casing Beads:** Square-edged style, fabricated from aluminum coated with clear plastic, preformed into curve of radius indicated.
- F. **Control Joints:** Prefabricated, of material and type indicated below:
 - 1. One-Piece Type: Folded pair of non-perforated screeds in M-shaped configuration, with expanded or perforated flanges.

2. Two-Piece Type: Pair of casing beads with back flanges formed to provide slip-joint action, adjustable for joint widths from 3 to 16 mm (2/16" to 3/4").

- a) Provide removable protective tape on plaster face of control joints.

- G. **Foundation Sill (Weep) Screed:** Manufacturer's standard profile designed for use at sill plate line to form plaster stop and prevent plaster from contacting damp earth, fabricated from zinc-coated (galvanized) steel sheet.
- H. **Lath Attachment Devices:** Material and type required by ASTM C 1063 for installations indicated.

7.3.2.4 PLASTER MATERIALS

- A. **Base-Coat Cements:** Type as indicated below:
 1. Portland cement, ASTM C 150, Type I.
- B. **Job-Mixed Finish-Coat Cement:** Material and color as indicated below:
 1. Portland cement: sand aerated mix
- C. **Cement Color:** Gray.
- D. **Lime:** do not use lime.
- E. **Plasticizer:** ASTM C260.
- F. **Sand Aggregate for Base Coats:** ASTM C 897.
- G. **Aggregate for Finish Coats:** ASTM C 897 system and as indicated below:
 1. Manufactured or natural sand, White in color.

7.3.2.5 MISCELLANEOUS MATERIALS

- A. **Fiber for Base Coat:** Alkaline-resistant glass or polypropylene fibers, 13 mm long, free of contaminates, manufactured for use in Portland cement plaster.
- B. **Water for Mixing and Finishing Plaster:** Potable.
- C. **Acid-Etching Solution:** Muriatic acid (10 percent solution of commercial hydrochloric acid) mixed 1 part to not less than 6 nor more than 10 parts water.
- D. **Dash-Coat Material:** 2 parts Portland cement to 3 parts fine sand, mixed with water to a mushy-paste consistency.

7.3.2.6 PLASTER MIXES AND COMPOSITIONS

- A. **General:** Comply with ASTM C 926 for base- and finish-coat mixes as applicable to plaster bases, materials, and other requirements indicated. Do not use lime in plaster mixes.
- B. **Base-Coat Mixes and Compositions:** Proportion materials for respective base coats in parts by volume per sum of cementations materials for aggregates to comply with the following requirements for each method of application and plaster base indicated. Adjust mix proportions below within limits specified to attain workability.
- C. **Fiber Content:** Add fiber to following mixes after ingredients have mixed at least 2 minutes. Comply with fiber manufacturer's written instructions but do not exceed 16 kg/cu. m (1/2 kg/cft) of cementations materials. Reduce aggregate quantities accordingly to maintain workability.
- D. **Three-Coat Work over Metal Lath:** Base-coat proportions as indicated below:
 1. Scratch Coat: 1 part Portland cement, 2-1/2 to 4 parts aggregate.
 2. Brown Coat: 1 part Portland cement, 3 to 5 parts aggregate.
 3. Admixtures and workability aids, as per manufacturer's printed instructions

- E. **Two-Coat Work over Concrete and Concrete Unit Masonry:** Base-coat proportions as indicated below:
 - 1. Base Coat: 1 part Portland cement, 5 parts aggregate, aerating plasticizer as per manufacturer's recommendation.
- F. **Job-Mixed Finish Coats:** Proportion materials for finish coats in parts by volume for cementations materials and parts by volume per sum of cementations materials to comply with the following requirements:
 - 1. Proportions using sand aggregates as indicated below:
 - a) 1 part Portland cement, 4 parts aggregate, aerating plasticizer as per manufacturer's recommendation.

MIXING

- A. Mechanically mix cementations and aggregate materials for plasters to comply with applicable referenced application standard and with recommendations of plaster manufacturer.

PART 7 - EXECUTION

7.3.3.1 INSTALLATION OF CEILING SUSPENSION SYSTEMS

- A. **Preparation and Coordination:** Coordinate installation of ceiling suspension system with installation of overhead structural systems to ensure inserts and other structural anchorage provisions have been installed to receive ceiling hangers in a manner that will develop their full strength and at spacing's required to support ceiling.
- B. **Hanger Installation:** Attach hangers to structure above ceiling to comply with ML/SFA 920, "Guide Specifications for Metal Lathing and Furring," and with referenced standards.
- C. Install ceiling suspension system components of sizes and spacing's indicated, but not in smaller sizes or greater spacing's than those required by referenced lathing and furring installation standards.
 - 1. Wire Hangers: Space 4-mm- (3/16") diameter wire hanger's not over 1200 mm (48") o.c., parallel with and not over 900 mm (36") perpendicular to direction of carrying channels, unless otherwise indicated, and within 150 mm (6") of carrying channel ends.
 - 2. Carrying Channels: Space carrying channels not over 900 mm (36") o.c. with 1200-mm (48") o.c. hanger spacing.
 - 3. Furring Channels to Receive Metal Lath: Space furring channels not over 500 mm (20") o.c. for 1.8-kg/sq. m (16 kg / sft) flat rib lath.

7.3.3.2 PREPARATIONS FOR PLASTERING

- A. Clean plaster bases and substrates for direct application of plaster, removing loose material and substances that may impair the Work.
- B. Etch concrete and concrete unit masonry surfaces indicated for direct plaster application. Scrub with acid-etching solution on previously wetted surface and rinse thoroughly with clean water. Repeat application, if necessary, to obtain adequate suction and mechanical bond of plaster (where dash coat, bonding agent, or additive is not used).

- C. **Dissimilar Backgrounds:** where rendering is to be continued without break across joints between dissimilar solid backgrounds which are in the same plane and rigidly bonded or tied together, cover joints with 150mm (6") wide strip of building paper overlaid with 300mm (12") wide galvanized steel lathing fixed with corrosion resistant fasteners at not more than 600mm (24") centers along both edges.
- D. Apply dash coat on concrete and concrete masonry surfaces indicated for direct plaster application. Moist-cure dash coat for at least 24 hours after application and before plastering.
- E. Install temporary grounds and screeds to ensure accurate rodding of plaster to true surfaces; coordinate with scratch-coat work.
- F. Refer to 6.0 Sections for installing permanent wood grounds, if any.
- G. **Surface Conditioning:** Immediately before plastering, dampen concrete and concrete unit masonry surfaces that are indicated for direct plaster application. Determine and apply amount of moisture and degree of saturation that will result in optimum suction for plastering.

7.3.3.3 LATHING

- A. Install metal lath for the following applications where plaster base coats are required. Provide appropriate type, configuration, and weight of metal lath selected from materials indicated that comply with referenced ML/SFA specifications and ASTM lathing installation standards.
 - 1. Dissimilar Backgrounds: where rendering is to be continued without break across joints between dissimilar solid backgrounds which are in the same plane and rigidly bonded or tied together, cover joints with 150 mm (6") wide strip of building paper overlaid with 300 mm (12") wide galvanized steel lathing fixed at not more than 600 mm (24") centers along both edges.

7.3.3.4 INSTALLATION OF PLASTERING ACCESSORIES

- A. **General:** Comply with referenced lathing and furring installation standards for provision and location of plaster accessories of type indicated. Miter or cope accessories at corners; install with tight joints and in alignment. Attach accessories securely to plaster bases to hold accessories in place and in alignment during plastering. Install accessories of type indicated at following locations:
 - 1. External Corners: Install corner reinforcement at external corners.
 - 2. Terminations of Plaster: Install casing beads, unless otherwise indicated.
 - 3. Control Joints: Install at locations indicated or, if not indicated, at locations complying with the following criteria and approved by Consultant:
 - a) Where an expansion or contraction joint occurs in surface of construction directly behind plaster membrane.
 - b) Distance between Control Joints: Not to exceed 5.5 m (4/16") in either direction or a length-to-width ratio of 2-1/2 to 1.
 - c) Wall Areas: Not more than 13 sq. m (140 Sft).
 - d) Horizontal Surfaces: Not more than 9 sq. m (97 Sft) in area.
 - e) Where plaster panel sizes or dimensions change, extend joints full width or height of plaster membrane.

7.3.3.5 PLASTER APPLICATION

- A. **Plaster Application Standard:** Apply plaster materials, composition, and mixes to comply with ASTM C 926.
- B. Do not use materials that are frozen, caked, lumpy, dirty, or contaminated by foreign materials.
- C. Do not use excessive water in mixing and applying plaster materials.
- D. **Flat Surface Tolerances:** Do not deviate more than plus or minus 3 mm (2/16") in 3 m (10'-0") from a true plane in finished plaster surfaces, as measured by a 3-m (10'-0") straightedge placed at any location on surface.
- E. Grout hollow-metal frames, bases, and similar work occurring in plastered areas, with base-coat plaster material, and before lathing where necessary. Except where full grouting is indicated or required for fire-resistance rating, grout at least 150 mm (6") at each jamb anchor.
- F. Sequence plaster application with installation and protection of other work so that neither will be damaged by installation of other.
- G. Plaster flush with metal frames and other built-in metal items or accessories that act as a plaster ground, unless otherwise indicated. Where interior plaster is not terminated at metal frame by casing beads cut base coat free from metal frame before plaster sets and groove finish coat at junctures with metal.
- H. **Corners:** Make internal corners and angles square; finish external corners flush with corner beads on interior work, square and true with plaster faces on exterior work.
- I. **Finish Coats:** Apply finish coats to comply with the following requirements:
 - 1. Float Finish: Apply finish coat to a minimum thickness of 3 mm (2/16") to completely cover base coat, uniformly floated to a true even plane with fine-textured finish matching samples approved by the Consultant.
- J. **Number of Coats and Thickness:** Excluding dash coats and dubbing out coats apply plaster of composition indicated, to comply with the following requirements:
 - 1. Two Coats: Base and finish coats over the following plaster bases:
 - a) Concrete unit masonry.
 - b) Concrete, cast-in-place or precast when surface condition complies with ASTM C 926 for plaster bonded to solid base.
 - 2. Three Coats: Scratch, base and finish coats over metal lath backgrounds and installations.
 - 3. Overall thickness is to be 15.00 mm (3/4") for internal plaster and 20.00 mm (3/4") for external plaster.
 - 4. One plaster base coat (15 mm (3/4") thick) for walls to be finished with ceramic tiles set with thin bed adhesive.
 - 5. One coat work (15 mm (3/4") thick) for plaster on concrete structural slabs uniformly floated to a true even plane.
- K. Moist-cure plaster base and finish coats to comply with ASTM C 926, including written instructions for time between coats and curing in "Annex A2 Design Considerations."

7.3.3.6 CUTTING AND PATCHING

- A. Cut, patch, replace, repair, and point up plaster as necessary to accommodate other work. Repair cracks and indented surfaces. Point-up finish plaster surfaces around items that are built into or penetrate plaster surfaces. Repair or replace work to eliminate blisters, buckles, check cracking,

dry outs, efflorescence, excessive pinholes, and similar defects. Repair or replace work as necessary to comply with required visual effects.

7.3.3.7 CLEANING AND PROTECTING

- A. Remove temporary covering and other provisions made to minimize spattering of plaster on other work. Promptly remove plaster from doorframes, windows, and other surfaces not to be plastered. Repair surfaces stained, marred or otherwise damaged during plastering work. When plastering work is completed, remove unused materials, containers, equipment, and plaster debris.
- B. Provide final protection and maintain conditions, in a manner acceptable to Consultant, that ensure plaster work is without damage or deterioration at the time of Substantial Completion.

7.4 - CERAMIC TILE

PART 8 - GENERAL

7.4.1.1 RELATED DOCUMENTS

- A. Drawing and general provisions of the contract, including general and supplementary Conditions.

7.4.1.2 SUMMARY

- A. This Section includes the following:
 - 1. Porcelain Tiles.
- B. Related Sections include the following:
 - 1. 7.0 Section "Liquid Applied Waterproofing" for waterproofing under thickset mortar beds.
 - 2. 9.0 Section "Portland Cement Plaster" for Portland cement scratch coat over metal lath on wall surfaces.

7.4.1.3 DEFINITIONS

- A. **Module Size:** Actual tile size (minor facial dimension as measured per ASTM C 499) plus joint width indicated.
 - 1. **Facial Dimension:** Actual tile size (minor facial dimension as measured per ASTM C 499).
 - 2. **Facial Dimension:** Nominal tile size as defined in ANSI A137.1.

7.4.1.4 PERFORMANCE REQUIREMENTS

- A. **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:
 - 1. Level Surfaces: Minimum 0.6 (1/32").
- B. **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:
 - 1. Heavy: Passes cycles 1 through 12. Use where indicated in Finishing Schedules.
 - 2. Moderate: Passes cycles 1 through 10. Use for other applications indicated on Schedule where heavy duty is not indicated.

7.4.1.5 SUBMITTALS

- A. **Product Data:** For each type of tile, mortar, grout, and other products specified.
 - 1. **Shop Drawings:** For the following:
 - a) Tile patterns and locations.
 - b) Widths, details, and locations of expansion, contraction, control, and isolation joints in tile substrates and finished tile surfaces.
 - c) 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.
- B. **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.

- C. **Grout Samples for Initial Selection:** Manufacturer's color charts consisting of actual sections of grout showing the full range of colors available for each type of grout indicated.
- D. **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.
 - 1. Each type and composition of tile and for each color and texture required, at least 400 mm square, (1.76 Sft) mounted on braced cementations backer units, and with grouted joints using product complying with specified requirements and approved for completed work in color or colors selected by Consultant.
 - 2. Full-size units of each type of trim and accessory for each color required.
 - 3. Stone thresholds in 150-mm (6") lengths.
- E. **Master Grade Certificates:** For each shipment, type, and composition of tile, signed by tile manufacturer and Installer.
- F. **Product Certificates:** Signed by manufacturers certifying that the products furnished comply with requirements.
- G. **Installer Experience:** List of five projects (minimum) of a similar nature carried out successfully by the installer with the same product.
- H. **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.
- I. **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.
- J. **Setting Material Test Reports:** Indicate and interpret test results for compliance of tile-setting and -grouting products with specified requirements.

7.4.1.6 QUALITY ASSURANCE

- A. **Quality System:** Comply with ISO 9001/9002 Quality System as a minimum. Incorporate all the standard procedures supplied by the Consultant and the Employer.
 - 1. **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.
 - 2. **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.
 - 3. **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:

- a) Stone thresholds.
 - b) Cementations backer units.
 - c) Joint sealants.
 - d) Waterproofing.
- B. **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.
- 1. Locate mockups in the location and of the size indicated or, if not indicated, as directed by Consultant.
 - 2. Notify Consultant 7 days in advance of the dates and times when mockups will be constructed.
 - 3. Demonstrate the proposed range of aesthetic effects and workmanship.
 - 4. Obtain Consultant's approval of mockups before proceeding with final unit of Work.
 - 5. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
 - a) 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.

7.4.1.7 DELIVERY, STORAGE AND HANDLING

- A. 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.
- 1. Prevent damage or contamination to materials by water, freezing, foreign matter, and other causes.
 - 2. 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.

7.4.1.8 PROJECT CONDITIONS

- A. **Environmental Limitations:** Do not 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.

7.4.1.9 EXTRA MATERIALS

- A. 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.
- 1. 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.

PART 9 - PRODUCTS

7.4.2.1 PRODUCTS, GENERAL

1. Provide tile complying with Standard Grade requirements, unless otherwise indicated.
2. Retain below with appropriate definitions in referenced part 1 article.
3. For facial dimensions of tile, comply with requirements relating to tile sizes.
4. Tiles are to be highest grade of production in manufacturer's quality grading system.
- A. **ANSI Standards for Tile Installation Materials:** Provide materials complying with ANSI standards referenced in "Setting Materials" and "Grouting Materials" articles.
- B. **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:
 1. Provide Consultant's selections from manufacturer's full range of colors, textures, and patterns for products of type indicated.
- C. **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.
- D. **Mounting:** Where factory-mounted tile is required, provide back- or edge-mounted tile assemblies as standard with manufacturer, unless another mounting method is indicated.
- E. **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.

7.4.2.2 TILE PRODUCTS

- A. **General Characteristics:** Tiles are to comply with the following general requirements:
 1. Floor Tiles:
 - a) Abrasive Hardness: Minimum Index 253 to ASTM C 501 (unglazed tiles), unless otherwise specified.
 - b) Bending Strength: Minimum 35 Kg/cm² to ASTM C 648
 - c) Water Absorption: As specified.
 - d) Chemical Resistance: Unaffected with moderate acids.
 - e) Tile Rating: For heavy duty floor by a rating system acceptable to the Consultant.
 2. Wall Tiles:
 - a) Water Absorption: Maximum 6% to ASTM C 373.
- B. **Unglazed Paver Tile:** Provide flat tile complying with the following requirements:
 1. Composition: Porcelain mix.
 2. Constriction: Color-through.
 3. Water Absorption: Less than 0.5% to ASTM C 373.
 4. Surface Finish: Matt or Polished as indicated on Drawings.

5. Facial Dimensions: As indicated on Drawings.
6. Thickness: minimum 9.0 mm (1/2") for tiles and 8.50 mm (1/2") for fittings.
7. Face: Plain with Square or cushion edges.

C. **Wall Tile:** Provide flat tile complying with the following requirements:

1. Module Size: As indicated on Drawings.
2. Water Absorption: Less than 6% to ASTM C373.
3. Thickness: minimum 20 mm (3/4").
4. Face: Plain with modified square edges or cushion edges.

D. **Trim Units:** Provide tile trim units to match characteristics of adjoining flat tile and to comply with the following requirements:

1. Size: As indicated, coordinated with sizes and coursing of adjoining flat tile where applicable.
2. Shapes: As follows, selected from manufacturer's standard shapes:
 - a) Base for Portland Cement Mortar Installations: Coved.
 - b) Wainscot Cap for Thin-Set Mortar Installations: Surface bullnose.
 - c) External Corners for Thin-Set Mortar Installations: Surface bullnose.
 - d) Internal Corners: Field-buttet square corners, except with coved base and cap angle pieces designed to member with stretcher shapes.

E. **Tiles Thickness of Tiles:** Specified thickness of tiles excludes thickness of keying patterns on back.

Background/Base: 15mm thick 1:4 cement/sand render on concrete or concrete block works

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: 6mm

Accessories: all exposed edges and corners to have preformed rounded edges

7.4.2.3 PORECALIN WALL TILING

- Background/Base: 15mm (3/4") thick 1:4 cement/sand render on concrete or concrete block works.
- Bedding: Thin bed cement based adhesive. 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.
- Joint width: 3mm. (2/16") Movement joints: Location: All internal corners; Width: 6mm (2/8").
- Accessories: all exposed edges and corners to have preformed rounded edges In toilets, no tiles behind low level ducts or full height ducts. Complete tiling should be done behind mirrors. In pantry, tiles are to be fixed behind base and wall units but not behind service duct panels. Plaster only where no tiles.

7.4.2.4 FLOOR TILING

- Background/Base: screed 1 in-situ concrete
- Screed: 11.5:3 cement/sand/aggregate semi-dry screed laid to falls and towards
- Floor drain outlets, overall thickness of flooring to be 75mm (3").
- 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: 2.5mm (3/32").
- Movement joints: location: At all perimeters including door thresholds; Width: 6mm (1/4").
- Accessories:
 - o Skirting: Coved skirting tiles, 100mm (4") high to match ceramic floor tiles, set flush with 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.

7.4.2.5 CERAMIC FLOOR TILING TO HALL AREA

- Type/Size: Vitrified matt finish floor tiles 400mmx400mm (16" x 16") as manufactured by GRANITS or equivalent. Tiles to be beige colour as per approved sample and to Carrefour standard requirements. Tile size tolerance to be not greater than + or – 0.25mm (1/64") in any side.
- Background/Base: screed on in-situ concrete.
- Screed: Quick curing proprietary wet mix sand/cement screed, such as *Isocrete Heavy Duty Kscreed' laid in panels (maximum area 90m2) (970 Sft) and as per manufacturer's recommendations.
- **Note:** semi-dry screed will not be permitted in these areas.
- Adhesive and grout: Adhesive shall be Laticrete 325 or equivalent. Application strictly in accordance with manufacturer's instruction. Grout shall be epoxy Laticrete or equivalent. Colour to Architect approval.
- Joint width: 3mm (2/16")

7.4.2.6 GROUTING MATERIALS

- A. **Sand-Portland Cement Grout:** ANSI A108.10, composed of white or gray cement and white or colored aggregate as required to produce color indicated.
- B. **Chemical-Resistant Epoxy Grout:** ANSI A 118.3, color as indicated.
 1. 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.
- C. **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.

7.4.2.7 ELASTOMERIC SEALANTS

- A. **General:** Provide manufacturer's standard chemically curing, elastomeric sealants of base polymer and characteristics indicated that comply with applicable requirements of 7.0 Section "Joint Sealants."
- B. **Colors:** Provide colors of exposed sealants to match colors of grout in tile adjoining sealed joints, unless otherwise indicated.

7.4.2.8 MISCELLANEOUS MATERIALS

- A. **Trowelable Underlayments and Patching Compounds:** Latex-modified, Portland-cement-based formulation provided or approved by manufacturer of tile-setting materials for installations indicated.
- B. **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.
 - 2. 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.
- C. **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.

MIXING MORTARS AND GROUT

- A. Mix mortars and grouts to comply with referenced standards and mortar and grout manufacturers' written instructions.
 - 1. Add materials, water, and additives in accurate proportions.
 - 2. 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.

PART 10 - EXECUTION

7.4.3.1 EXAMINATION

- A. 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.
 - 1. 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.

7.5 - MARBLE AND GRANITE

PART 11 - GENERAL

7.5.1.1 RELATED DOCUMENTS

- A. Drawing and general provisions of the contract, including general and supplementary Conditions.

7.5.1.2 SUMMARY

- A. This Section includes the following:
 - 1. Marble & Granite.
- B. Related Sections include the following:
 - 1. 7.0 Section "Liquid Applied Waterproofing" for waterproofing under thickset mortar beds.
 - 2. 9.0 Section "Portland Cement Plaster" for Portland cement scratch coat over metal lath on wall surfaces.

7.5.1.3 DEFINITIONS

- A. **Module Size:** Actual tile size (minor facial dimension as measured per ASTM C 499) plus joint width indicated.
 - 1. **Facial Dimension:** Actual tile size (minor facial dimension as measured per ASTM C 499).
 - 2. **Facial Dimension:** Nominal tile size as defined in ANSI A137.1.

7.5.1.4 PERFORMANCE REQUIREMENTS

- A. **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:
 - 1. Level Surfaces: Minimum 0.6 (1/32").
- B. **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:
 - 1. Heavy: Passes cycles 1 through 12. Use where indicated in Finishing Schedules.
 - 2. Moderate: Passes cycles 1 through 10. Use for other applications indicated on Schedule where heavy duty is not indicated.

7.5.1.5 SUBMITTALS

- A. **Product Data:** For each type of tile, mortar, grout, and other products specified.
- B. **Shop Drawings:** For the following:
 - 1. Tile patterns and locations.
 - 2. Widths, details, and locations of expansion, contraction, control, and isolation joints in tile substrates and finished tile surfaces.
 - 3. 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.
- C. **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.

- D. **Grout Samples for Initial Selection:** Manufacturer's color charts consisting of actual sections of grout showing the full range of colors available for each type of grout indicated.
- E. **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.
 - 1. Each type and composition of tile and for each color and texture required, at least 400 mm square, (1.80 Sft) mounted on braced cementations backer units, and with grouted joints using product complying with specified requirements and approved for completed work in color or colors selected by Consultant.
 - 2. Full-size units of each type of trim and accessory for each color required.
 - 3. Stone thresholds in 150-mm (6") lengths.
- F. **Master Grade Certificates:** For each shipment, type, and composition of tile, signed by tile manufacturer and Installer.
- G. **Product Certificates:** Signed by manufacturers certifying that the products furnished comply with requirements.
- H. **Installer Experience:** List of five projects (minimum) of a similar nature carried out successfully by the installer with the same product.
- I. **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.
- J. **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.
- K. **Setting Material Test Reports:** Indicate and interpret test results for compliance of tile-setting and -grouting products with specified requirements.

7.5.1.6 QUALITY ASSURANCE

- A. **Quality System:** Comply with ISO 9001/9002 Quality System as a minimum. Incorporate all the standard procedures supplied by the Consultant and the Employer.
- B. **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.
- C. **Source Limitations for Marble & Granite:** 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.
- D. **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.
- E. **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:
 - 1. Stone thresholds.

2. Cementations backer units.
 3. Joint sealants.
 4. Waterproofing.
- F. **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.
1. Locate mockups in the location and of the size indicated or, if not indicated, as directed by Consultant.
 2. Notify Consultant 7 days in advance of the dates and times when mockups will be constructed.
 3. Demonstrate the proposed range of aesthetic effects and workmanship.
 4. Obtain Consultant's approval of mockups before proceeding with final unit of Work.
 5. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
 - a) 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.
- G. **Pre-installation Conference:** Conduct conference at Project site to comply with requirements of 1.0 Section "Project Management and Coordination."

7.5.1.7 DELIVERY, STORAGE AND HANDLING

- A. 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.
1. Prevent damage or contamination to materials by water, freezing, foreign matter, and other causes.
 2. 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.

7.5.1.8 PROJECT CONDITIONS

- A. **Environmental Limitations:** Do not 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.

7.5.1.9 EXTRA MATERIALS

- A. 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.
1. 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.

PRODUCTS

7.5.2.1 PRODUCTS, GENERAL

1. Provide tile complying with Standard Grade requirements, unless otherwise indicated.
 2. Retain below with appropriate definitions in referenced part 1 article.
 3. For facial dimensions of tile, comply with requirements relating to tile sizes specified in Part 1 "Definitions" Article.
 4. Marble & Granite are to be highest grade of production in manufacturer's quality grading system.
- A. **ANSI Standards for Tile Installation Materials:** Provide materials complying with ANSI standards referenced in "Setting Materials" and "Grouting Materials" articles.
1. **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:
 - a) Provide Consultant's selections from manufacturer's full range of colors, textures, and patterns for products of type indicated.
 2. **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.

7.5.2.2 PRODUCTS

- A. **General Characteristics:** Materials are to comply with the following general requirements:
1. For Flooring:
 - a) Abrasive Hardness: Minimum Index 253 to ASTM C 501 (unglazed tiles), unless otherwise specified.
 - b) Water Absorption: As specified.
 - c) Chemical Resistance: Unaffected with moderate acids.
 - d) Tile Rating: For heavy duty floor by a rating system acceptable to the Consultant.
 2. For Wall:
 - a) Water Absorption: Maximum 6% to ASTM C 373.
- B. **Unglazed Paver Tile:** Provide flat tile complying with the following requirements:
1. Composition: Natural Stone.
 2. Constriction: Color-through.
 3. Water Absorption: Less than 0.5% to ASTM C 373.
 4. Surface Finish: Matt or Polished as indicated on Drawings.
 5. Facial Dimensions: As indicated on Drawings.
 6. Thickness: minimum 9.0 mm (1/2") for tiles and 8.50 mm (3/4") for fittings.
 7. Face: Plain with Square or cushion edges.
- C. **Wall Tile:** Provide flat tile complying with the following requirements:

8. Module Size: As indicated on Drawings.

- a) Water Absorption: Less than 10% to ASTM C373.
- b) Thickness: minimum 20 mm (3/4").
- c) Face: Plain with modified square edges or cushion edges.

D. **Trim Units:** Provide tile trim units to match characteristics of adjoining flat tile and to comply with the following requirements:

1. Size: As indicated, coordinated with sizes and coursing of adjoining flat tile where applicable.
2. Shapes: As follows, selected from manufacturer's standard shapes:
 - a) Base for Portland Cement Mortar Installations: Coved.
 - b) Wainscot Cap for Thin-Set Mortar Installations: Surface bull-nose.
 - c) External Corners for Thin-Set Mortar Installations: Surface bull-nose.
 - d) Internal Corners: Field-buttet square corners, except with coved base and cap angle pieces designed to member with stretcher shapes.

E. **Tiles Thickness of Marble:** Specified thickness of tiles exclude thickness of keying patterns on back.

- Background/Base: 15mm (3/4") thick 1:4 cement/sand render on concrete or concrete block works
- 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: 6mm (2/8")
- Accessories: all exposed edges and corners to have preformed rounded edges

7.5.2.3 MARBLE WALL TILING

- Background/Base: 15mm (3/4") thick 1:4 cement/sand render on concrete or concrete block works.
- Bedding: Thin bed cement based adhesive. 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.
- Joint width: 3mm (2/16"). Movement joints: Location: All internal corners; Width: 6mm
- Accessories: all exposed edges and corners to have preformed rounded edges In toilets, no tiles behind low level ducts or full height ducts. Complete tiling should be done behind mirrors. In pantry, tiles are to be fixed behind base and wall units but not behind service duct panels. Plaster only where no tiles.

7.5.2.4 FLOOR

- Background/Base: screed 1 in-situ concrete
- Screed: 11.5:3 cement/sand/aggregate semi-dry screed laid to falls and towards floor drain outlets, overall thickness of flooring to be 75mm (3")
- 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: 2.5mm (3/32").
- Movement joints: location: At all perimeters including door thresholds; Width: 6mm(2/8")

Accessories:

Skirting: Coved skirting tiles, 100mm (4") high to match ceramic floor tiles, set flush with 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.

Joint width: 3mm (2/16")

7.5.2.5 GROUTING MATERIALS

- A. **Sand-Portland Cement Grout:** ANSI A108.10, composed of white or gray cement and white or colored aggregate as required to produce color indicated.
- B. **Chemical-Resistant Epoxy Grout:** ANSI A 118.3, color as indicated.
 1. 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.
- C. **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.

7.5.2.6 ELASTOMERIC SEALANTS

- A. **General:** Provide manufacturer's standard chemically curing, elastomeric sealants of base polymer and characteristics indicated that comply with applicable requirements.
- B. **Colors:** Provide colors of exposed sealants to match colors of grout in tile adjoining sealed joints, unless otherwise indicated.

7.5.2.7 MISCELLANEOUS MATERIALS

- A. **Trowel able Underlayment's and Patching Compounds:** Latex-modified, Portland-cement-based formulation provided or approved by manufacturer of tile-setting materials for installations indicated.
- B. **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.
 1. 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.
- C. **Marble 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.

7.5.2.8 MIXING MORTARS AND GROUT

- A. Mix mortars and grouts to comply with referenced standards and mortar and grout manufacturers' written instructions.
 - 1. Add materials, water, and additives in accurate proportions.
 - 2. 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.

PART 12 - EXECUTION

7.5.3.1 EXAMINATION

- A. 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.
 - 1. 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.

END OF SECTION

7.6 - PORCELAIN TILES

PART 13 - GENERAL

7.6.1.1 RELATED DOCUMENTS

- A. Drawing and general provisions of the contract, including general and supplementary Conditions.

7.6.1.2 SUMMARY

- A. This Section includes the following:
 - 1. Porcelain Tiles.
- B. Related Sections include the following:
 - 1. 7.10 Section "Liquid Applied Waterproofing" for waterproofing under thickset mortar beds.
 - 2. D9.24 Section "Portland Cement Plaster" for Portland cement scratch coat over metal lath on wall surfaces.

7.6.1.3 DEFINITIONS

- A. **Module Size:** Actual tile size (minor facial dimension as measured per ASTM C 499) plus joint width indicated.
 - 1. **Facial Dimension:** Actual tile size (minor facial dimension as measured per ASTM C 499).
 - 2. **Facial Dimension:** Nominal tile size as defined in ANSI A137.1.

7.6.1.4 PERFORMANCE REQUIREMENTS

- A. **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:
 - 1. Level Surfaces: Minimum 0.6 (1/32").
- A. **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:
 - 1. Heavy: Passes cycles 1 through 12. Use where indicated in Finishing Schedules.
 - 2. Moderate: Passes cycles 1 through 10. Use for other applications indicated on Schedule where heavy duty is not indicated.

7.6.1.5 SUBMITTALS

- A. **Product Data:** For each type of tile, mortar, grout, and other products specified.
- B. **Shop Drawings:** For the following:
 - 1. Tile patterns and locations.
 - 2. Widths, details, and locations of expansion, contraction, control, and isolation joints in tile substrates and finished tile surfaces.
 - 3. 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.
- C. **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.

- D. **Grout Samples for Initial Selection:** Manufacturer's color charts consisting of actual sections of grout showing the full range of colors available for each type of grout indicated.
- E. **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.
 - 1. Each type and composition of tile and for each color and texture required, at least 400 mm square, (1.80 Sft) mounted on braced cementations backer units, and with grouted joints using product complying with specified requirements and approved for completed work in color or colors selected by Consultant.
 - 2. Full-size units of each type of trim and accessory for each color required.
 - 3. Stone thresholds in 150-mm (6") lengths.
- F. **Master Grade Certificates:** For each shipment, type, and composition of tile, signed by tile manufacturer and Installer.
- G. **Product Certificates:** Signed by manufacturers certifying that the products furnished comply with requirements.
- H. **Installer Experience:** List of five projects (minimum) of a similar nature carried out successfully by the installer with the same product.
- I. **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.
- J. **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.
- K. **Setting Material Test Reports:** Indicate and interpret test results for compliance of tile-setting and -grouting products with specified requirements.

7.6.1.6 QUALITY ASSURANE

- A. **Quality System:** Comply with ISO 9001/9002 Quality System as a minimum. Incorporate all the standard procedures supplied by the Consultant and the Employer.
- B. **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.
- C. **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.

- D. **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.
- E. **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:
 - 1. Stone thresholds.
 - 2. Cementations backer units.
 - 3. Joint sealants.
 - 4. Waterproofing.
- F. **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.
 - 1. Locate mockups in the location and of the size indicated or, if not indicated, as directed by Consultant.
 - 2. Notify Consultant 7 days in advance of the dates and times when mockups will be constructed.
 - 3. Demonstrate the proposed range of aesthetic effects and workmanship.
 - 4. Obtain Consultant's approval of mockups before proceeding with final unit of Work.
 - 5. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
 - a) 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.
- G. **Pre-installation Conference:** Conduct conference at Project site to comply with requirements of 1.0 Section "Project Management and Coordination."

7.6.1.7 DELIVERY, STORAGE AND HANDLING

- A. 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.
- B. Prevent damage or contamination to materials by water, freezing, foreign matter, and other causes.
- C. 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.

7.6.1.8 PROJECT CONDITIONS

- A. **Environmental Limitations:** Do not 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.

A. **EXTRA MATERIALS**

- B. 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.
1. 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.

PART2 – PRODUCTS

PRODUCTS, GENERAL

1. Provide tile complying with Standard Grade requirements, unless otherwise indicated.
 2. Retain below with appropriate definitions in referenced part 1 article.
 3. For facial dimensions of tile, comply with requirements relating to tile sizes specified in Part 1 "Definitions" Article.
 4. Tiles are to be highest grade of production in manufacturer's quality grading system.
- A. **ANSI Standards for Tile Installation Materials:** Provide materials complying with ANSI standards referenced in "Setting Materials" and "Grouting Materials" articles.
- B. **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:
1. Provide Consultant's selections from manufacturer's full range of colors, textures, and patterns for products of type indicated.
- C. **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.
- D. **Mounting:** Where factory-mounted tile is required, provide back- or edge-mounted tile assemblies as standard with manufacturer, unless another mounting method is indicated.
- E. **Factory-Applied Temporary Protective Coating:** Where indicated under tile type, protect exposed surfaces of tile against adherence of mortar and grout

by pre-oating them with continuous film of petroleum paraffin wax, applied hot. Do not coat unexposed tile surfaces.

7.6.2.1 TILE PRODUCT

- A. **General Characteristics:** Tiles are to comply with the following general requirements:
 1. Floor Tiles:
 - a) Abrasive Hardness: Minimum Index 253 to ASTM C 501 (unglazed tiles), unless otherwise specified.
 - b) Bending Strength: Minimum 35 Kg/cm² (1 kg / cft) to ASTM C 648
 - c) Water Absorption: As specified.
 - d) Chemical Resistance: Unaffected with moderate acids.
 - e) Tile Rating: For heavy duty floor by a rating system acceptable to the Consultant.
 2. Wall Tiles:
 - a) Water Absorption: Maximum 6% to ASTM C 373.
- B. **Unglazed Paver Tile:** Provide flat tile complying with the following requirements:
 1. Composition: Porcelain mix.
 2. Constriction: Color-through.
 3. Water Absorption: Less than 0.5% to ASTM C 373.
 4. Surface Finish: Matt or Polished as indicated on Drawings.
 5. Facial Dimensions: As indicated on Drawings.
 6. Thickness: minimum 9.0 mm (1/2") for tiles and 8.50 mm (1/2") for fittings.
 7. Face: Plain with Square or cushion edges.
- C. **Wall Tile:** Provide flat tile complying with the following requirements:
 1. Module Size: As indicated on Drawings.
 - a) Water Absorption: Less than 6% to ASTM C373.
 - b) Thickness: minimum 8.0 mm (1/2").
 - c) Face: Plain with modified square edges or cushion edges.
- D. **Trim Units:** Provide tile trim units to match characteristics of adjoining flat tile and to comply with the following requirements:
 1. Size: As indicated, coordinated with sizes and coursing of adjoining flat tile where applicable.
 2. Shapes: As follows, selected from manufacturer's standard shapes:
 - a) Base for Portland cement Mortar Installations: Coved.
 - b) Wainscot Cap for Thin-Set Mortar Installations: Surface bull nose.
 - c) External Corners for Thin-Set Mortar Installations: Surface bull nose.
 - d) Internal Corners: Field-buttet square corners, except with coved base and cap angle pieces designed to member with stretcher shapes.
- E. **Thickness of Tiles:** Specified thickness of tiles excludes thickness of keying patterns on back.
 - Background/Base: 12mm (1/2") thick 1:4 cement/sand render on concrete or concrete block works
 - 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: 6mm (2/8")
- Accessories: all exposed edges and corners to have preformed rounded edges.

7.6.2.2 PORCELAIN WALL TILING

- Background/Base: 15mm (3/4") thick 1:4 cement/sand render on concrete or concrete block works.
- Bedding: Thin bed cement based adhesive. 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.
- Joint width: 3mm (2/16"). Movement joints: Location: All internal corners; Width: 6mm (2/8")
- Accessories: all exposed edges and corners to have preformed rounded edges in toilets, no tiles behind low level ducts or full height ducts. Complete tiling should be done behind mirrors. In pantry, tiles are to be fixed behind base and wall units but not behind service duct panels. Plaster only where no tiles.

7.6.2.3 FLOOR TILING

- Background/Base: screed 1 in-situ concrete
- Screed: 1 1.5:3 cement/sand/aggregate semi-dry screed laid to falls and towards floor drain outlets, overall thickness of flooring to be 75mm (3")
- 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: 2.5mm (3/32").
- Movement joints: location: At all perimeters including door thresholds; Width: 6mm- Accessories:
- Skirting: Coved skirting tiles, 100mm (4") high to match ceramic floor tiles, set flush with 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.

7.6.2.4 CERAMIC FLOOR TILING TO HALL AREA

- Type/Size: Vitritied matt finish floor files 400mmx400mm (16" x 16") as manufactured by GRANITO or equivalent. Tiles to be beige colour as per approved sample and to Carrefour standard requirements. Tile size tolerance to be not greater than + or – 0.25mm (1/32") in any side.
- Background/Base: screed on in-situ concrete.
- Screed: Quick curing proprietary wet mix sand/cement screed, such as *Isocrete Heavy Duty Kscreed' laid in panels (maximum area 90m2) (970

Sft) and as per manufacturer's recommendations. **Note:** semi-dry screed will not be permitted in these areas.

- Adhesive and grout: Adhesive shall be Laticrete 325 or equivalent. Application strictly in accordance with manufacturer's instruction. Grout shall be epoxy Laticrete or equivalent. Colour to Architect approval.
- Joint width: 3mm (2/16")

7.6.2.5 GROUTING MATERIALS

- A. **Sand-Portland Cement Grout:** ANSI A108.10, composed of white or gray cement and white or colored aggregate as required to produce color indicated.
- B. **Chemical-Resistant Epoxy Grout:** ANSI A 118.3, color as indicated.
 - 1. 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.
- C. **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.

7.6.2.6 ELASTOMERIC SEALANTS

- A. **General:** Provide manufacturer's standard chemically curing, elastomeric sealants of base polymer and characteristics indicated that comply with applicable requirements of 7.0 Section "Joint Sealants."
- B. **Colors:** Provide colors of exposed sealants to match colors of grout in tile adjoining sealed joints, unless otherwise indicated.

7.6.2.7 MISCELLANEOUS MATERIALS

- A. **Trowel able Underlayment's and Patching Compounds:** Latex-modified, Portland-cement-based formulation provided or approved by manufacturer of tile-setting materials for installations indicated.
- B. **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.
 - 1. 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.
- C. **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.

7.6.2.8 MIXING MORTARS AND GROUT

- A. Mix mortars and grouts to comply with referenced standards and mortar and grout manufacturers' written instructions.
 - 1. Add materials, water, and additives in accurate proportions.
 - 2. 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.

PART 14 - EXECUTION

7.6.3.1 EXAMINATION

- A. 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.
 - 1. 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.

END OF SECTION

7.7 - PAINTING

PART 15 - GENERAL

7.7.1.1 RELATED DOCUMENTS

- A. Drawing and general provision of the contract, including general and supplementary Conditions.

7.7.1.2 SUMMARY

- A. This Section includes surface preparation and field painting of the following:
 - 1. Exposed exterior items and surfaces.
 - 2. Exposed interior items and surfaces.
 - 3. Surface preparation, priming, and finish coats specified in this Section are in addition to shop priming and surface treatment specified in other Sections.
- B. Paint exposed surfaces, except where the paint schedules indicate that a surface or material is not to be painted or is to remain natural. If the paint schedules do not specifically mention an item or a surface, paint the item or surface the same as similar adjacent materials or surfaces whether or not schedules indicate colors. If the schedules do not indicate color or finish, the Consultant will select from standard colors and finishes available.
- C. Do not paint pre-finished items, concealed surfaces, finished metal surfaces, operating parts, and labels.
 - 1. Concealed surfaces include walls or ceilings in the following generally inaccessible spaces:
 - 2. Operating parts include moving parts of operating equipment and the following:
 - 3. Labels: Do not paint over Underwriters Laboratories (UL), Factory Mutual (FM), or other code-required labels or equipment name, identification, performance rating, or nomenclature plates.
- D. Related Sections include the following:
 - 1. 5.0 Section "Metal Fabrications" for shop priming ferrous metal.
 - 2. 6.0 Section "Flush Wooden Doors" for shop priming wood doors.

7.7.1.3 DEFINITIONS

- A. **General:** the following coating terms apply to this Section.
 - 1. Flat refers to a lusterless or matte finish with a gloss range below 15 when measured at an 85-degree meter.
 - 2. Eggshell refers to low-sheen finish with a gloss range between 5 and 20 when measured at a 60-degree meter.

3. Satin refers to low-sheen finish with a gloss range between 15 and 35 when measured at a 60-degree meter.
4. Semi-gloss refers to medium-sheen finish with a gloss range between 30 and 65 when measured at a 60-degree meter.
5. Full gloss refers to high-sheen finish with a gloss range more than 65 when measured at a 60-degree meter.

7.7.1.4 SUBMITTALS

- A. **Product Data:** For each paint system specified. Include block fillers and primers.
 1. **Material List:** Provide an inclusive list of required coating materials. Indicate each material and cross-reference specific coating, finish system, and application. Identify each material by manufacturer's catalog number and general classification.
 2. **Manufacturer's Information:** Provide manufacturer's technical information, including label analysis and instructions for handling, storing, and applying each coating material proposed for use.
- B. **Samples for Initial Selection:** Manufacturer's color charts showing the full range of colors available for each type of finish-coat material indicated.
 1. After color selection, the Consultant will furnish color chips for surfaces to be coated.
- C. **Samples for Verification:** Of each color and material to be applied, with texture to simulate actual conditions, on representative Samples of the actual substrate.
 1. Provide stepped Samples, defining each separate coat, including block fillers and primers. Use representative colors when preparing Samples for review. Resubmit until required sheen, color, and texture are achieved.
 2. Provide a list of materials and applications for each coat of each sample. Label each sample for location and application.

3. Submit Samples on the following substrates for the Consultant's review of color and texture only:

- a) Concrete: Provide two 100-mm- (4") square samples for each color and finish.
- b) Ferrous Metal: Provide two 100-mm- (4") square samples of flat metal and two 200-mm- long samples of solid metal for each color and finish.

D. 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 and addresses of Consultants and owners, and other information specified.

7.7.1.5 QUALITY ASSURANCE

- A. **Quality System:** Comply with ISO 9001/9002 Quality System as a minimum. Incorporate all the standard procedures supplied by the Consultant and the Employer.
- B. **Applicator Qualifications:** Engage an experienced applicator who has completed painting system applications similar in material and extent to that indicated for this Project with a record of successful in-service performance.
- C. **Source Limitations:** Obtain fillers, primers, and undercoat materials for each coating system from the same manufacturer as the finish coats.
- D. **Benchmark Samples (Mockups):** Provide a full-coat benchmark finish sample of each type of coating and substrate required on the Project.
 - 1. The Consultant will select one room or surface to represent surfaces and conditions for each type of coating and substrate to be painted.
 - a) Wall Surfaces: Provide samples on at least 9 sq. m (97 Sft) of wall surface.
 - b) Small Areas and Items: The Consultant will designate an item or area as required.
 - 2. After permanent lighting and other environmental services have been activated, apply coatings in this room or to each surface according to

the Schedule or as specified. Provide required sheen, color, and texture on each surface.

a) After finishes are accepted, the Consultant will use the room or surface to evaluate coating systems of a similar nature.

3. Final approval of colors will be from job-applied samples.

E. **Manufacturers Qualifications:** Paint materials shall be the products of paint and coating manufacturers whose qualifications are as follows:

1. Manufacturers shall be reputable of multi-national scale in production and distribution with capabilities to deliver paint materials quantities necessary for the project on due time.

2. Manufacturers shall have evidence from scientific bodies that demonstrate their participation and share in the development of paint industry generally and production of new painting materials kinds.

3. Manufacturers shall have their own proprietary brand names that are well known worldwide.

4. Manufacturers shall have minimum 25 years of successful experience in producing painting materials for use in prestigious projects worldwide of same standard of quality as that intended for the Project.

5. Manufacturers shall be registered in the associations, councils, boards, federations or other similar bodies of paint manufacturers in countries of origin and practice.

F. **Performance of Paints:** Paints shall be fit for purpose and manufactured specifically for the applications indicated and uses intended, taking into account the type, nature, location, and aesthetic and utility requirements of the Project.

1. Opacity: Paint shall cover or hide the substrate to the Consultant's satisfaction.

2. Clean ability: Paint shall not absorb dirt and shall be capable of being washed or scrubbed periodically, to the Consultant's satisfaction, without adverse effect on its attributes or appearance.

3. Scrub resistance wet and dry: paint shall resist abrasion caused by scrubbing in accordance with ASTM D 2486.

4. Adhesion: Paint shall adhere firmly to the substrate without peeling.

5. Exposure resistance: Paint shall resist yellowing and weathering caused by UV rays and ozone.

G. **Standards:** Paints shall be manufactured to relevant US standards, or any other international standard approved by Authorities having jurisdiction.

7.7.1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials to the Project Site in manufacturer's original, unopened packages and containers bearing manufacturer's name and label, and the following information:
 - 1. Product name or title of material.
 - 2. Product description (generic classification or binder type).
 - 3. Manufacturer's stock number and date of manufacture.
 - 4. Contents by volume, for pigment and vehicle constituents.
 - 5. Thinning instructions.
 - 6. Application instructions.
 - 7. Color name and number.
 - 8. VOC content.
- B. Store materials not in use in tightly covered containers in a well-ventilated area at a minimum ambient temperature of 7 deg C. Maintain containers used in storage in a clean condition, free of foreign materials and residue.
 - 1. Keep storage area neat and orderly. Remove oily rags and waste daily. Take necessary measures to ensure that workers and work areas are protected from fire and health hazards resulting from handling, mixing, and application.

7.7.1.7 PROJECT CONDITIONS

- A. Apply water-based paints only when the temperature of surfaces to be painted and surrounding air temperatures are between 10 and 32 deg C.
- B. Apply solvent-thinned paints only when the temperature of surfaces to be painted and surrounding air temperatures are between 7.2 and 35 deg C.
- C. Do not apply paint in snow, rain, fog, or mist; or when the relative humidity exceeds 85 percent; or at temperatures less than 3 deg C above the dew point; or to damp or wet surfaces.
 - 1. Painting may continue during inclement weather if surfaces and areas to be painted are enclosed and heated within temperature limits specified by manufacturer during application and drying periods.

7.7.1.8 EXTRA MATERIALS

- A. Furnish extra paint materials from the same production run as the materials applied and in the quantities described below. Package with protective

covering for storage and identify with labels describing contents. Deliver extra materials to the Employer.

1. Quantity: Furnish the Employer with an additional 5 percent, but not less than 3.8 L or 1 case, as appropriate, of each material and color applied.

PART 2 – PRODUCTS

7.7.2.1 PAINT MATERIALS, GENERAL

- A. **General:** Employed paints and painting materials shall be the highest grade and top quality in manufacturer's range of products for the generic kind of paint or paint material.
- B. **General:** Materials for paint works shall comply with requirements of BS 6150, as applicable.
- C. **Material Compatibility:** Provide block fillers, primers, undercoats, and finish-coat materials that are compatible with one another and the substrates indicated under conditions of service and application, as demonstrated by manufacturer based on testing and field experience.
- D. **Material Quality:** Provide manufacturer's best-quality paint material of the various coating types specified. Paint-material containers not displaying manufacturer's product identification will not be acceptable.
- E. **Colors:** Provide color selections made by the Consultant or by reference to manufacturer's color designations.

7.7.2.2 ANTI-CARBONATION PAINT MATERIALS, GENERAL

- A. Paint for application on internal and external is to be anti-carbonation paint that is easy to clean, applicable on new or existing concrete, Portland cement plaster or masonry, water-based and non toxic, allows substrate to breath, Protects substrates form Carbonation, of elastic nature with crack bridging properties.
- B. Anti-carbonation paint is to be self-cleaning by application of just sprayed water, highly durable, copolymer based coating which cures to form a tightly adherent, decorative weatherproof membrane guaranteed for up to 15 years. The formed coating membrane shall tolerate thermal movement in the substrate without splitting or cracking and will retain its elastomeric properties even after prolonged exposure to ultra-violet light. Coating shall have the advantage of being reinforced using glass fiber matting or tapes and shall be capable of bridging cracks or joints between different substrates. The finished surface shall be chemical and pollution-resistant surface that has been specially manufactured to shed dirt, ensuring that it retains a bright, attractive appearance throughout its life. Coating shall be vapor permeable and allows entrapped substrate moisture to escape without causing blistering or delimitation and shall produce an effective barrier to carbon dioxide diffusion

and provide reinforced concrete substrates with an excellent defense against the harmful effects of carbonation. Color and sheen shall be selected by the Consultant from manufacturer's full range of products.

C. Anti carbonation paint shall also comply with following properties;

1. Carbon Dioxide Diffusion Resistance, Tay wood Method
 - a) Equivalent Thickness of Air: More than 175 mm (7").
 - b) Equivalent Thickness of 30N Concrete: More than 500 mm (20").
2. Chloride Ion Diffusion Coefficient: No chloride ion diffusion after 60 days; Tay wood Method
3. Static Crack Spanning Capability for 200-micron Dry Film Thickness at 23 °C: Minimum 2.00 mm to ASTM C836.
4. Tear Resistance: 15 N/mm to ASTM D1004.
5. Tensile Strength: 5.00 N/mm² to ASTM D412.
6. Reduction in Water absorption: Not less than 82% to ASTM C642.
7. Reduction in Chloride Ions Penetration: Not less than 92% to AASHTO M259.
8. Adhesion: Not less than 1.00 N/mm², BS 1881.

PART 3 – EXECUTION

7.7.3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with the Applicator present, under which painting will be performed for compliance with paint application requirements.
 - 1. Do not begin to apply paint until unsatisfactory conditions have been corrected and surfaces receiving paint are thoroughly dry.
 - 2. Start of painting will be construed as the Applicator's acceptance of surfaces and conditions within a particular area.
- B. **Coordination of Work:** Review other Sections in which primers are provided to ensure compatibility of the total system for various substrates. On request, furnish information on characteristics of finish materials to ensure use of compatible primers.
 - 1. Notify the Consultant about anticipated problems using the materials specified over substrates primed by others.

7.7.3.2 PREPARATION

- A. **General:** Preparation of surfaces to receive paints is to be according with requirements of BS 6150 and recommendations of paints manufacturer.
- B. **General:** Remove hardware and hardware accessories, plates, machined surfaces, lighting fixtures, and similar items already installed that are not to be painted. If removal is impractical or impossible because of the size or weight of the item, provide surface-applied protection before surface preparation and painting.
 - 1. After completing painting operations in each space or area, reinstall items removed using workers skilled in the trades involved.
- C. **Cleaning:** Before applying paint or other surface treatments, clean the substrates of substances that could impair the bond of the various coatings. Remove oil and grease before cleaning.
 - 1. Schedule cleaning and painting so dust and other contaminants from the cleaning process will not fall on wet, newly painted surfaces.
- D. **Surface Preparation:** Clean and prepare surfaces to be painted according to manufacturer's written instructions for each particular substrate condition and as specified.
 - 1. Provide barrier coats over incompatible primers or remove and re-prime.
 - 2. **Cementations Materials:** Prepare concrete, concrete masonry block, cement plaster, and mineral-fiber-reinforced cement panel surfaces to be painted. Remove efflorescence, chalk, dust, dirt, grease, oils, and release agents. Roughen as required to remove glaze. If hardeners or sealers have been used to improve curing, use mechanical methods of surface preparation.
 - a) Use abrasive blast-cleaning methods if recommended by paint manufacturer.
 - b) Determine alkalinity and moisture content of surfaces by performing appropriate tests. If surfaces are sufficiently alkaline to cause the finish paint to blister and burn, correct this condition before application. Do

not paint surfaces where moisture content exceeds that permitted in manufacturer's written instructions.

- c) Clean concrete floors to be painted with a 5 percent solution of muriatic acid or other etching cleaner. Flush the floor with clean water to remove acid, neutralize with ammonia, rinse, allow to dry, and vacuum before painting.
- d) Clean concrete floors to be painted with a 5 percent solution of muriatic acid or other etching cleaner. Flush the floor with clean water to remove acid, neutralize with ammonia, rinse, allow to dry, and vacuum before painting.

Ferrous Metals: Clean un-galvanized ferrous-metal surfaces that have not been shop coated; remove oil, grease, dirt, loose mill scale, and other foreign substances. Use solvent or mechanical cleaning methods that comply with recommendations of referenced standards.

- a) Blast steel surfaces clean as recommended by paint system manufacturer and according to requirements of referenced standards.
 - b) Treat bare and sandblasted or pickled clean metal with a metal treatment wash coat before priming.
 - c) Touch up bare areas and shop-applied prime coats that have been damaged. Wire-brush, clean with solvents recommended by paint manufacturer, and touch up with the same primer as the shop coat.
3. **Galvanized Surfaces:** Clean galvanized surfaces with nonpetroleum-based solvents so surface is free of oil and surface contaminants. Remove pretreatment from galvanized sheet metal fabricated from coil stock by mechanical methods.
- E. **Materials Preparation:** Mix and prepare paint materials according to manufacturer's written instructions.
- 1. Maintain containers used in mixing and applying paint in a clean condition, free of foreign materials and residue.
 - 2. Stir material before application to produce a mixture of uniform density. Stir as required during application. Do not stir surface film into material. If necessary, remove surface film and strain material before using.
 - 3. Use only thinners approved by paint manufacturer and only within recommended limits.
- F. **Tinting:** Tint each undercoat a lighter shade to simplify identification of each coat when multiple coats of the same material are applied. Tint undercoats to

match the color of the finish coat, but provide sufficient differences in shade of undercoats to distinguish each separate coat.

7.7.3.3 APPLICATION

- A. **General:** Apply paint according to recommendations of BS 6150 and manufacturer's written instructions. Use applicators and techniques best suited for substrate and type of material being applied.
1. Paint colors, surface treatments, and finishes are indicated in the schedules.
 2. Do not paint over dirt, rust, scale, grease, moisture, scuffed surfaces, or conditions detrimental to formation of a durable paint film.
 3. Provide finish coats that are compatible with primers used.
 4. The term "exposed surfaces" includes areas visible when permanent or built-in fixtures, convector covers, covers for finned-tube radiation, grilles, and similar components are in place. Extend coatings in these areas, as required, to maintain the system integrity and provide desired protection.
 5. Paint surfaces behind movable equipment and furniture the same as similar exposed surfaces. Before the final installation of equipment, paint surfaces behind permanently fixed equipment or furniture with prime coat only.
 6. Paint interior surfaces of ducts with a flat, non-specular black paint where visible through registers or grilles.
 7. Paint back sides of access panels and removable or hinged covers to match exposed surfaces.
 8. Finish exterior doors on tops, bottoms, and side edges the same as exterior faces.
 9. Finish interior of wall and base cabinets and similar field-finished casework to match exterior.
 10. Sand lightly between each succeeding enamel or varnish coat.

- B. **Scheduling Painting:** Apply first coat to surfaces that have been cleaned, pretreated, or otherwise prepared for painting as soon as practicable after preparation and before subsequent surface deterioration.
1. The number of coats and the film thickness required are the same regardless of application method. Do not apply succeeding coats until the previous coat has cured as recommended by the manufacturer. If sanding is required to produce a smooth, even surface according to manufacturer's written instructions, sand between applications.
 2. Omit primer on metal surfaces that have been shop primed and touchup painted.
 3. If undercoats, stains, or other conditions show through final coat of paint, apply additional coats until paint film is of uniform finish, color, and appearance. Give special attention to ensure edges, corners, crevices, welds, and exposed fasteners receive a dry film thickness equivalent to that of flat surfaces.
 4. Allow sufficient time between successive coats to permit proper drying. Do not recoat surfaces until paint has dried to where it feels firm, does not deform or feel sticky under moderate thumb pressure, and where application of another coat of paint does not cause the undercoat to lift or lose adhesion.
- C. **Application Procedures:** Apply paints and coatings by brush, roller, spray, or other applicators according to manufacturer's written instructions.
1. Brushes: Use brushes best suited for the type of material applied. Use brush of appropriate size for the surface or item being painted.
 2. Rollers: Use rollers of carpet, velvet back, or high-pile sheep's wool as recommended by the manufacturer for the material and texture required.
 3. Spray Equipment: Use airless spray equipment with orifice size as recommended by the manufacturer for the material and texture required.
- D. **Minimum Coating Thickness:** Apply paint materials no thinner than manufacturers recommended spreading rate. Provide the total dry film thickness of the entire system as recommended by the manufacturer.
- E. **Mechanical and Electrical Work:** Painting of mechanical and electrical work is limited to items exposed in equipment rooms and in occupied spaces.
- F. **Prime Coats:** Before applying finish coats, apply a prime coat of material, as recommended by the manufacturer, to material that is required to be painted

or finished and that has not been prime coated by others. Recoat primed and sealed surfaces where evidence of suction spots or unsealed

- G. areas in first coat appears, to ensure a finish coat with no burn through or other defects due to insufficient sealing.
- H. **Pigmented (Opaque) Finishes:** Completely cover surfaces as necessary to provide a smooth, opaque surface of uniform finish, color, appearance, and coverage. Cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness, or other surface imperfections will not be acceptable.
- I. **Transparent (Clear) Finishes:** Use multiple coats to produce a glass-smooth surface film of even luster. Provide a finish free of laps, runs, cloudiness, color irregularity, brush marks, orange peel, nail holes, or other surface imperfections.
 - 1. Provide satin finish for final coats.
- J. **Stipple Enamel Finish:** Roll and redistribute paint to an even and fine texture. Leave no evidence of rolling, such as laps, irregularity in texture, skid marks, or other surface imperfections.
- K. **Completed Work:** Match approved samples for color, texture, and coverage. Remove, refinish, or repaint work not complying with requirements.

7.7.3.4 FIELD QUALITY CONTROL

- A. The Employer reserves the right to invoke the following test procedure at any time and as often as the Employer deems necessary during the period when paint is being applied:
 - 1. The Employer will engage the services of an independent testing agency to sample the paint material being used. Samples of material delivered to the Project will be taken, identified, sealed, and certified in the presence of the Contractor.
 - 2. The testing agency will perform appropriate tests for the following characteristics as required by the Employer:
 - a) Quantitative material analysis.
 - b) Abrasion resistance.
 - c) Apparent reflectivity.
 - d) Flexibility.
 - e) Wash ability.
 - f) Absorption.
 - g) Accelerated weathering.
 - h) Dry opacity.
 - i) Accelerated yellowness.
 - j) Recoating.
 - k) Skinning.
 - l) Color retention.
 - m) Alkali and mildew resistance.
 - 3. The Employer may direct the Contractor to stop painting if test results show material being used does not comply with specified requirements. The Contractor shall remove non-complying paint from the site, pay for testing,

and repaint surfaces previously coated with the rejected paint. If necessary, the Contractor may be required to remove rejected paint from previously painted surfaces if, on repainting with specified paint, the 2 coatings are incompatible.

7.7.3.5 **CLEANING**

- A. **Cleanup:** At the end of each workday, remove empty cans, rags, rubbish, and other discarded paint materials from the site.
 - 1. After completing painting, clean glass and paint-spattered surfaces. Remove spattered paint by washing and scraping. Be careful not to scratch or damage adjacent finished surfaces.

7.7.3.6 **PROTECTION**

- A. Protect work of other trades, whether being painted or not, against damage by painting. Correct damage by cleaning, repairing or replacing, and repainting, as approved by Consultant.
- B. Provide "Wet Paint" signs to protect newly painted finishes. Remove temporary protective wrappings provided by others to protect their work after completing painting operations.
 - 1. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

7.7.3.7 **EXTERIOR PAINT SCHEDULE**

- A. Coordinate the following paint coats with surface preparation steps as specified.
- B. Concrete and Cement Sand Portland Plaster: Provide the following finish system over exterior concrete and Portland Cement Plaster.
 - 1. Light Textured Emulsion Paint
 - a) 100% pure acrylic-based paint specially formulated for external application. The paint is to dry by evaporation of water and will produce a durable, flexible, excellent water and alkali resistant and is to provide long lasting protection for coated surfaces. The paint is to be UV-resistant, of high bond strength to substrates and distinguished color retention, and is to provide anti-carbonation shield for the substrate while allowing moisture of substrate to escape to the outside.
 - b) Finished surface is to be of light texture.
- C. **Ferrous Metal:** Provide the following finish system over exterior ferrous metal.
 - 1. Full-Gloss, Epoxy-Based Enamel: Two finish coat over primer.
 - a) Primer: High-molecular-weight, epoxy-resin primer at spreading rate recommended by manufacturer.
 - b) Finish Coat: High-molecular-weight, epoxy-resin topcoat at spreading rate recommended by the manufacturer.
 - c) Protection Coating: Two Coats of clear polyurethane-based, UV resistant protection coating.

7.7.3.8 **INTERIOR PAINT SCHEDULE**

- A. Coordinate the following paint coats with surface preparation steps as specified.

- B. **Concrete:** Provide the following paint systems over interior concrete and masonry surfaces:
1. Flat Acrylic Finish: 2 finish coats over a primer.
 - a. Primer: Alkali-resistant, acrylic-latex, interior primer applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 0.025 mm.
 2. First and Second Coats: Flat, acrylic latex-based, interior paint applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 0.060 mm per coat.
- C. **Plaster:** Provide the following finish systems over new, interior Portland cement plaster surfaces:
- A.
1. Flat Acrylic Finish: 2 finish coats over a primer.
 - a) Primer: Alkali-resistant, acrylic-latex, interior primer applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 0.036 mm.
 - b) Undercoat: same material for finish coats specified hereafter diluted to the manufacturer's recommendations.
 - c) First and Second Finish Coats: Flat, acrylic-latex, interior paint applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 0.064 mm per coat.
 2. Semi gloss, Alkyd-Enamel Finish: One finish coat over an undercoat and a primer.
 - a) Primer: Alkali-resistant, alkyd- or latex-based, interior primer, as recommended by the manufacturer for this substrate, applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 1.2 mils (0.031 mm).
 - b) First and Second Coats: Semi gloss, alkyd, interior enamel applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 0.066 mm.
- D. **Woodwork and Hardboard:** Provide the following paint finish systems over new, interior wood surfaces:
1. Semigloss, Acrylic-Enamel Finish: 2 finish coats over a wood undercoated.
 - a) Undercoat: Alkyd- or acrylic-latex-based, interior wood undercoated, as recommended by the manufacturer for this substrate, applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 0.031 mm.
 - b) First and Second Coats: Semi gloss, acrylic-latex, interior enamel applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 0.066 mm.
 2. Full-Gloss, Alkyd-Enamel Finish: 2 finish coats over a wood undercoated.
 - a) Undercoat: Alkyd, interior enamel undercoated applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 0.031 mm.
 - b) First and Second Coats: Full-gloss, alkyd, interior enamel applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 0.061 mm.

- E. **Stained Woodwork:** Provide the following stained finishes over new, interior woodwork:
1. Alkyd-Based, Satin-Varnish Finish: 2 finish coats of an alkyd-based, clear-satin varnish over a sealer coat and an alkyd-based, interior wood stain. Wipe wood filler before applying stain.
 - a) Filler Coat: Paste-wood filler applied at spreading rate recommended by the manufacturer.
 - b) Stain Coat: Alkyd-based, interior wood stain applied at spreading rate recommended by the manufacturer.
 - c) Sealer Coat: Clear sanding sealer applied at spreading rate recommended by the manufacturer.
 - d) First and Second Finish Coats: Alkyd-based or polyurethane varnish, as recommended by the manufacturer, applied at spreading rate recommended by the manufacturer.
- F. **Zinc-Coated Metal:** Provide the following finish systems over zinc-coated metal:
1. Full-Gloss, Alkyd-Enamel Finish: One finish coat over an enamel undercoat and a primer.
 - a) Primer: Galvanized metal primer applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 0.031 mm.
 - b) Undercoat: Alkyd, interior enamel undercoat or semigloss, interior, alkyd-enamel finish coat, as recommended by the manufacturer for this substrate, applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 0.031 mm.
 - c) Finish Coat: Full-gloss, alkyd, interior enamel applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 0.031 mm.
- G. **Ferrous Metal:** Provide the following finish systems over ferrous metal:
1. Full-Gloss, Alkyd-Enamel Finish: two finish coat over a primer.
 - a) Primer: Interior ferrous-metal primer at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 0.031 mm.
 - b) Finish Coat: Full-gloss, alkyd, interior enamel applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 0.031 mm per coat.

H. **Ferrous Metal:** Provide the following finish systems over ferrous metal:

1. Full-Gloss, Epoxy-Based Enamel: Two finish coat over primer.
 - a) Primer: High-molecular-weight, epoxy-resin primer at spreading rate recommended by manufacturer.
 - b) Finish Coat: High-molecular-weight, epoxy-resin topcoat at spreading rate recommended by the manufacturer.

End of Section

7.8 - ACOUSTICAL CEILING

PART 1 – GENERAL

7.9.1.1 RELATED DOCUMENTS

- A. Drawing and general provision of the contract, including general and supplementary Conditions.

7.9.1.2 SUMMARY

- A. This Section includes acoustical tiles for ceilings and the following:
 - 1. Concealed and Semi-concealed suspension systems.
 - 2. Glass fiber acoustical tiles.
- B. Related Sections include the following:
 - 1. 9.0 Section "Acoustical Panel Ceilings" for ceilings consisting of glass-fiber-base acoustical panels and exposed suspension systems.
- C. Products furnished, but not installed under this Section, include anchors, clips, and other ceiling attachment devices to be cast in concrete at ceilings.

7.9.1.3 DEFINITIONS

- A. CAC: Ceiling Attenuation Class.
- B. LR: Light Reflectance coefficient.
- C. NRC: Noise Reduction Coefficient.

7.9.1.4 SUBMITTALS

- A. **Product Data:** For each type of product indicated.
- B. **Coordination Drawings:** Reflected ceiling plans drawn to scale and coordinating penetrations and ceiling-mounted items. Show the following:
 - 1. Ceiling suspension assembly members.
 - 2. Method of attaching hangers to building structure.
 - a) Furnish layouts for cast-in-place anchors, clips, and other ceiling attachment devices whose installation is specified in other Sections.
 - 3. Size and location of initial access modules for acoustical tile.
 - 4. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
 - 5. Minimum Drawing Scale: 1:50.
- C. **Samples for Initial Selection:** For components with factory-applied color finishes.
- D. **Samples for Verification:** For each component indicated and for each exposed finish required, prepared on Samples of size indicated below.
 - 1. Acoustical Tile: Set of full-size Samples of each type, color, pattern, and texture.
 - 2. Concealed Suspension System Members: 300-mm (12") long Sample of each type.
 - 3. Exposed Moldings and Trim: Set of 300-mm (12") long Samples of each type and color.
- E. **Qualification Data:** For testing agency.
- F. **Product Test Reports:** Based on evaluation of comprehensive tests performed by a qualified testing agency, for each acoustical tile ceiling.
- G. **Research/Evaluation Reports:** For acoustical tile ceiling and components and anchor type.
- H. **Maintenance Data:** For finishes to include in maintenance manuals.

7.9.1.5 QUALITY ASSURANCE

- A. **Quality System:** Comply with ISO 9001/9002 Quality System as a minimum.

Incorporate all the standard procedures supplied by the Consultant and the Employer.

- B. **Acoustical Testing Agency Qualifications:** An independent testing laboratory, or an NVLAP-accredited laboratory, with the experience and capability to conduct the testing indicated, as documented according to ASTM E 548. NVLAP-accredited laboratories must document accreditation, based on a "Certificate of Accreditation" and a "Scope of Accreditation" listing the test methods specified.
- C. **Source Limitations:**
 - 1. Acoustical Ceiling Tile: Obtain each type through one source from a single manufacturer.
 - 2. Suspension System: Obtain each type through one source from a single manufacturer.
- D. **Source Limitations:** Obtain each type of acoustical ceiling tile and supporting suspension system through one source from a single manufacturer.
- E. **Fire-Test-Response Characteristics:** Provide acoustical tile ceilings that comply with the following requirements:
- F. **Surface-Burning Characteristics:** Provide acoustical tiles with the following surface-burning characteristics complying with ASTM E 1264 for Class A materials as determined by testing identical products per ASTM E 84:
 - 1. Smoke-Developed Index: 450 or less.
- G. **Seismic Standard:** Provide acoustical tile ceilings designed and installed to withstand the effects of earthquake motions according to the following:
 - 1. CISCA's Recommendations for Acoustical Ceilings: Comply with CISCA's "Recommendations for Direct-Hung Acoustical Tile and Lay-in Panel Ceilings--Seismic Zones 0-2."
- H. **Mockups:** Build mockups to verify selections made under sample Submittals and to demonstrate aesthetic effects and qualities of materials and execution.
 - 1. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.
- I. **Preinstallation Conference:** Conduct conference at Project site to comply with requirements in 1.0 Section "Project Management and Coordination."

7.9.1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver acoustical tiles, suspension system components, and accessories to Project site in original, unopened packages and store them in a fully enclosed, conditioned space where they will be protected against damage from moisture, humidity, temperature extremes, direct sunlight, surface contamination, and other causes.
- B. Before installing acoustical tiles, permit them to reach room temperature and a stabilized moisture content.
- C. Handle acoustical tiles carefully to avoid chipping edges or damaging units in any way.

7.9.1.7 PROJECT CONDITIONS

- A. **Environmental Limitations:** Do not install acoustical tile ceilings until spaces are enclosed and weatherproof, wet work in spaces is complete and dry, work above ceilings is complete, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.

1. Pressurized Plenums: Operate ventilation system for not less than 48 hours before beginning acoustical tile ceiling installation.

7.9.1.8 COORDINATION

- A. Coordinate layout and installation of acoustical tiles and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

7.9.1.9 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 1. Acoustical Ceiling Units: Full-size units equal to 2.0 percent of quantity installed.
 2. Suspension System Components: Quantity of each concealed grid and exposed component equal to 2.0 percent of quantity installed.

PART 2 – PRODUCTS

7.9.2.1 ACOUSTICAL TILES, GENERAL

- A. **Acoustical Tile Standard:** Provide manufacturer's standard tiles of configuration indicated that comply with ASTM E 1264 classifications as designated by types, patterns, acoustical ratings, and light reflectances, unless otherwise indicated.
 - 1. Mounting Method for Measuring NRC: Type E-400; plenum mounting in which face of test specimen is 400 mm (16") away from test surface per ASTM E 795.
- B. **Acoustical Tile Colors and Patterns:** Match appearance characteristics indicated for each product type.
 - 1. Where appearance characteristics of acoustical tiles are indicated by referencing pattern designations in ASTM E 1264 and not manufacturers' proprietary product designations, provide products selected by Architect from each manufacturer's full range that comply with requirements indicated for type, pattern, color, light reflectance, acoustical performance, edge detail, and size.
- C. **Tile-Based Antimicrobial Treatment:** Provide acoustical tiles treated with manufacturer's standard antimicrobial solution that inhibits fungus, mold, mildew, and gram-positive and gram-negative bacteria.

7.9.2.2 NODULAR, CAST OR MOLDED, MINERAL-BASE ACOUSTICAL PANELS

- A. **Classification:** Provide panels complying with ASTM E 1264 for type, form, and pattern as follows:
 - 1. Type and Form: Type III, mineral base with painted finish; Form 1, nodular or Form 4, cast or molded according to manufacturer standard.
- B. **Composition:**
 - 1. Core: 100% glass wool treated with water repellent.
 - 2. Backing: Glass tissue bonded to backing.
 - 3. Surface Coating: Manufacturer's standard latex.
 - 4. Thickness: 20.00 mm.
- C. **Pattern and Color of Surface:** Smooth surface with microscopic holes, White color.
- D. **Size:** 600 x 600 mm.
- E. **Edge Condition:** Rabbeted to allow flush reveal ceiling to ASTM E 1264.
- F. **Particle Emission:** Low emission classification to an international classification system acceptable to the Consultant.
- G. **Fire burning Characteristics:** As specified in Clause 1.5 of the Section.
- H. **Acoustical Performance:**
 - 1. Reverberation Time: less than 0.60 second between 250-4000 Hz.
 - 2. Sound Absorption (ap): Not less than 0.80 between 250 - 4000 Hz to ISO 354 and ISO 11654.
 - 3. Noise Reduction Coefficient - 0.85 to ASTM C 423.
 - 4. Sound Insulation (R_w) - Not less than 35 dB room to room air borne sound insulation to ISO 14019.
 - 5. Moisture Resistant withstand minimum 95% relative humidity at 30 C without sagging, warp.
 - 6. Light Reflectance Not less than 84%.

7.9.2.3 METAL SUSPENSION SYSTEMS, GENERAL

- A. **Metal Suspension System Standard:** Provide manufacturer's standard metal suspension systems of types, structural classifications, and finishes indicated that comply with applicable requirements in ASTM C 635.
- B. **Finishes and Colors, General:** Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes. Provide manufacturer's standard factory-applied finish for type of system indicated.
 - 1. High-Humidity Finish: Comply with ASTM C 635 requirements for "Coating Classification for Severe Environment Performance" where high-humidity finishes are indicated.
- C. **Attachment Devices:** Size for five times the design load indicated in ASTM C 635, Table 1, "Direct Hung," unless otherwise indicated.
 - 1. Anchors in Concrete: Anchors of type and material indicated below, with holes or loops for attaching hangers of type indicated and with capability to sustain, without failure, a load equal to five times that imposed by ceiling construction, as determined by testing per ASTM E 488 or ASTM E 1512 as applicable, conducted by a qualified testing and inspecting agency.
 - a) Type: Postinstalled expansion anchors.
 - b) Corrosion Protection: Carbon-steel components zinc plated to comply with ASTM B 633, Class Fe/Zn 5 (0.005 mm) for Class SC 1 service condition.
- D. **Wire Hangers, Braces, and Ties:** Provide wires complying with the following requirements:
 - 1. Zinc-Coated Carbon-Steel Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper.
 - 2. Size: Select wire diameter so its stress at three times hanger design load (ASTM C 635, Table 1, "Direct Hung") will be less than yield stress of wire, but provide not less than 3.5-mm diameter wire.
- E. **Hanger Rods and Flat Hangers:** Mild steel, zinc coated or protected with rust-inhibitive paint.
- F. **Angle Hangers:** Angles with legs not less than 22 mm (1") wide; formed with 1-mm thick, galvanized steel sheet complying with ASTM A 653/A 653M, G90 (Z275) coating designation; with bolted connections and 8-mm (3/8") diameter bolts.
- G. **Seismic Struts:** Manufacturer's standard compression struts designed to accommodate lateral forces.
- H. **Seismic Clips:** Manufacturer's standard seismic clips designed and spaced to secure acoustical tiles in-place.

7.9.2.4 METAL SUSPENSION SYSTEM FOR ACOUSTICAL TILE CEILING

- A. **Direct-Hung, Single-Web Suspension System:** Main and cross runners roll formed from and capped with cold-rolled steel sheet, pre-painted, electrolytic zinc coated, or hot-dip galvanized according to ASTM A 653/A 653M, Z90 coating designation.
 - 1. Structural Classification: Heavy duty system.
 - 2. Access: Downward and end or side pivoted, with initial access openings of size indicated below and located throughout ceiling within each module formed by main and cross runners, with additional access available by progressively removing remaining acoustical tiles.
 - 3. Initial Access Opening: In each module as indicated on Drawings or approved

shop drawings.

7.9.2.5 METAL EDGE MOLDINGS AND TRIM

- A. **Roll-Formed Sheet-Metal Edge Moldings and Trim:** Type and profile indicated or, if not indicated, manufacturer's standard moldings for edges and penetrations that fit acoustical tile edge details and suspension systems indicated; formed from sheet metal of same material and finish as that used for exposed flanges of suspension system runners.
 1. For circular penetrations of ceiling, provide edge moldings fabricated to diameter required to fit penetration exactly.
- B. **Extruded-Aluminum Edge Moldings and Trim:** Where indicated, provide manufacturer's extruded-aluminum edge moldings and trim of profile indicated or referenced by manufacturer's designations, including splice plates, corner pieces, and attachment and other clips, complying with the following requirements:
 1. **Aluminum Alloy:** Alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, and with not less than the strength and durability properties of aluminum extrusions complying with ASTM B 221 (ASTM B 221M) for alloy and temper 6063-T5.
 2. Finish designations prefixed by AA comply with system established by the Aluminum Association for designating aluminum finishes.
 3. **Baked-Enamel Finish:** AA-C12C42R1x (Chemical Finish: cleaned with inhibited chemicals; Chemical Finish: acid-chromate-fluoride-phosphate conversion coating; Organic Coating: as specified below). Apply baked enamel complying with paint manufacturer's written instructions for cleaning, conversion coating, and painting.
 - a) Organic Coating: Thermosetting, enamel primer/topcoat system with a minimum dry film thickness of 0.8 to 1.2 mils (0.02 to 0.03 mm).

7.9.2.6 ACOUSTICAL SEALANT

- A. **Acoustical Sealant for Exposed and Concealed Joints:** Manufacturer's standard non-sag, paintable, non-staining latex sealant complying with ASTM C 834 and effective in reducing airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E 90.
- B. **Acoustical Sealant for Concealed Joints:** Manufacturer's standard nondrying, non-hardening, non-skinning, non-staining, gunnable, synthetic-rubber sealant recommended for sealing interior concealed joints to reduce airborne sound transmission.

PART 3 – EXECUTION

7.9.3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, including structural framing and substrates to which acoustical tile ceilings attach or abut, with Installer present, for compliance with requirements specified in this and other Sections that affect ceiling installation and anchorage and with requirements for installation tolerances and other conditions affecting performance of acoustical tile ceilings.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

7.9.3.2 PREPARATION

- A. **Testing Substrates:** Before installing adhesively applied tiles on wet-placed substrates such as cast-in-place concrete or plaster, test and verify that moisture level is below tile manufacturer's recommended limits.
- B. Measure each ceiling area and establish layout of acoustical tiles to balance border widths at opposite edges of each ceiling. Avoid using less-than-half-width tiles at borders, and comply with layout shown on reflected ceiling plans.

7.9.3.3 INSTALLATION, SUSPENDED ACOUSTICAL TILE CEILINGS

- A. **General:** Install acoustical tile ceilings to comply with ASTM C 636 and seismic requirements indicated, per manufacturer's written instructions and Cisca's "Ceiling Systems Handbook."
- B. Suspend ceiling hangers from building's structural members and as follows:
 - 1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structure or of ceiling suspension system.
 - 2. Splay hangers only where required to miss obstructions; offset resulting horizontal forces by bracing, counters playing, or other equally effective means.
 - 3. Splay hangers only where required and, if permitted with fire-resistance-rated ceilings, to miss obstructions; offset resulting horizontal forces by bracing, counters playing, or other equally effective means.
 - 4. Where width of ducts and other construction within ceiling plenum produces hanger spacing's that interfere with location of hangers at spacing's required to support standard suspension system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards and publications.
 - 5. Secure wire hangers to ceiling suspension members and to supports above with a minimum of three tight turns. Connect hangers directly either to structures or to inserts, eye screws, or other devices that are secure and appropriate for substrate and that will not deteriorate or otherwise fail due to age, corrosion, or elevated temperatures.
 - 6. Secure flat, angle, channel, and rod hangers to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices that are secure and appropriate for both structure to which hangers are attached and type of hanger involved. Install hangers in a manner that will not cause them to deteriorate or fail due to age, corrosion, or elevated temperatures.
 - 7. Do not support ceilings directly from permanent metal forms or floor deck. Fasten hangers to cast-in-place hanger inserts, postinstalled mechanical or adhesive anchors, or power-actuated fasteners that extend through forms into concrete.
 - 8. Do not attach hangers to steel deck tabs.
 - 9. Do not attach hangers to steel roof deck. Attach hangers to structural members.
 - 10. Space hangers not more than 1200 mm (48") o.c. along each member supported directly from hangers, unless otherwise indicated; provide hangers not more than 200 mm from ends of each member.

- C. Secure bracing wires to ceiling suspension members and to supports with a minimum of four tight turns. Suspend bracing from building's structural members as required for hangers, without attaching to permanent metal forms, steel deck, or steel deck tabs. Fasten bracing wires into concrete with cast-in-place or post installed anchors.
- D. Install edge moldings and trim of type indicated at perimeter of acoustical tile ceiling area and where necessary to conceal edges of acoustical units.
 - 1. Apply acoustical sealant in a continuous ribbon concealed on back of vertical legs of moldings before they are installed.
 - 2. Screw attach moldings to substrate at intervals not more than 400 mm (16") o.c. and not more than 75 mm (3") from ends, leveling with ceiling suspension system to a tolerance of 3.2 mm in 3.66 m (10 ft). Miter corners accurately and connect securely.
 - 3. Do not use exposed fasteners, including pop rivets, on moldings and trim.
- E. Install suspension system runners so they are square and securely interlocked with one another. Remove and replace dented, bent, or kinked members.
- F. Arrange directionally patterned acoustical tiles as follows:
 - 1. As indicated on reflected ceiling plans.
- G. Install acoustical tiles in coordination with suspension system and exposed moldings and trim. Place splines or suspension system flanges into kerfed edges so tile-to-tile joints are closed by double lap of material.
 - 1. Fit adjoining tile to form flush, tight joints. Scribe and cut tile for accurate fit at borders and around penetrations through tile.
 - 2. Hold tile field in compression by inserting leaf-type, spring-steel spacers between tile and moldings, spaced 300 mm (12") o.c.
 - 3. Protect lighting fixtures and air ducts to comply with requirements indicated for fire-resistance-rated assembly.

7.9.3.4 **CLEANING**

- A. Clean exposed surfaces of acoustical tile ceilings, including trim and edge moldings. Comply with manufacturer's written instructions for cleaning and touchup of minor finish damage. Remove and replace tiles and other ceiling components that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage.

End of Section

7.10 - PERFORATED METAL CEILING

- A. Aluminum Clip-in tiles ceiling in white standard powder coated finish as produced by Thermec Engineering Co. or similar approved. Beveled edge linear ceiling system ideally suited for large halls where quick and complete access to the void above is required.

B. **Design**

Rectangular, modular aluminum units in size 300 x 1200 x 0.7 mm thick with long sides beveled and combined with the square unit ends to achieve the linear effect.

C. **Suspension System**

Galvanized steel metal suspension system consisting of spring tee runners, splices, edge trim and 8SWG wire hanger with adjustment clips etc. The suspenders shall be fixed to the soffit with nylon anchors and 1 ½ x No.12 round head steel screw.

D. **Perforation**

Perforation patterns in various hole sizes give a combination of perfect acoustic properties and aesthetic appearance. Tile shall be perforated with 1.8 mm holes.

E. **Acoustic Felt**

To achieve optimal acoustics, acoustic felt is bonded to the reverse side of the units. Acoustic felt also prevents any dust fall-out from perforated ceiling types. Acoustic felt is available in three colours. The units shall be provided with a factory applied Soundtex (Germany) high sound absorption acoustic felt in black colour.

F. **Material**

Ceiling panels are produced from steel coils on roll-forming plant. Uniformity must be assured.

G. **Quality**

Ceiling units must be produced to Quality Management System approved by Lloyd's Register in accordance with ISO 9002.

MEASUREMENT AND PAYMENT

- A. Payment for all the items under this section shall be made at the Unit rates entered in the BOQ appended to the contract and in accordance with the applicable conditions of the contract.

End of Section

7.11 - RAISED ACCESS FLOOR SYSTEM

A raised floor or access floor system comprises of load bearing floor panels laid in a horizontal grid supported by adjustable vertical pedestals to provide an under floor space for the housing and distribution of services.

A. ACCESSABILITY

The floor panels are readily removable to allow quick access to the under floor services for installation and maintenance. Space allows for ever increasing volume of power, data and telecom services and is often used as a large duct for HVAC system.

1. CEMENT CORE RAISED ACCESS FLOORING

These are robust lightweight panels comprising of a hollow shell made of a flat top and profiled steel base welded together and filled with a foam cemented base core.

Cement core panels are available in 600x600 x35mm size module.

A. COVERING

Top surface can be Carpet Tile, Wooden Flooring or Vinyl Tiles as per requirement; however these can also be used without any cover.

B. PEDESTALS AND STRINGERS

Pedestals made of galvanized steel with levelling provision. Pedestals are connected through stringer made of Galvanized pipes and concealed screws for perfect fit. Heavy Duty European standard EN 12825 of Ultimate, Concentration & Rolling Loads Class 6 as manufactured and provided by The Protectors or similar approved.

C. TECHNICAL DATA

a) PANEL

- Floor panel without HPL finish - 600X600X35mm, steel plate and cementitious infill, top steel-SPCC, bottom steel-ST14

b) SUBSTRUCTURE

- Flat head pedestal – 600mm, top 75X75X3mm, base 95X95X2mm, tube 25X1.2mm, galvanized steel, base plate dowelled by expansion bolt
- Stringer – 570X21X32mm
- Construction height as per design.

c) LOAD VALUES

- Concealed load: 3560N
- Tested acc. To DIN EN 12825, class 6
- Impact load: ≥536N
- Unlimited load: ≥10680N

- Rolling load: 10 times 3560N & 10000 times 2670N
- Distribution load: 16100 N/m²
- d) **FIRE RATING** 2 HRS

2. WOOD CORE HPL RAISED ACCESS FLOORING

This panel construction comprises of a high density particle board core that is encase by galvanized steel laminated to the particle board by a structural polyurethane or epoxy resin adhesive.

Wood core HPL panels are available in 600x600 x40mm size module.

A. COVERING

These panels are supplied with a factory applied HPL (high pressure laminate) finish in two standard colours, grey-white and wooden; however top surface can be Carpet Tile, Wooden Flooring or Vinyl Tiles as per requirement.

B. PEDESTALS AND STRINGERS

Pedestals made of galvanized steel with levelling provision. Pedestals are connected through stringer made of Galvanized pipes and concealed screws for perfect fit. Heavy Duty European standard EN 12825 of Ultimate, Concentration & Rolling Loads Class 6 as manufactured and provided by The Protectors or similar approved.

C. TECHNICAL DATA

a) PANEL

- Floor panel - 600X600X40mm, coated with HPL, under side: coated with 0.3mm galvanized steel sheet, panel material: 38mm Chipboard

b) SUBSTRUCTURE

- Flat head pedestal – 600mm, top 75X75X3mm, base 95X95X2mm, tube 25X1.2mm, galvanized steel, base plate dowelled by expansion bolt
- Stringer – 540X20X30mm
- Construction height as per design.

c) LOAD VALUES

- Concealed load: 3560N
- Tested acc. To DIN EN 12825, class 6
- Impact load: ≥536N
- Unlimited load: ≥10680N
- Rolling load: 10 times 3560N & 10000 times 2670N
- Distribution load: 16100 N/m²

d) FIRE RATING 1 HRS

3. MEASUREMENT AND PAYMENT

- B. Payment for all the items under this section shall be made at the Unit rates entered in the BOQ appended to the contract and in accordance with the applicable conditions of the contract.

End of Section

7.12 - CARPET TILE

1.1 GENERAL

- A. Submittals: Submit Product Data for each type of carpet tile material and the following:
 - 1. Shop Drawings showing carpet tile type, color, and dye lot; type of subfloor; pile direction; and type, color, and location of insets and borders.
 - 2. Samples of each type of carpet tile required.
 - 3. Schedule of carpet tile using same room designations indicated on Drawings.
 - 4. Maintenance data for carpet tile to include in the operation and maintenance manual.
- B. Carpet Tile Surface Flammability: Passes CPSC 16 CFR, Part 1630.
 - 1. Critical Radiant Flux Classification: Class I, not less than 0.45 W/sq. cm per ASTM E 648.
 - 2. Critical Radiant Flux Classification: Class II, not less than 0.22 W/sq. cm per ASTM E 648.
 - 3. Flame Spread: 25 or less per ASTM E 84.
 - 4. Smoke Developed: 450 or less per ASTM E 84.
- C. Project Conditions: Comply with CRI 104, Section 6: "Site Conditions."
- D. Subfloor Moisture Conditions: Moisture emission rate of not more than 3 lb/1000 sq. ft./24 hours (14.6 kg/1000 sq. m/24 hours) when tested by calcium chloride moisture test in compliance with CRI 104, 6.2.1, with subfloor temperatures not less than 55 deg F (12.7 deg C).
- E. Subfloor Alkalinity Conditions: A pH range of 5 to 9 when subfloor is wetted with potable water and pHydron paper is applied.
- F. Furnish full-size carpet tile units equal to 5 percent of amount installed, packaged with protective covering for storage, and identified with labels clearly describing contents, before installation begins.

1.2 PRODUCTS

- A. Available Products: Subject to compliance with requirements, products that may be incorporated in the Work include, but are not limited to, the products specified in each carpet tile Product Data sheet at end of this Section.
- B. Products: Subject to compliance with requirements, provide one of the products specified in each carpet tile Product Data sheet at end of this Section.
- C. Concrete-Slab Primer: Nonstaining type as recommended by carpet tile manufacturer.
- D. Trowelable Underlayments and Patching Compounds: As recommended by carpet tile manufacturer.
- E. Adhesives: Water-resistant, mildew-resistant, nonstaining type to suit products and subfloor conditions indicated and to comply with flammability requirements for installed carpet tile as recommended by carpet tile manufacturer.

1.3 EXECUTION

- A. Verify that subfloors and conditions are satisfactory for carpet tile installation and comply with requirements specified in this Section and those of carpet tile

- manufacturer.
- B. Level subfloor within 1/4 inch in 10 feet (6 mm in 3 m), noncumulative, in all directions.
 - 1. Use leveling and patching compounds to fill cracks, holes, and depressions in subfloor as recommended by carpet tile manufacturer.
 - C. Remove subfloor coatings, including curing compounds, and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone.
 - D. Broom or vacuum clean subfloors to be covered with carpet tile. Following cleaning, examine subfloors for moisture, alkaline salts, carbonation, or dust.
 - E. Concrete-Subfloor Preparation: Apply concrete-slab primer, according to manufacturer's directions, where recommended by carpet tile manufacturer.
 - F. Wood-Subfloor Preparation: Apply wood-floor sealer, according to manufacturer's directions, where recommended by carpet tile manufacturer.
 - G. Resilient-Flooring Substrate Preparation: Replace missing pieces of existing resilient flooring or patch to level as recommended by carpet tile manufacturer.
 - H. Terrazzo-Subfloor Preparation: Patch grout lines and cracks to level with latex underpayment as recommended by carpet tile manufacturer.
 - I. Installation: Comply with CRI 104, Section 13: "Carpet Modules (Tiles)."
 - J. Install borders parallel to walls.
 - K. Protection: Comply with CRI 104, Section 15: "Protection of Indoor Installation."

1.4 **MEASUREMENT AND PAYMENT**

- C. Payment for all the items under this section shall be made at the Unit rates entered in the BOQ appended to the contract and in accordance with the applicable conditions of the contract.

End of Section

7.13 - RESILIENT FLOOR TILE

PART 1 GENERAL

1.1 RELATED DOCUMENTS

Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

1.2.1 This Section includes the following:

- Rubber floor tile

1.2.2 Related Sections include the following:

- Division 9 Section "Resilient Athletic Flooring" for resilient floor tile for use in athletic activity pr support areas.
- Division 9 Section "Static-Control Resilient Floor coverings" for resilient floor tile
designed to control electrostatic discharge (ESD).

1.3 SUBMITTALS

Product Data	:	For each type of product indicated
Samples for Initial Selection	:	For each type of product indicated.
Samples for Verification	:	Full-size units of each color and pattern of resilient floor tile required.
Maintenance Data	:	For resilient products to include in maintenance manuals.

1.4 QUALITY ASSURANCE

1.4.1 Fire-Test-Response Characteristics: Provide products identical to those tested for fire exposure behavior per test method indicated by a testing and inspecting agency acceptable to authorities having jurisdiction.

1.4.2 Technical Data

Material	Recycled rubber particles molded with a custom formulated solvent free pure MDI polyurethane binder
Properties "	Water permeable, resilient, durable, slip proof, insulating, flexible, frost proof, non-flammable, non-toxic, sound deadening
Thickness	15mm, 20mm, 25mm, 45mm, and 60mm
Sound Absorption	Approx. 5Db
Flammability	DIN 51960 Class 1
Slip Resistance	95 (dry) 65 (wet)
Abrasion Resistance	- after air aging 0.10 (gr.) - after water aging 0.36 (gr.) - after artificial weathering 0.20 (gr.)
Residual Indentation	0.64mm after recovery
Fatigue Resistance	No cracking or fracture
Resistance to Ozone	No cracking or fracture
Infiltration Rate	25mm - approx. 180mm / hr 45mm - approx. 285mm / hr

1.5 DELIVERY, STORAGE. AND HANDLING

- 1.5.1 Store resilient products and installation materials in dry spaces protected from the Weather, with ambient temperature maintained within range recommended by manufacturer, but not less than 50 deg F (10 deg C) or more than 90 deg F (32 deg C). Store files on flat surfaces.

1.6 PROJECT CONDITIONS

1.6.1 Maintain temperatures within range recommended by manufacturer, but not less than

70°F, or more than 95°F, in spaces to receive floor tile during the following time periods.

- 48 hours before installation
- During installation
- 48 hours after installation

1.6.2 After post installation period, maintain temperatures within range recommended by manufacturer, but not less than 55°F, or more than 95°F.

1.6.3 Close spaces to traffic during floor covering installation.

1.6.4 Install resilient products after other finishing operations, including painting, have been completed.

1.7 EXTRA MATERIAL

1.7.1 Furnish extra materials described below that match products installed and that are

packaged with protective covering for storage and identified with labels describing contents.

- Floor Tile: Furnish 1 box for every 50 boxes or fraction thereof, of each type, color, and pattern of floor tile installed.

PART 2 PRODUCTS

2.1.1 MANUFACTURERS

2.1.1 Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the products listed in other Part 2 articles.

2.1.2 Products: Subject to compliance with requirements, provide one of the products listed in other part articles.

2.2 COLORS AND PATTERNS

2.2.1 Colors and Patterns: As selected by Architect from manufacturer's full range.

2.3 INSTALLATION MATERIALS

2.3.1 **Trowel able leveling and Patching Compounds:** Latex modified, Portland cement based or blended hydraulic cement based formulation provided or approved by resilient product manufacturer for applications indicated.

2.3.2 **Adhesives:** Water-resistant type recommended by manufacturer to suit resilient products and substrate conditions indicated.

- 2.3.3 **Metal Edge Strips:** Extruded aluminum with mill Finish of width shown, of height required to protect exposed edges of tiles, and in maximum available lengths to minimize running joints.

PART 3 EXECUTION

3.1 EXAMINATION

- 3.1.1 Examine substrates with Installer present, for compliance with requirements for installation tolerances, moisture control, and other conditions affecting performance.

- 3.1.1.1 Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of resilient products.

- 3.1.1.2 Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- 3.2.1 Prepare substrates according to manufacturer's written recommendations to ensure adhesion of resilient products.

- 3.2.2 **Concrete Substrates:** Prepare according to ASTM F 710.

- 3.2.2.1 Verify that substrates are dry and free of curing compounds, sealers, and hardeners.

- 3.2.2.2 **Alkalinity and Adhesion Testing:** Perform tests recommended by manufacturer. Proceed with installation only after substrates pass testing.

- 3.2.2.3 **Moisture Testing:**

- Perform anhydrous calcium chloride test, ASTM F 1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of 3 lbs of water/1000 sq. ft. in 24-hours.
- Perform tests recommended by manufacturer. Proceed with installation only after substrates pass testing.

- 3.2.3 Remove substrate coatings and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by manufacturer. Do not use solvents.

- 3.2.4 Access Flooring Panels: Remove film of oil or other coating using method recommended by access flooring manufacturer.

- 3.2.5 Use trowel able leveling and patching compound to fill cracks, holes, and depressions in substrates.

- 3.2.6 Move resilient products and installation materials into spaces where they will be installed at least 48-hours in advance of installation.

- Do not install resilient products until they are same temperature as space where they are to be installed.

- 3.2.7 Sweep and vacuum clean substrates to be covered by resilient products

immediately before installation. After cleaning, examine substrates for moisture, alkaline sales, carbonation, and dust. Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 **TILE INSTALLATION**

- 3.3.1 Layout tiles from center marks established with principal walls, discounting minor offsets, so

files at opposite edges of room are of equal width. Adjust as necessary to avoid using cut widths that equal less than one-half tile at perimeter.

- Lay tiles in pattern indicated.

- 3.3.2 Match tiles for color and pattern by selecting tiles from cartons in the same sequence as manufactured and packaged, if so numbered. Discard broken, cracked, chipped or deformed tiles.

Lay tiles in pattern of colors and sizes indicated.

- 3.3.3 Scribe, cut, and fit tiles to butt neatly and tightly to vertical surfaces and permanent fixtures including built-in furniture, cabinets, pipes, outlets edgings, door frames, thresholds, and nosing.

- 3.3.4 Extend tiles into toe spaces, door reveals, closets, and similar openings.

- 3.3.5 Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on floor tiles as marked on substrates. Use chalk or other non-permanent, constraining marking, device.

- 3.3.6 Install tiles on covers for telephone and electrical ducts and similar items in finished floor areas. Maintain overall continuity of color and pattern with pieces of tile installed on covers. Tightly adhere tile edges to substrates that abut covers and to cover perimeters.

- 3.3.7 Adhere tiles to flooring substrates using a full spread of adhesive applied to substrate to produce a completed installation without open racks, voids, raising and puckering at joints, telegraphing of adhesive spreader marks, and other surface imperfections.

3.4 **CLEANING AND PROTECTION**

- 3.4.1 Perform the following operations immediately after completing resilient product installation:

- 3.4.1.1 Remove adhesive and other blemishes from exposed surfaces.

- 3.4.1.2 Sweep and vacuum surfaces thoroughly.

- 3.4.1.3 Damp-mop surfaces to remove marks and soil.

- Do not wash surfaces until after time period recommended by manufacturer.

- 3.4.2 Protect resilient products from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period. Use protection methods recommended in writing by manufacturer.

- 3.4.3 Apply protective floor polish to horizontal surfaces that are free from soil, visible adhesive and surface blemishes if recommended in writing by manufacturer.

- 3.4.3.1 Use commercially available product acceptable to manufacturer.

- 3.4.3.2 Coordinate selection of floor polish with Owner's maintenance service.
- 3.4.4 Cover products installed on horizontal surfaces with un-dyed, untreated building paper until Substantial Completion.
- 3.4.5 Do not move heavy and sharp objects directly over surfaces. Place hardboard or plywood panels over flooring and under objects while they are being moved. Slide or roll objects over panels without moving panels.

PART 4 MEASUREMENTS AND PAYMENT

- A. Payment for all the items under this section shall be made at the Unit rates entered in the BOQ appended to the contract and in accordance with the applicable conditions of the contract.

END OF SECTION

8 SPECIALITIES

8.1 - TOILET AND BATH ACCESSORIES

PART 1 – GENERAL

1.1.1.1 RELATED DOCUMENTS

Drawing and general provisions of the contract, including general and supplementary Conditions.

1.1.1.2 SUMMARY

- This Section includes the following:
- Toilet and bath accessories.
- Warm-air dryers.
- Related Sections include the following:
 - o Section "Ceramic Tile" for ceramic toilet and bath accessories.

1.1.1.3 SUBMITTALS

- A. Product Data: Include construction details, material descriptions and thicknesses, dimensions, profiles, fastening and mounting methods, specified options, and finishes for each type of accessory specified.
- B. Samples: For each accessory item to verify design, operation, and finish requirements.
 1. Approved full-size Samples will be returned and may be used in
 2. the Work.
 3. Setting Drawings: For cutouts required in other work; include templates, substrate preparation instructions, and directions for preparing cutouts and installing anchoring devices.
 4. Product Schedule: Indicating types, quantities, sizes, and installation locations by room of each accessory required. Use designations indicated in the Toilet and Bath Accessory Schedule and room designations indicated on Drawings in product schedule.
 5. Maintenance Data: For accessories to include in maintenance manuals specified in 1.0 section. Provide lists of replacement parts and service recommendations.

1.1.1.4 QUALITY ASSURANCE

- A. Product Options: Accessory requirements, including those for materials, finishes, dimensions, capacities, and performance, are established by specific products indicated in the Toilet and Bath Accessory Schedule.
- B. Products of other manufacturers listed in Part 2 with equal characteristics, as judged solely by Consultant, may be provided.
- C. Other manufacturers' products with equal characteristics may be considered.
 - See 1.0 Section "Substitutions."
- D. Do not modify aesthetic effects, as judged solely by Consultant, except with
- E. Consultant's approval. Where modifications are proposed, submit comprehensive explanatory data to Consultant for review.

1.1.1.5 **COORDINATION**

- A. Coordinate accessory locations with other work to prevent interference with clearances required for access by disabled persons, proper installation, adjustment, operation, cleaning, and servicing of accessories.
- B. Deliver inserts and anchoring devices set into concrete or masonry as required to prevent delaying the Work.

1.1.1.6 **WARRANTY**

- A. General Warranty: Special warranty specified in this Article shall not deprive Employer of other rights Employer may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.
- B. Manufacturer's Mirror Warranty: Written warranty, executed by mirror manufacturer agreeing to replace mirrors that develop visible silver spoilage defects within minimum warranty period indicated.
- C. Minimum Warranty Period: 15 years from date of Substantial Completion.

PART 2 – PRODUCTS

8.1.2.1 **MATERIALS**

- A. Stainless Steel: ASTM A 666, Type 304, with No. 4 finish (satin), in 0.8-mm minimum nominal thickness, unless otherwise indicated.
- B. Brass: ASTM B 19, leaded and unleaded flat products; ASTM B 16M, rods, shapes, forgings, and flat products with finished edges; ASTM B 30, castings.
- C. Sheet Steel: ASTM A 366/A 366M, cold rolled, commercial quality, 0.9-mm minimum nominal thickness; surface preparation and metal pretreatment as required for applied finish.
- D. Galvanized Steel Sheet: ASTM A 653/A 653M, Z180.
- E. Chromium Plating: ASTM B 456, Service Condition Number SC 2 (moderate service), nickel plus chromium electrodeposited on base metal.
- F. Baked-Enamel Finish: Factory-applied, gloss-white, baked-acrylic-enamel coating.
- G. Mirror Glass: as per requirements of 8.0, section "Mirrored Glass".
- H. Galvanized Steel Mounting Devices: ASTM A 153/A 153M, hot-dip galvanized after fabrication.
- I. Fasteners: Screws, bolts, and other devices of same material as accessory unit, tamper and theft resistant when exposed, and of galvanized steel when concealed.

8.1.2.2 **FABRICATION**

- A. General: Names or labels are not permitted on exposed faces of accessories. On interior surface not exposed to view or on back surface of each accessory, provide printed, waterproof label or stamped nameplate indicating manufacturer's name and product model number.
- B. Surface-Mounted Toilet Accessories: Unless otherwise indicated, fabricate units with tight seams and joints, and exposed edges rolled. Hang doors and access panels with continuous stainless-steel hinge. Provide concealed anchorage where possible.
- C. Recessed Toilet Accessories: Unless otherwise indicated, fabricate units of all-

welded construction, without mitered corners. Hang doors and access panels with full-length, stainless-steel hinge. Provide anchorage that is fully concealed when unit is closed.

- D. Mirror-Unit Hangers: Provide mirror-unit mounting system that permits rigid, tamper- and theft-resistant installation, as follows:
 - 1. One-piece, galvanized steel, wall-hanger device with spring-action locking mechanism to hold mirror unit in position with no exposed screws or bolts.
 - 2. Heavy-duty wall brackets of galvanized steel, equipped with concealed locking devices requiring a special tool to remove.
 - 3. Keys: Provide universal keys for internal access to accessories for servicing and resupplying. Provide minimum of six keys to Employer's representative.

PART 3 – EXECUTION

8.1.3.1 INSTALLATION

- A. Install accessories according to manufacturers' written instructions, using fasteners appropriate to substrate indicated and recommended by unit manufacturer. Install units level, plumb, and firmly anchored in locations and at heights indicated.
- B. Secure mirrors to walls in concealed, tamper-resistant manner with special hangers, toggle bolts, or screws. Set units level, plumb, and square at locations indicated, according to manufacturer's written instructions for substrate indicated.

8.1.3.2 ADJUSTING AND CLEANING

- A. Remove temporary labels and protective coatings.
- B. Clean and polish exposed surfaces according to manufacturer's written recommendations.

8.1.3.3 TOILET AND BATH ACCESSORY SCHEDULE

- A. Toilet Tissue Dispenser (Toilet Paper Holder): Provide toilet tissue dispenser complying with the following:
 - 1. Type Single-roll dispenser.
 - 2. Mounting: Surface mounted with concealed anchorage.
 - 3. Material: Stainless steel
 - 4. Operation: Noncontrol delivery with mfr's standard spindle.
 - 5. Capacity: Designed for standard diameter-core tissue rolls up to 140 mm (6") diameter (800 sheets)
- B. Soap Dish: Stainless steel size and shape as selected by the Consultant from manufacturer's standard range.
- C. Soap Dispenser: Provide soap dispensers complying with the following:
 - 1. Liquid Soap Dispenser, Vertical-Tank Type: Wall mounted type, minimum 1182.9 ml capacity tank with stainless steel piston, springs, and internal parts designed to dispenses soap in measured quantity by pump action, and stainless-steel cover with unbreakable window-type refill indicator.
 - a) Mounting: Designed for wall mounting.
 - b) Soap Valve: Designed for dispensing soap in liquid form.
- D. Paper Towel Dispenser: 800 multi-hold towels capacity, stainless steel, surface mounted.
- E. Robe Hook
 - 1. Stainless steel.

2. Double-prong with rectangular wall bracket and back plate for concealed mounting.

F. Grab Bar

1. Surface mounting, exposed.
2. Stainless steel.
3. 38 mm (1.5") outside diameter and 1.20 mm minimum wall thickness and 38 mm (1.5") distance from inside of bar and face of wall.
4. Furnish complete with two end flanges, 3 mm (2/16") thick minimum and 76 mm (3") diameter, each of three countersunk screw holes for attachment to walls.

5. Use of flanges with snap covers is acceptable.

G. Warm-Air Dryer: Provide warm-air dryer complying with the following:

1. Touch-Button-Activated Hand Dryer: Surface-mounted, warm-air hand dryer activated by touch button and with manufacturers' standard, white-painted metal cover and 30-second-timed power cut-off switch.

8.2 - TERMITE CONTROL

PART 1 – GENERAL

- A. General provisions of the Contract, including Conditions of Contract apply to this Section.

8.9.3.1 SUMMARY

- B. This Section includes the following for termite control:
 - 1. Termite prevention
 - 2. Soil treatment
 - 3. Wood protection

8.9.3.2 TERMITE PREVENTION

- A. Avoid creation of conditions that invite termites wherever possible. Take the following measures:
 - 1. Remove stumps, roots, wood, and other cellulose materials from the building site before commencing construction.
 - 2. Remove cellulose materials from around the foundation before final backfill.
 - 3. Promptly remove form boards and grade stakes used in construction from site.
 - 4. Allow no contact between building woodwork and soil or fill material.
 - a) Locate exterior woodwork a minimum of 15 cm above ground and beams in crawl spaces at least 45 cm above ground to provide ample space to make future inspections.
 - b) Make foundation areas accessible for inspection if possible.
 - c) If wood that contacts the soil, such as fence posts and foundation elements, use pressure treated wood.
 - 5. Design ventilation openings in foundations to prevent dead air pockets and to help keep the ground dry.
 - 6. Direct water away from the structure through proper grading.
 - 7. Assure that the roof drainage system directs all water away from the foundation.
 - 8. Avoid plantings near the foundation. Any tree that has the potential to grow to a height of 12 meters or taller shall not be planted within 15 meters of the foundation.

8.2.1.3 DEFINITIONS

- A. EPA: United States Environmental Protection Agency.
- B. PMP: Pest Management Professional

8.2.1.4 SUBMITTALS

- A. Product Data: For termiticide and borate.
 - 1. Include the EPA-Registered Label for termiticide and borate products.
- B. Product Certificates: For termite control products, signed by product manufacturer.
- C. Qualification Data: For Installer of termite control products.
- D. Soil Treatment Application Report: After application of termiticide is completed, submit report for Owner's record information, including the following:
 - 1. Date and time of application.

2. Moisture content of soil before application.
 3. Brand name and manufacturer of termiticide.
 4. Quantity of undiluted termiticide used.
 5. Dilutions, methods, volumes, and rates of application used.
 6. Areas of application.
 7. Water source for application.
- E. Wood Treatment Application Report: After application of borate is completed, submit report for Owner's record information, including the following:
1. Date and time of application.
 2. Brand name and manufacturer of borate.
 3. Quantity of undiluted borate used.
 4. Dilutions, methods, volumes, and rates of application used.
 5. Areas of application.
- F. Warranty: Special warranty specified in this Section.

8.2.1.5 **QUALITY ASSURANCE**

- A. Applicator Qualifications: A PMP who is licensed according to regulations of authorities having jurisdiction to apply termite control treatment in jurisdiction where Project is located and who is experienced and has completed termite control treatment similar to that indicated for this Project and whose work has a record of successful in-service performance.
- B. Regulatory Requirements: Formulate and apply termiticide, and label with a US EPA registration number, to comply with EPA regulations and authorities having jurisdiction.
- C. Document any applicable local codes or authorities and ensure that all relevant work is in compliance.
- D. Implement applicable provisions of the Quality Control program as established in:
 - Section 01401, "Contractor Quality Control."

8.2.1.6 **PROJECT CONDITIONS**

TERMITE CONTROL SECTION 02361 - 3

- A. Environmental Limitations: To ensure penetration, do not treat soil that is water saturated or frozen. Do not treat soil while precipitation is occurring. Comply with EPA-Registered Label requirements and requirements of authorities having jurisdiction.

8.2.1.7 **COORDINATION**

- A. Coordinate soil treatment application with excavating, filling, and grading and concreting operations. Treat soil under footings, grade beams, and ground-supported slabs, before construction.

8.2.1.8 **WARRANTY**

- A. Warranty: Written warranty, signed by applicator and Contractor certifying that termite control work, consisting of applied soil termiticide treatment, will prevent infestation of subterranean termites. If subterranean termite activity or damage is discovered during warranty period, retreat soil and repair or replace damage caused by termite infestation.

- B. Warranty Period: Five years from date of Substantial Completion.

PART 2 – PRODUCTS

8.2.2.1 TERMITICIDES

- A. Soil Termiticide: Provide an EPA-registered termiticide complying with requirements of authorities having jurisdiction, in a soluble or amusable, concentrated formulation that dilutes with water or foaming agent, and formulated to prevent termite infestation for review and acceptance by the COR.
1. The Department of State currently authorizes Termidor and Premise as soil termiticide.
 2. Provide quantity required for application at the label volume and rate for the maximum termiticide concentration allowed for each specific use, according to the product's EPA Registered Label.
- B. Wood Protection Termiticide:
1. Provide an EPA-registered termiticide complying with requirements of authorities having jurisdiction, in a soluble or emulsible, concentrated formulation that dilutes with water or foaming agent, and formulated to prevent termite infestation for review and acceptance by COR.
 2. The Department of State currently authorizes Timber and Bora Care for preventive wood treatment.
 3. Provide quantity required for application at the label volume and rate for the maximum termiticide concentration allowed for each specific use, according to the product's EPA Registered Label.
 4. Protect vegetation from contact with Timber and Bora Care.

END OF SECTION

Approved List of Manufacturers

No	Product	Manufacturer / Supplier by Approved List
1	Cement	Falcon, Attock & Lucky
2	Steel / structural steel	Razzaq, Amreli, Abbas
3	Water Stoper	Matrix, Aquafin
4	Fiber (for concrete)	BASF, Fospak
5	Water Proofing	Pak Hy Oil, Aquafin, BASF, Sika, Bituthene & Resichem
6	Blocks	Bes Block, Concrete Concept, Prime crete, Izhar
7	Precast Item	Envicrete, Hubcrete, Finecrete, Izhar
8	Insulation	Knauf, Pakistan Insulation
9	Gypsum board	DFB Gypsum, Elephant
10	Cement Board	DFB Gypsum, Framacad
11	Porcelain/Ceramic Tiles	Imperial, Granito, Benitoz, Floorissa
12	Ceramic Industrial Tiles	National Tiles
13	Aluminum	Pak. Cable, Krudsons, Gulf Extrusion, Arabian Extusion, APC, Alubond, alfa Engineering
14	Paint, Varnishes	ICI, Berger, Nippon, Kansai, Jotun,
15	Lamination Sheet	Wilson Art, Formite, Al-Noor
16	Glass	Pilkington, Emirates, Saint-Gobain
17	Lamination Board	Popular, Balochistan Lamination, Formite
18	Door lock, Iron mongery,	Yele (Italy), Bonoco, Newstar, Kale (Turky), Star, Dorma, Hager
19	Special floor finish/ coatings	Sika, Fosroc, BASF
20	Roller Shutter	Protector, MIT, or equivalent
21	Raised Floor	Protector, MIT, or equivalent

CORRIDOR LIGHTING & MV DISTRIBUTION

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SECTION – E – 1

SPECIFICATION FOR MATERIALS AND EQUIPMENT

GENERAL:

This Technical Specification refers to the Corridor Lighting and Medium Voltage distribution Electrical Services, to be supplied and installed in BRTS – Green Line Karachi Project and adjacent roads.

The Contract shall include the supply of equipment and materials installation, completion, testing and commissioning of the individual components of electrical system and finally the complete installation of electrical system in accordance with the conditions of contract, specifications, drawings, bill of quantities and as per applicable International Codes & Standards.

General Electrical Requirements

The Contractor shall carry out all the work in accordance with the specification and in conformity with the Electricity Act and Rules as adopted in PAKISTAN and the latest edition of the British Standard Specifications and Wiring Rules of the Institute of Electrical Engineers (London) hereinafter referred to as the (I.E.E. Wiring Rules). Where these specifications differ from the rules stated, these specifications shall be followed:

The entire electrical installation/work shall be carried out by the licensed contractor, authorized to undertake such work under the provisions of Electricity Act and The Electricity Rules as adopted and modified up to date by the Government of PAKISTAN. The licensed contractor must be registered with PAKISTAN Engineering Council (PEC).

Any special requirements of the Local Electrical Inspector shall be complied with by the contractor, and all works shall be to the entire satisfaction of the Government Inspector/Engineer / Power Supply provided (KE).

The Contractor shall be responsible for completing all formalities and submitting the test certificates as per prevailing rules and regulations and shall have the installation passed by the Government Electric Inspector of that region and by Power supply authorities (KE).

If during preparation of the bid, the Contractor finds any error /discrepancies /omission / ambiguity/ uncertainty that need clarification, the same shall be referred to the consultant.

- a. Any installation not complying with the specification shall be corrected/ replaced
- b. It shall be the responsibility of the Contractor to protect equipment and materials (installed or stored) from damage till final taking over by the Employer.
- c. The materials shall be purchased from approved supplier / manufacturer.
- d. The Contractor shall produce comprehensive documentation of individual testing, calibration and installation together with an overall record of the state of completion to the client as per tender conditions.

- e. It will be the responsibility of the Contractor to coordinate between other agencies and client shall accommodate other utilities/services.
- f. The work shall be carried out in accordance with the B.S.S, I.E.C and I.E.E. Rules and Regulations as adopted in PAKISTAN, to satisfy the requirements of the client.
- g. The Contractor shall ensure at his own cost the permanent availability of this specification, drawings and Contract agreement on site.
- h. The quantities set out in the bill of quantities are the estimated quantities and they shall not be taken as actual and correct quantities of work to be executed by the Contractor. The Contractor shall carry out work as per approved drawings.

ELECTRICAL EQUIPMENT AND MATERIALS

- a. The Contractor shall supply all materials, tools, plants, equipment, scaffolding, hardware, supports and fixing as necessary to complete the installation satisfactorily.
- b. All material and equipment supplied by the Contractor shall be new and in all respects conform to the high standards of Engineering design, workmanship, performance, quality and function as here in specified and fully meet the quality level and requirements of the specifications and shall be purchased from approved sources.
- c. The Contractor shall be solely responsible for ensuring proper functional requirements of various equipment.
- d. Where any materials in the Contractor's supply are specified on the drawings or in Bill of Quantities, the same shall form part of the specification.
- e. Where equipment, materials or articles are referred to in the specifications as "Equal to" any particular standard, the choice and approval of the same shall rest with the client.
- f. Approval of the Contractor's supplied equipment / installation works shall not relieve the Contractor of any of his obligations or liabilities under the Contract, except insofar as provided under the conditions of the Contract.
- g. The Contractor shall supply all small installation and consumable materials without any extra cost such as nuts, bolts, washers, shims, angles, levelling materials, insulation tape, PVC strap-on or heat shrinkable type cable tags, cable ties, bushes, sealing compound, AVO meter, electrical testing and measuring instruments, etc., and all such other material not listed in BOQ, required for complete installation as intended by the specification and scope of works.

CODES AND STANDARDS

- a. The latest published rules British Standards (BS), International Electro Technical Commission (IEC), Institute of Electrical Engineers (IEE) and National Standards. Rules and Regulations of Provincial/Local Authorities shall be considered included as part of these specifications and all their requirements shall be fully met.

- b. The entire installation shall be free from improper grounds, open and short circuit faults. Tests shall be made in accordance with Section “E” of IEE Regulations for the electrical equipment of building 17th Edition. Each panel shall be tested with mains connected to the riser, branches connected, switches off, all fixtures in place and permanently connected, and lamps removed or omitted, sockets and wall switches closed. Each individual power line shall be tested with the power equipment connected for proper and intended operation. In no case shall the insulation resistance be less than that allowed by the Regulations for electrical equipment of buildings and manufacturer’s recommendations based on British standards. Failure shall be corrected in a manner satisfactory to the client.
- c. It shall be the responsibility of the Contractor to test all systems of the entire electrical installation as well as those installations where sequence in operation is required. The electrical contractor shall test for proper sequence and the consultant shall leave the entire electrical installation in satisfactory working condition.
- d. The Contractor shall guarantee that the electrical systems including all components and accessories used therein are free of all grounds, shorts and open circuit faults, defective workmanship and materials.

ALTERATIONS

The location of various items indicated on the drawings are presumed to be approximately correct, but it is to be understood, however, that the small scale drawings are necessarily diagrammatic and that such locations as are shown, are subject to slight revision, the work is in progress or equipment is installed, which may be necessary to accommodate local construction condition or interference with other services. No major changes shall be made without the approval in writing of the client. On obtaining client approval, the position of any point may be altered without extra charge being made. The location of poles/LCP shown in the systematic plans should be considered as approximately correct.

PROTECTION

The Contractor shall effectively protect the work from damage during and as may be necessary, after installation and he shall likewise protect adjoining work of other trades from damage resulting from installation of electrical work.

OPERATION AND MAINTENANCE MANUALS

The contractor shall submit the operation & maintenance manual for all equipments, which were supplied by vendors. The completion of document and preparing a comprehensive manual shall be the responsibility of contractor.

DRAWING AND DATA TO BE FURNISHED BY THE CONTRACTOR

- a) **Shop Drawings:** The location, routing and installation heights of the equipment etc., which are given on the detailed approved drawings, are approximate. These drawings depict only the position of various fixtures and outlets. All the detailed planning for electrical system including conduit routes etc. shall be carried out well in advance of the actual execution of work, by the Contractor to the satisfaction of the client. For this purpose the Contractor shall prepare three (3) sets of “Shop drawings” prior to installation duly coordinated with other services and submitted to the client for approval.

- b) **As-built Drawings:** Clearly annotated As-Built electrical drawings and diagrams shall be maintained up to date on site on completion of the project. Contractor shall submit four (4) sets of “**As built**” drawings to the client after completion of works.

SECTION – E – 2

15 KV, MEDIUM VOLTAGE CABLE

1.0 SCOPE

The work under this section consists of supplying, installing, testing and commissioning of all material and services of Medium Voltage cable and accessories as specified herein or as stated on the drawings and 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 MV cables.

The Medium Voltage cable with accessories shall also comply with the General Specifications for Electrical Works Section- 1 and with other relevant provisions of the Tender Documents.

2.1 GENERAL

The 15kV MV cable shall be three core, Aluminium conductor, cross-linked polyethylene (XLPE) insulated, shielded, armoured as per requirements and overall sheathed. It shall be suitable for indoor and outdoor use in the transmission and distribution of electrical energy.

The cables shall be capable of operating continuously at a conductor temperature of not less than 90°C and shall be suitable for 8.7/15 kV, 50 Hz in three phase grounded system in accordance with IEC 60502.

The cable shall be treated for vermin proofing and be protected against rodents during storage, laying.

2.2 APPLICABLE STANDARD / CODES

The following standards and codes shall be applicable for the materials within the scope of this Section:

- IEC 60502** - Extruded solid electric insulated power cable for rated voltage from 1 kV to 30 kV.
- IEC 60540** - Test methods for insulation and sheaths of electric cables and cords.
- IEC 60228** - For resistance of conductors.
- IEC 60332-1** - For flame retardant test.
- IEC 60332-3** - For fire resistant test on fire resistant cables.
- IEC 60227** - For core identification by colours.

2.3 MATERIAL

2.3.1 15kV Cable

The cable shall meet the following specifications:

Nominal/System Voltage	-	11 kV
Frequency	-	50 Hz
Conductor Size	-	Sq.mm. As given in BOQ,
Number of Cores	-	3
Rated Voltage	-	8.7 / 15kV
Continuous operating Temperature of conductor	-	90 °C
Conductor material	-	Aluminium stranded
Insulation	-	Cross-linked polyethylene (XLPE)
Shielding	-	Aluminium tape
Jacket	-	PVC
Armouring	-	Galvanized steel wire
Over sheathing	-	Extruded PVC
Phase identification	-	Red, Yellow, Blue

2.3.2 Conductor

The conductors shall be of high conductivity electrolytic Aluminium, stranded in accordance with specified standard.

2.3.3 Insulation

The insulation shall be cross-linked polyethylene extruded over the conductor. The insulation shall be laid to avoid any gap/air pockets between the conductor and insulation. The insulation colour red, yellow and blue for phase identification by providing tape.

The insulation shall be easy to strip from individual conductors and to separate for jointing/termination purposes.

2.3.4 Shielding

Each core shall be shielded by a layer of semi-conducting material applied directly over the insulation. The semi-conducting insulation shall be covered by a bare copper tape applied with suitable overlapping.

Phase identification tape of red, yellow and blue colours shall be wrapped over the copper shield.

2.3.5 Assembly

The three insulated conductors shall be assembled with PVC or any non-hydroscopic filler and bounded with tape. The tape binder shall then be covered with extruded PVC jacket. The PVC jacket shall be padded with a suitable material before application of armour.

2.3.6 Armour

Armouring shall be provided with single layer of galvanized steel wire to provide cable protection and also act as a low resistance earth return path. The armouring shall be covered with binder tape. The armour shall be of appropriate size to carry the system fault current.

2.3.7 Over sheath

The entire cable assembly shall be covered with a PVC jacket of thickness not less than 2.5 mm. The colour of the jacket shall be black.

Embossed marking on the over sheath at 3 meters intervals shall give the following information:

- **Name of Manufacturer**
- **Year of Manufacture**
- **Size of cable in sq.mm.**
- **Voltage grade**
- **Type of cable i.e. Al., XLPE/SWA/PVC**
- **Project/ Client name (if required)**

2.3.8 Factory Tests

Physical and electrical acceptance tests in accordance with applicable standard shall be carried out at the manufacturer works in the presence of Engineer. Three copies of test reports will be furnished to the Engineer, which shall include brief description of tests, test records and results.

The tests shall include, but not limited to, the followings:

- AC High Voltage Test
- Partial Discharge Test
- DC Resistance Test

2.3.9 Termination Kits

Cold shrink Termination kits for 15 kV cable shall be indoor/outdoor type as per requirement and recommended by cable manufacturer and as approved by Engineer. The termination kits shall be complete with all materials including boots etc.,.

2.3.10 Cable Accessories

All cable accessories shall be provided for the complete cabling system without any additional cost unless specifically mentioned in BOQ. These shall include but not limited to the items such as saddles, clamps, fixing channels, connectors, clips, lugs, tapes, solder identification tags, bushes, glands etc.

2.3.11 Cable Reels

The cable shall be supplied in non-returnable, mechanically strong, rail/ road worthy, wooden or metallic cable drums, protected against weather. The cable drum should bear the markings for cable type, cable size, voltage grade, year of manufacture, name of manufacturer, direction of unreeling, and any other additional marking normally provided by the manufacturer. Cable ends on cable reels shall be protected by means of suitable seal.

2.3.12 Cable Markers

Above ground cable markers made of Grade-25 reinforced concrete shall be erected at a maximum interval of 200 metres along the straight trench, at each bend and joint box for indicating the presence of underground cables. Where the trench changes its direction two number of markers shall be installed one in each direction to indicate the two directions of the trench. At the joint box, additionally a symbol shall be engraved just beneath the letters MV to indicate the presence of the joint box.

The cable markers shall be finished in grey paint. The letters and symbols for indication shall be engraved in concrete on both sides. Letters shall be MV for medium voltage or low voltage cable. The colour of the engraved letters and symbol shall be black. The dimensions of the markers shall be as shown on the drawing and shall be installed in the ground as shown.

2.4 INSTALLATION

2.4.1 General

All installation material, labour, tools and accessories for cable installation shall be furnished by the Contractor. The cable and accessories shall be installed as described in these Specifications, drawings and in accordance with manufacturer's instructions.

Necessary precautions for safety of cables shall be taken during the laying of cables to avoid scratches/ cuts to the cable surface. Pulling force on cable at all times shall remain well within the manufacturer's recommended limits.

The exact cut lengths for cable shall be confirmed by the Contractor by actual measurements at site prior to the commencement of manufacturing. The cable lengths where shown on the drawing are tentative and only for general guidance. The Contractor shall be solely responsible for furnishing correct lengths of cable to avoid joints in cable length except where necessary, after obtaining approval of the Engineer.

Prior to installation of jointing and termination kits, the cable lengths shall be checked and tested to ensure that the cables are in sound condition, and no damage has been done during handling and installation. After the MV cable and jointing/termination kits are installed,

it shall again be tested prior to commissioning and in accordance with recommendations of standard to which the cable is manufactured. All protective pipes/ sleeves shall be plugged to attain the same after installation.

SECTION – E – 3

LOW VOLTAGE CABLES AND WIRES

1.0 GENERAL

This item shall consist of supplying, laying, testing, connecting and commissioning of all material and services of Low Voltage (LV) cables and wires and the accessories according to the specifications, bill of quantities, drawings and/or as directed by the Engineer. The Cables shall be supplied from the approved supplier, as specified in approved manufacture list for the LV cables.

The Contractor shall discuss the electrical layout with client and coordinate at site with others for exact route, location and positions of LV cables.

The LV Works shall comply with requirements of relevant IEC and British Standards, the LV cables and wires with accessories shall also comply with the requirements of BOQ Item.

All cables shall be certified by the manufacturer as suitable for installation in Pakistan.

All materials shall be procured from approved Vendor. Only products with a proven record of performance, efficiency and long life will be considered for approval.

All works, equipment and materials shall comply with statutory and other regulations, Codes of Practice and Standards current at the date of Tender.

2.0 MATERIAL REQUIREMENTS

All multicore and single core wires shall be as per Bill of Quantities. All single and three core sheathed cables shall be of 450 / 750 volt grade. Power cables for main feeders, main to sub main feeders, power equipment, etc., armored or unarmored shall be of 600 / 1000 volts grade. Armoring of cables shall be done with appropriate size galvanized steel wire as per codes.

The conductors shall be stranded, high conductivity, soft annealed copper. Conductor of single core cables shall be circular, whereas of multicore cables may be circular or shaped according to standard practices and codes. The PVC insulation shall be extruded with a PVC compound having good flexibility, resistance to aging and ability to withstand the ambient temperatures.

All the cables shall be suitable for operation in 400 / 220 Volts; 50 Hz three phase multiple neutral and Earthed Distribution System. The Electrical cable should be suitable for direct burial, for installation in air or running in the ducts/conduits. The maximum Ambient Temperature shall be 50°C.

3.0 Standards

Particular reference shall be made to:

- BS 6004 / 6346 PVC insulated cables for lighting and power.
- BS 6746 PVC insulation for electrical cables.
- BS 6360 Copper conductors
- BS 6500 Insulated flexible cords.

Any other standard referred to in above standards or these specifications

4.0 CONSTRUCTION REQUIREMENTS

The lighting and control cables shall be furnished and installed in accordance with the routes and requirements shown on the drawings.

The Voltage grade of the multi core LV Power cables shall be of 600/1000 volts.

All multi core cables shall be provided with identifications colour scheme, i.e. red, yellow, blue for phases and black for neutral. The insulated earth continuity conductors shall be having Green or green Yellow colour.

The ends of each length of multicore armored or un-armored cables shall be properly marked for clockwise and anti clock-wise sequence of core colors.

The armoured cables shall comprise of shaped stranded copper conductor, PVC insulated taped bedding, galvanized steel wire armour and PVC over sheath.

The insulation resistances of the cables shall conform to the relevant British Standard and these specifications.

All cable accessories shall be provided for the complete cabling and wiring system without any additional cost, unless specifically mentioned in BOQ. These shall include but not limited to the items such as saddles, clamps, fixing channels, connectors, cable joints (where necessary and approved by the Engineer), clips, lugs, tapes, solder, identification tags, bushes, Cable glands, etc.

Embossed marking on the over sheath at 3 meters intervals shall give the following information:

- Name of Manufacturer
- Year of Manufacture
- Size of cable in sq.mm.
- Voltage grade
- Type of cable i.e. Cu., PVC/SWA/PVC
- Project/ Client name (if required)

5.0 INSTALLATION OF LV CABLES

Cable shall be laid as shown on the drawing, if the laying is effected by others utility services, the contractor shall test the cable characteristics insulation and continuity, of all phases and these shall communicate in a report to the Engineer/Client.

If cable is crossing the road extra protection of bricks, uPVC pipe class “D’ other than mentioned in underground cable laying detail shall be provided.

The cables shall be spaced by categories along their entire length as well as upon penetration into buildings and in their interiors, according to their following rated voltages:

- 30 cm at least between a cable carrying 1 kV – 30kV and other cables.
- 20 cm at least between a cable carrying voltages between 50V - 500V, and any power or control
- 10 cm at least between a cable carrying voltages lower than 50V and telephone or these possible being grouped.

All installation material, labor, tools and accessories for cable installation shall be furnished by the Contractor. The cable and accessories shall be installed as described in accordance with these specifications, drawings and manufacturer's instructions.

6.0 INSTALLATION OF LV CABLES LAID DIRECT IN THE GROUND / PIPE

All the cables shall be laid in the trenches/duct according to the drawings or as directed by the Engineer. For burial of cables in ground, the following instruction shall be followed:

- a) The Contractor shall plan and take special care to prevent any damage to existing underground facilities such as underground piping, cables, foundations, etc. The Contractor shall notify the client of any obstruction encountered and shall provide protective support or removal of such obstructions as instructed by the client. Excavation adjacent to existing facilities, such as foundations manholes, ducts, underground pipelines and paving shall be braced and / or shored properly to protect those facilities during excavation and construction or elsewhere as designated, they shall be drawn into underground pipe ducts.

Where cables

- ❖ cross roads or other paved areas with vehicular access
- ❖ cross unpaved areas regularly used by vehicles
- ❖ Pass through corrosive soils.

A steel draw wire or nylon or polypropylene cord shall be inserted in each duct run immediately after its installation. A 2m surplus shall be left at each end of each run, neatly coiled and attached to a cross bar preventing the wire or cord from being drawn into the duct.

Underground pipe ducts shall be Heavy gauge un-plasticized PVC conduits with tapered sleeve or spigot and socket joints.

All ducts shall have a nominal internal diameter of 100 mm unless designated otherwise.

All dual systems shall be installed so that no undue strain is placed on cables when pulled in.

All underground cable ducts shall so far as possible, be run in straight lines.

Duct runs crossing roads shall be straight and, wherever possible, perpendicular to the axis of the road.

Except in the case of short isolated duct runs such as road crossings, underground cable duct runs shall terminate in draw pits.

Cable ducts passing under roads carrying heavy vehicles shall be completely surrounded with lean concrete to a minimum radial thickness of 150 mm.

Ducts shall be laid so as to drain naturally towards one or both ends, where adequate provision of drainage shall be made. Adequate precautions shall be taken to prevent the cable duct system acting as storm water or ground water drainage system. A minimum fall of 1 in 200 shall be provided for drainage purposes.

Any work carried out requiring the use of split ducts shall be carried out in such a manner as to preserve the withdraw ability of the cables concerned.

If two or more cables are to be installed in the same duct, the aggregate of their cross sectional areas shall not exceed 30% of the cross-sectional area of the duct.

All trenches excavated for the laying of cable ducts shall be completely backfilled and rammed before cable installation work begins.

Immediately following the installation of any duct run, the interior of the duct shall be thoroughly cleaned by twice drawing through the ducts a suitable brush once in each direction. Following this, the ends of each run shall be sealed with a suitable hardwood or plastic sealing plug which shall be left in position until cable laying is about to begin.

Before any cables are installed in the ducts, each duct shall be proved by drawing through it a polished hardwood mandrel 300 mm long having spherical ends and a diameter 6mm less than the nominal duct diameter.

Sufficient slack shall be left in cables for this purpose that cut lengths of cables shall allow about 3% more in the measured lengths between terminations.

Cables, whether installed underground or in concrete trenches, shall not be bent to a radius less than 12 times the diameter of the cable or as recommended by the cable manufacturer, whichever is higher.

All cables shall be marked at least at each end, switch gear and equipment termination, where cable enter or leave underground cable trenches or channels, where cable rises from one level to another, at 30M intervals with predetermined identification numbers, by means of proprietary non-deteriorating type, PVC, heat shrinkable, strap-on type or equivalent, for the identification of cable and circuit. These shall be indelibly marked with cable number and securely fixed to the cable. Where conductors are left to be terminated by another party or left to be connected later, they shall be identified. The earth continuity conductor shall be laid in the trench with the cables. When crossing road the cable must be drawn through pipes, which should extend upto the unpaved area..

- b) Low voltage cables shall be laid in PVC conduit at a depth of not less than 900 mm or as shown on the drawings. For external cabling, trenches shall be excavated as per the details shown on the drawings or as directed by the Engineer.
- c) The bottom of the trench shall be covered with clean sand or soft soil of minimum 100 mm thickness before laying the cables. After laying the cables they shall be covered with clean sand. The clean sand shall be placed well punned over and around the cables to a level of 100 mm above the uppermost cable. Mechanical punnets shall not be used. Protective cable tiles shall be carefully covered over each cable as per drawing. Polyethylene warning tapes with danger sign shall be laid below 300mm of finished ground level along the route of buried cables.

- d) It is the responsibility of the Contractor to take actual measurements of cable length, required between two termination points, as per drawings and site conditions and install single length of cables without joints of any nature.

7.0 CABLE TERMINATION AND JOINTS

Cables shall be terminated in a safe, neat and approved manner at the associated equipment, included that erected by others.

Compression type connectors (lugs) shall be of the correct size and approved type for the conductors concerned. Compression tools shall be used for installation of Lugs. After compression, the conductor and terminal shall form a solid mass ensuring good conducting properties and mechanical strength. The Engineer or his representative before use must approve the compression jointing system used throughout the installation.

The Contractor shall be responsible for all drilling and if necessary, tapping entries where these have not been provided by others.

When preparing cables prior to fitting glands, the gland manufacturer's instructions for cable preparation shall be observed. In all cases where armored cables are used, care shall be taken to ensure that the lay of the armor is maintained after the gland is completely fitted.

Termination and joints shall be suitably insulated for the voltage of the circuits in which they are used.

Every compression joint shall be of a type, which has been the subject of a test certificate as described in BS 4579.

Cable ends, which are not terminated immediately after cutting, shall be sealed effectively to prevent ingress of moisture and shall be protected from damage until termination.

For all cables in section, if a substantial mechanical clamp is not provided a compression type lug or socket shall be provided. At all equipment, cable shall be installed and terminated so that no strain is imposed on the cable or gland and due allowance made to counter the effect of vibration. At all termination, an ample length of 'tail' shall be left.

Where joints in cable conductors and bare conductors are required, they shall be mechanically and electrically sound and they shall be accessible for inspection. Joints in non-flexible cables shall be made either by soldering or by means of mechanical clamps or compression type socket, which shall securely retain all the wires of the conductors.

Any joint in flexible cable shall be affected by means of cable coupler. Cable couplers and connectors shall be mechanically and electrically sound and shrouded in metal, which can be earthed. Where the apparatus to be connected require earthing every cable coupler shall have adequate provision for maintaining earth continuity.

SECTION – E – 4

LOW VOLTAGE (LV) LIGHTING CONTROL PANEL (LCP)

1.0 GENERAL

The work under this section consists of design, manufacturing, fabricating, supplying, installing, connecting, testing and commissioning of all material and services of the complete indoor and outdoor type LV, Lighting Control Panel (LCP) as specified herein and shown on drawings and stated in Bill of Quantities.

2.0 APPLICABLE STANDARDS / CODES

The latest editions of the following standards and codes shall be applicable for the materials specified within the scope of this Section:

BS 4752-1	-	Triple Pole Moulded Case Circuit Breaker
IEC 60947	-	Low Voltage Switchgear and Control Gear
IEC 60439	-	Factory Built Assemblies of LV Switchgear
IEC 60475-2	-	Switchgear & Control Gear for Voltages up to & including 1 kV
BS 88	-	HRC Fuses
IEC 60073	-	Colors for indicator lights and push buttons
IEC 60446	-	Identification of insulated / bare conductors

Any other standard referred to in above standards or these specifications.

3.0 INSTALLATION AND SERVICE CONDITIONS

Outdoor LCP for rehabilitation shall be installed on pole and indoor LCP for BRT corridor shall be installed on surface as per drawing. The equipment shall be capable of operation under the prevailing ambient conditions without any deleterious effect of any kind. Distribution board shall be suitable for continuous operation at full load rating under combined variation of both voltage and frequency.

Transient voltage depression down to 80% of rated voltage shall not affect the performance of the equipment.

4.0 ROAD LIGHTING CONTROL PANEL CONSTRUCTION

The outdoor Lighting Control Panel shall be sheet steel fabricated, suitable for pole mounting, totally enclosed, dead front, dust tight and vermin proof requiring front access only. It shall be complete in all respects with material and accessories, factory assembled, tested and finished all according to the specifications and to normal requirements. For outdoor installations, the international classification shall be IP65.

The LCP with all components and accessories shall be suitable for front operation only and shall:

- Have a rated service short service-breaking capacity, as per BOQ, conforming to IEC 60157- 1, category P2 unless otherwise stated on the drawings.

- Be suitable for 400 / 230 Volts, 3 phase 4 wires, 50 Hz.
- Have incoming and outgoing cable termination arrangement, terminal block / line up terminals.
- Be provided with wiring diagram on inside of the door.
- Have all incoming and outgoing connections from top and / or bottom according to site requirements.

5.0 ACCESSIBILITY

Distribution Board shall preferably be arranged for bottom cable entries. Adequate space must be provided for cable entries and termination.

Adequate space shall be provided for installation and clamping of cables inside the Distribution Board. Position of terminals and cables shall allow use of clamp ammeter.

Power and Control cable termination shall avoid obstruction to other cable termination and provide easy access for terminating cables. Cable supports shall be provided to avoid undue strain on cable termination. Easily accessible locations shall be reserved in the compartment for measuring transformers.

6.0 MECHANICAL DESIGN

6.1 General Construction

The enclosure of the LCP shall be fabricated from electro-galvanized / zinc coated sheet steel.

The LV outdoor LCP shall be fabricated with 15 SWG sheet steel. All components shall be installed on a common component mounting plate made of 14 SWG sheet steel inside the enclosure and protected from the front with screwed sheet steel front plate. The door and dead front covers shall be made of 14 SWG sheet steel. The door shall be fully gasketed with hinges on the left-hand side and locking handle on the right hand side for fastening the door. The locking handle should be detachable. The dead / front assembly shall be fastened to the enclosure by means of self - locating fasteners for quick and easy fixing.

The indoor Lighting Control Panel shall be fabricated with 16 SWG sheet steel surface mounting as approved by the Engineer. All the components shall be installed on a common component mounting plate inside the enclosure and protected from the front with screwed sheet steel front plate. The enclosure shall be provided with rubber gasketing and a lockable hinged door with cam fastener. The Control Panel should have adequate space and well design for installing lighting control relays as per drawing.

The LCP shall be supplied complete with all installation materials as recommended by the manufacturer. The incoming and outgoing cable connections shall be according to the wiring requirements. If required, an adapter box for accommodating the cables and conduits may be provided. The box shall be of the same material and finish as the Distribution Boards. An earth bar or terminal strips shall be provided for connection of incoming and outgoing earth conductors. The earth bar or terminals shall be permanently connected to the body of LCP at two points. Flexible copper strip shall be provided for earthing of the door of Distribution Board.

Neutral bus assembly shall consist of outgoing screw terminals with one terminal for each MCB. All holes, cut outs, etc., shall be tool or jib manufactured and free from burrs and rough edges. Removable gland plates shall be provided at both the top and / or bottom, as required.

The cabling inside the LCP shall be suitably numbered and harnessed by means of straps or cords. Wiring to door mounted components shall be in flexible PVC conduit. All indicating, control and selecting equipment shall be suitably arranged and clearly labeled with indelible labels indicating the rating of fuses, switches, etc.

All metal work of the distribution board shall be cleaned down to bare shining metal, phosphated and the surfaces chemically prepared for powder coating. Then these shall be coated with powder of color RAL 7032 and then baked in oven. The thickness of powder coating shall not be less than 120 microns.

6.2 LABELING

On the front side, a nameplate shall be provided at the top to indicate the name of manufacturer, system voltage and frequency and the current carrying capacity of switchboard.

Each breaker shall have a circuit identification label fitted below the breaker aperture or as suitable.

Drawing indicating the branch circuit names, breaker elements, cable sizes and connecting services shall be placed in a clear plastic pocket provided at the back of the front access. Labels described shall have block letters 7 mm high on a white background, to be made from trifoliate and be fixed with screws.

Each incoming and outgoing circuit shall also be labeled with nameplate 75 mm x 15 mm, as described above on the front side of door.

The Distribution Board shall be supplied fitted with warning labels.

7.0 COMPONENT OF LV, LIGHTING CONTROL PANEL

The LV, LCP shall be provided with all components as specified or shown on the Drawings and as necessary for the satisfactory operation of the LCP and of the electrical system. Typical specifications are given hereunder:

7.1 BUS BARS

Bus bars shall be made of 99.9% high conductivity hard drawn electrolytic tinned copper, completely isolated and mechanically braced and rated to withstand the specified fault level.

Bus bars shall be clearly marked with their respective colors and these shall be red, yellow and blue for phases and white for neutral. The earth bus bar shall be green. Bus bars shall be provided for three phases, neutral and multi- terminal earth. The temperature rise shall not exceed 45 degree centigrade at rated current. Neutral bus assembly shall consist of outgoing screw terminals with one terminal for every MCCB / MCB.

Horizontal bus bars shall be of the same current rating throughout their length.

7.2 MOLDED CASE CIRCUIT BREAKER

These shall be triple pole 400/500 volts or single phase 250 volts of current rating shown on the drawings. The breakers shall have both time delay over current and instantaneous short circuit protection.

The MCCBs shall be installed such that their switching levers are accessible through the dead front plate for operation. Circuit numbers / designation on all circuits shall be conspicuously marked to facilitate connection and maintenance.

The triple pole MCCBs shall have short circuit rupturing capacity suitable for distribution system as approved by the Engineer or as shown on the drawings. The MCCBs shall be suitable for lighting and power circuits.

The breaker shall have quick make - quick break toggle mechanism with positive 'ON', 'OFF' and intermediate 'Tripped' positions.

Trip mechanism shall be trip free on overload or short circuit ensuring that the breaker will not close / remain close even if the close command is given while the circuit breaker has tripped due to short circuit or continuing overload.

7.3 AIR BREAK CONTACTORS

The contactors shall be air break, triple pole, 400 VAC and suitable for the type of duty to be performed. The main contacts shall be silver tipped, butt type with double break per pole. Each contactor shall be provided with single phase 230 VAC operating coil, one 5 watt 230 Volt red color signaling lamp, control fuse and two normally open and two normally closed auxiliary contacts wired up to terminals for electrical interlocking.

7.4 CURRENT TRANSFORMERS

Current transformers shall comply with the requirements of IEC 60185 (or equivalent).

Current Transformers shall be polyester resin insulated, ring type, air-cooled having transformation ratio as indicated on the drawings. The Current Transformers shall be of suitable burden having accuracy class 1.0. The Current Transformers shall have rated secondary current 5A / 1A as required.

Current Transformers shall mechanically and thermally withstand the specified short circuit capacity.

7.5 PILOT LAMPS

Distribution Board shall be provided with phase indicating pilot lamps. The lamps shall be rated for 230 volts supply and suitable for flush mounting. The front of the lamps shall have colored rosettes for identification of phases.

7.6 LINEUP TERMINALS

Line up terminals wherever provided for Control or Power circuits shall be suitable for voltage and size of conductors as indicated on drawings. The Line up terminals for controls shall be suitable for channel mounting. All necessary accessories such as end plates, fixing clips, transparent label holder caps and label sheets with marking shall be provided.

7.7 AC VOLT METERS/AMPERE METERS

Shall be Digital type and shall be suitable for flush mounting on front door of the LV Switchboards. The front dimensions shall be as per standard. The voltmeters shall have 3-1/2 digit, 0.55 inch display.

7.8 VOLTMETER SELECTOR SWITCH:

The voltmeter reading shall be RY-YB-BR-OFF-RN-YN-BN positions.

7.9 SECONDARY WIRING

All wiring shall be copper conductor, thermoplastic insulated, at least 1.5 sq. mm flexible, neatly arranged and clipped in-groups.

Each conductor and its termination are to be identified and marked with numbered ferrules. All live terminals are to be shrouded.

Secondary wiring for Current Transformers shall be carried out with not less than 2.5-sq. mm. Terminals shall be specially marked to avoid opening of the circuit by accident.

7.10 TIMER SWITCH FOR STREET LIGHTING CONTROL

Timer Switch Operated shall be suitable for automatically switching street light ON & OFF. It should be possible to put it in service for any required time within 24 hours. The operating voltage shall be 220 volts between phase neutral, 50 cycle / Sec.

7.11 DAY LIGHT SWITCH FOR STREET LIGHTING CONTROL

The street lighting circuits shall be controlled by photo-electric daylight sensitive switches. The Day light Switch shall be suitable for automatically switching street light ON & OFF.

The operational level shall be factory preset for "ON" at a light level of approximately 54 lux and "OFF" at approximately 100 lux. Voltage variations shall not materially affect the operational levels.

A time delay of not less than 15 seconds shall be provided to prevent the unit from functioning due to short period changes in illumination.

The unit shall be effectively safeguarded against voltage surges by means of a suitable surge protector which shall preferably form an integral part of the unit.

8.0 INSTALLATION OF LCP

All installation material for installation on concrete pad of LCP, junction box such as bolts, nuts; galvanized, washers, supporting steel, etc., shall be provided and installed by the Contractor. The LCP shall be installed upright and in level and shall be firmly and rigidly installed on concrete pad.

The Lighting control Panel shall be completely installed on concrete pad as per manufacturer's instructions and as approved by the Engineer. Loose parts dispatched by the manufacturer shall be installed and connected as per assembly drawing provided by the manufacturer. Any safety locking provided by the manufacturer for safe transportation shall be released only after the distribution board is erected in position.

The Lighting control Panel installation shall include all related civil works, termination of all incoming and outgoing cables. The cable armor shall be connected effectively to ground. All outgoing and incoming cable connections shall be made neatly and firmly to ensure good contact. Special care should be taken in fixing cable lugs and lead connections so as to have no danger of leakage during operation.

Appropriate entry holes for metal or PVC glands / bushes are provided in order to avoid danger to pulling cables.

The Lighting control Panel body shall be connected to earth as per instructions given in section “Earthing “of these specifications. The distribution board shall be tested and commissioned in the presence of the Engineer. The tests to be carried out shall be tested before energizing as per instructions contained in the article “Testing “of General Specifications of Electrical Works, section 1 of these specifications.

9.0 FOLLOWING PROTECTION SHALL BE PROVIDED

- Triple pole series connected adjustable bimetallic over current release.
- Triple pole magnetic short circuit release.

Before procurement and installation the detailed shop drawings with make and type of the components shall be submitted to the Engineer for approval.

The manufacturer’s recommendations shall be followed while installing the Lighting Control Panel. The LV Lighting Control Panel shall be tested and commissioned in the presence of the Engineer.

10.0 TESTS AND INSPECTION

The following tests and inspections shall be performed in accordance with relevant engineering standards:

- a) Visual inspection of appearance, construction, dimensions and workmanship, and
- b) Electrical and Mechanical operation tests.

11.0 OPERATION AND MAINTENANCE MANUAL

1. Prior to delivery of the equipment the Vendor shall submit three (3) sets of manuals for all equipment supplied under the contract. The manual shall be A4 size bound in a loose leaf binder or booklets suitably enclosed and shall include the following:
 - a) A complete set of all corrected drawings prepared by the supplier and approved, by the Engineer. All drawings included shall be folded to fit within the binders.
 - b) Setting up, commissioning and operation instructions.
 - c) Trouble shooting procedure.
 - d) Maintenance instructions including schedules for preventive maintenance.
 - e) Complete recommended spare parts list including manufacturer's name and catalogue number with all required ordering information.
2. Operation and maintenance manuals shall be prepared to allow the purchaser and operators to truly understand the product, its theory of operations, its application and performance.

SECTION – E – 5

LIGHTING POLES AND LIGHTING FIXTURES

1.0 GENERAL

The work under this section consists of supply, storage, installation, testing & commissioning of Corridor / Road lighting system read together with drawings & bill of quantity. The Contractor shall furnish all labour, materials, services, and skilled supervision necessary for the construction, erection, installation, and connection of all equipment. The extent of work specified herein and/or shown on the drawings represents the minimum requirements.

Electrical Work Generally is to be in accordance with the requirements of the Specification Road lighting including luminaries, columns, related power distribution and control, protective earthing and related works including column foundations and cables etc.

2.0 STANDARDS:

Luminaries generally are to comply with IEC 60598 standards and recommendations. Manufacturer is to verify compliance with these standards and the applicable local regulations and design standards.

3.0 TECHNICAL REQUIREMENTS:

Minor deviations from the Drawings may be considered for improvement in construction details, but no changes are to be made without the written approval of the client/Engineer.

4.0 AMBIENT CONDITIONS:

Unless otherwise specified, equipment is to be designed and derated for continuous and trouble-free service at 50 °C ambient temperature and 100% relative humidity, with temperature reaching 70 °C in direct sunlight and with high content of ultra-violet rays. Equipment is to withstand full load operation whilst exposed to sun.

5.0 EQUIPMENT DATA:

Contractor shall submit complete data for approval including, but not limited to, the following:

- Detailed literature, in English, for each type of luminaire or fixture, lamp and control gear including manufacturer's name, catalogue number, rating, material specification, overall dimensions, operating characteristics and principles, and any modification to a standard product if applicable
- Detailed specification and drawings for each column type including shape, base/mounting flanges, bolts, nuts etc, cross-sections, design criteria and calculations, brackets, finishes, provisions for cabling, cut- out or circuit-breaker etc.
- Photometric data for lighting calculations including polar curves, coefficients of utilization efficiency and depreciation factors.

6.0 SHOP AND CONSTRUCTION DRAWINGS:

Contractor shall submit drawings for approval including, but not limited to, the following:

- a) Layout of equipment in exact positions.
- b) Cabling and wiring diagrams, single line drawings, loads, phase distribution, protection and control, earthing.

7.0 SAMPLES:

Submit fully equipped sample of luminaire or other materials or components if required by the Engineer.

8.0 WARRANTY

The supplier shall provide the full warranty on all equipment supplied during the period specified below. The warranty shall cover all parts and all costs, which are directly attributable to the supplier. Warranty coverage shall begin on the date that the equipment is received. The warranty period shall be 3 years.

9.0 O & M DOCUMENTATION

An Operation, Instruction and Maintenance Manual, in English and in the local language, shall be provided by the Supplier/Contractor. The following minimum details must be provided in the Manual:

- (a) About Photovoltaic
- (b) About White LED lighting system - its components and expected performance
- (c) About White LED Lights. The make, model number, country of origin and technical characteristics of LEDs should be stated in the product data sheet and furnished to the test centres.
- (e) DO's and DONT's
- (f) Name and address of the person or service centre to be contacted in case of failure or complaint.

10 PRODUCTS AND MATERIALS

10.1 LED STREET LIGHTING SYSTEM

The Road light operates from **Dusk to Dawn** i.e., the lamp automatically switches ON after the sunset and switches OFF after sunrise. The LED light should have programmable driver.

The light fixture shall be posted on single or double arm pole as shown in drawings. The luminaire shall be fixed on to the Pole and are interconnected through the cables. The street light operates in the stand alone mode.

The Street Lighting system components consist of:

- a) LED Luminaire
- b) Pole
- c) Interconnecting cables
- d) Terminal box & Circuit Breaker

10.4 LED LUMINAIRE

Luminaire with transparent acrylic cover, housing a high efficiency LED lamp shall be fitted with gasket and accessories for weather and insect proof operation. The light fixture shall be posted on single or double arm pole as shown in drawings. The light fixture should be fully comply with safety norms according to :

- IEC 62471 photo biological safety of lamps and lamp systems including luminaires.
- EN 61347-2-13:2006 ; Safety testing for LEDs.
- EN 60598-1 and EN 60598-2 ; Luminaires safety testing.

- a. **BODY CONSTRUCTION:** The Road light LED Luminaire shall be as per international standard and made of non-corrosive high pressure molded die cast aluminum housing and Tempered Flat glass with minimal glare. The surface must be finished with powder coating paint. The body should be aerodynamic profiled to give least air resistance. The Luminaire shall be consist of Heat Sink, One-piece cast, low-copper (<0.4% Cu) aluminum alloy. Which shall be effectively spreads heat to ensure long component life of LEDs and electronic components and provides precise alignment of LEDs and lenses. The Lamp compartment must be IP 66 with lens replaceable possibility.

b. **SOURCE OF LIGHT OUTPUT:**

The light source shall be of white LED type. Single lamp or multiple lamps can be used. View angles of a minimum of 120 or above. The luminous performance of individual LED used should not be less than 120 lumen / watt, when measured luminaire as a whole. The colour temperature of white LEDs used in the system should be in the range of 40000K – 50000K. Use of LEDs which emit ultraviolet light will not permitted.

The light output from the white LED light source should be constant throughout the duty cycle. The Supplier shall ensure that LED working life shall be >50,000 Hrs. and Color Index (CRI) Ra >75.

The make, model number, country of origin and technical characteristics of white LEDs used in the lighting system must be furnished by the supplier/manufacturer.

In absence of these above data the Road lighting fixture will not be accepted by the Engineer.

- c. **LED MODULES:** The LED modules utilize an aluminium metal-clad board for maximum heat transfer, leading to longer life. The product shall be enabling Pending Aimed Optics, which allows the direction and intensity of the light to be tightly controlled. This control of the

LEDs allow fixtures to maintain light levels equal to or greater than that of MH and HPS fixtures at a much lower energy consumption levels.

- d. **LENS:** The LED's Lens shall be High impact molded, UV-stabilized, Profile Acrylic lens, for maximum efficiency of light transmission.
- e. **LED DRIVER:** The LED driver, with high output current accuracy of $\pm 1.5\%$, with a high power factor correction to maximize power utilization shall be required. The driver should be comply UL 1310 / UL48 Class 2 with a built-in over-temperature protection.
- f. **FINISH/COLOR:** Thermally set polyester powder-coated for durability with 3 mils nominal paint thickness and corrosion resistant rated 500 hours salt spray endurance.
- g. **FULL CUT OFF:** The Luminaire should meet IEC standards for full cut-off luminaires.

11 LIGHTING POLE

- a. **CONSTRUCTION:** Columns are to have octagonal section, tapered, formed sheet steel, electrically welded, and of height specified in the drawing. Columns height are to be one piece section. Columns are to have minimum wall thickness of 4 mm at base. Sheet steel is to have minimum rupturing resistance of 490 to 610 N/mm² and minimum yield strength of 355 N/mm². The Columns shall be hot dipped galvanized with min 80 microns. The manufacturer shall provide quality assurance certificate.
Contractor should submit the Shop drawing / design details of Poles.
- b. **TOP OF COLUMN:** is to be designed to receive single or double arm brackets or other arrangement required, to support number of luminaires shown on the Drawings. Bracket arrangement is to be designed to ensure that failure, due to wind induced oscillations, does not occur and that rotation from desired alignment is not possible.
- c. **COLUMN DESIGN:** Column cross-section, thickness of steel, joints, welds, bolts etc. are to be designed to withstand gust wind velocity of 160 km/hr blowing in the most unfavourable direction at a height 20 m above ground level, with column fully equipped. Fatigue of steel is in no case to exceed half elasticity limit, taking into account dynamic stresses due to vibrations. Steel flange plate, of adequate thickness, is to be solidly welded onto lower edge of column as shown on the drawings, and is to have specified number of holes for holding down bolts together with central cable access hole not less than 150 mm diameter.
- d. **ACCESS DOOR:** of weatherproof construction is to be positioned hinged at column base and is to be suitably sized to insert and service the supply cable terminations and protective device. Door is to be flush fitting with retaining mechanism and positive locking arrangement with removable hexagonal key. Column is to be reinforced at door opening. Opposite each door, a non-hygroscopic baseboard of suitable size to accept appropriate equipment is to be fixed to inside of column by purpose-made brackets. Stainless steel earthing stud with washers and nuts is to be welded inside the column near the access door.
- e. **LIGHT BRACKET:** The road light bracket shall be made of Galvanized M.S pipe bent to shape as shown on the drawing. The light fixture bracket shall be fixed on pole, by means of bolt. The dimensions of the bracket shall be as shown on the drawing.

- f. **FINISH:** Welds are to be smooth with spatter removed, inside and outside surfaces of column are to be cleaned by pickling or blasting and are to be free of grease. Steel components of columns are to be hot-dip galvanized after fabrication. Minimum thickness of zinc coating is to be 500 g/m² on both inside and outside surfaces of column. Galvanizing is to be to NFA 91121 and NFA 91 122 (June 1958) or BS 729. Any damage to galvanizing is to be rectified during erection by wire brushing affected area and treating with approved rust converter to the satisfaction of the Engineer. Flange plate and inside and outside of column base are to be Galvanized.

TECHNICAL DATA SHEET FOR ROAD LIGHTING

DESCRIPTION :	SPECIFICATION
Road light :	
Light Source	LED light
lamp for LED light	As per BOQ
Heat dissipater	Air Convection radiator
LED luminous efficiency	>120 lm/w
LED Illumination flux	As per BOQ
Working Temperature	55 ° C
Lamp's Output Ratio/ Efficiency	>= 90%
P.F of LED Street/Flood Lighting	>= 0.99
Color Temperature(CCT)	As per engineers / consultant approval
Surge Protection	Min surge protection 15kV
Color Index(CRI)	As per consultant / engineer approval
Beam Angle	Vertical Axis:70°, Horizontal Axis: 140°
Lifespan	50,000hrs life, 3yrs warranty minimum
IP Rating	IP66
Illumination time	8~10 hours per day,

The Contractor shall provide following certificates with LED Light Fixture Sample for the approval from Consultant/Client.

- LM 80 certificate for Chips
- LM 79
- LM 82 -12
- ENEC Certificate @ 50 C

Following manufacturer declaration and submission should be provided with the Tender submission.

S. No.	Parameters.	Technical Specifications.	Documents to be provided.
1	System Voltage	220V to 240V 50 Hz	Laboratory Test Report
2	Power Factor	Not less than 0.90	Laboratory Test Report
3	Surge Protection.	15KV	Laboratory Test Report
4	LED Driver	Programmable for Dimming with 1-10V DC DALI On board standalone program	Manufacturer's Declaration
5	Lumen Maintenance	L70 at 50000hours or better	LM80 test report & TM21 Projection
6	Colour Temperature	Neutral White ~ 4000K $\pm$ 275K	Manufacturer's Declaration LM 79 Test report
7	Colour Rendering index	70 + / - 10	Manufacturer's Declaration LM 79 Test report
8	Ambient Temperature	50 Degrees Celsius	Manufacturer's Declaration with Thermal report
9	IP Rating	$\geq$ IP66 without glue	IEC 60596-1 Test report
10	IK Rating	$\geq$ IK08	IEC 60598-1 or IEC 62262 Test report
11	Cover	Transparent & weather resistant grade polycarbonate optic cover	Manufacturer's Declaration Material Datasheet Material UL94 rating of V2 (Minimum).
12	Housing	High Pressure Die Cast Aluminum with heat management system	Manufacturer's Declaration
13	Maintenance	Tool less Driver Cavity opening Tool less Gear Tray Change	Manufacturer's Declaration
14	Tel. management Controls.	Integrated Antenna or communication equipment in to luminaire housing	Manufacturer's Declaration and Evidence to show capability.

S. No.	Parameters.	Technical Specifications.	Documents to be provided.
15	3rd Party Test Report	Laboratory facility must be accredited according to ISO 17025 & recognized by ILAC /APLAC for testing of LED products.	IEC60598 Report (IEC 60598-2-3) EMC Test Report (EN55015,EN61547,61000-3-2) Photo biological Safety Test Report (IEC62471) EMF Test Report (IEC 62493) SPD Test (IEC 61643-1-2005 & IEC 61347-2-11) Factory Certificates (ISO 14001, ISO9001,OHSAS18001) Certificates for Test Laboratory (ISO 17025)
16	3rd Party Driver Test Report	Laboratory facility must be accredited according to ISO 17025.	IEC 61347-1,-2-13 Test Report. IEC 62384 Test Report.
17	Additional Test Report	Manufacturer's Test Report or from accredited lab.	Salt Spray Test Report (Minimum 500Hours Natural Salt Spray) as per ISO 9227 & ISO 10289 Vibration Test Report. Road Lighting simulations based on given configurations.

SECTION – E – 6

LIGHTING CONTROL SYSTEM

1. GENERAL

- 1.1. The lighting control system (LCS) shall control all lighting devices and lighting switch plate, with Infrared remote control bus system comprise a two-wire bus line and the connected bus-compatible installation devices, such as sensors, actuators and system components.
- 1.2. The system major have two parts component which are sensors and actuators. The sensors are lighting switch plate with scene function. The actuators are lighting actuator.
- 1.3. The two-wire bus line carries technology carrier power for the electronics of the bus devices and also the data. The bus line is connected to every bus device. Sensors normally only use the bus line, while actuators use the 230V mains supply to control.
- 1.4. The lighting control system and product shall apply standard open protocol with compliance to ISO/IEC 7498, EN50090 and CENELEC/C 205 or equivalent acceptable international open standard. The corresponding programming and application tools software must be open standard type and not only for particular manufacturer or product. The programming tools shall not be any manufacturer or proprietary products. It can be available through standard organization.
- 1.5. The lighting control system shall be a distributed intelligence system type network comprising microprocessor-based lighting control devices connected via a topology-free network that employs specified cable to supply power and facilitate communications between network devices.
- 1.6. The lighting control system should have the ability to support up to 64 units per single network, and all the units are connected through specified twisted pair cable, self-powered operations under extra-low voltage of 24Vdc.
- 1.7. The Contractor shall design, supply, install, test and commission the lighting control system comprising ON/OFF switching units, light level sensors, key input units, and all necessary accessories in accordance with the specific requirements stipulated in this Specification, also in accordance with Electrical general Specification, Drawings & BOQ.

2. DESIGN REQUIREMENT

- 2.1. The Contractor shall be responsible for the design, supply and install of the intelligent lighting control system and selection of equipment and components including the matching with other components to ensure that the system conforms to the specified performance requirements.
- 2.2. The Contractor shall provide power wiring diagram, control wiring diagram and the schedule of connection of lighting control system to the satisfaction of the Architect/Consultant. Both power and control wirings shall be provided from all lighting control output modules to their respective luminaries.
- 2.3. The lighting control system network bus should support free wiring topology. Star, daisy chain or any combination shall be possible.
- 2.4. The luminaries shall be connected to and supplied from lighting control output unit modules installed as indicated on the Drawings. All outputs and inputs shall be individually addressed and identified within the system. The output units can support ON/OFF. The ON/OFF relay modules shall each be capable of controlling up to 24 independent loads. All output modules shall be DIN rail mountable and fit into standard DIN switchboard enclosures. Each relay/dimmer's channel shall have an associated manual over-ride switch and operation indicator light.
- 2.5. The wall mounted button plate / Keypad shall support 1-gang, 2-gang or 4-gang with LED, which is used to indicate the operation status of each gang. The wall mounted button plate / keypad shall have the ability to be controlled remotely via infrared hand held remote control units.

3 PERFORMANCE REQUIREMENTS

- 3.1. The lighting control system protocol shall utilize communication algorithms based on IEEE Standard 802 or the latest one.
- 3.2. Scheduling function shall be set according to end-user's need and/or relevant requirements. Lighting control system module supports scheduling, logic engine, and code programming shall be included in the system.

SPECIFICATION FOR LIGHTING CONTROL SYSTEM

1 GENERAL

- 1.1 The lighting control system (LCS) shall be a specialist design system comprises input buttons, Keypad, relay actuators and system accessories, as per drawings and BOQ.
- 1.2 The lighting control system should operate at the extra low voltage of 24Vdc. The bus cable is laid as a line for entire length of BRTS corridor.
- 1.3 The programming of the system is carried out with the Engineering Tools Software (ETS) parameterization software via an RS232 or USB interface. They can be used in any location within the bus system. A programming of the KNX devices by the Ethernet is possible via IP gateway.
- 1.4 Each bus device receives a physical address. The device is queried or programmed via this address. The bus management is a multi-master operation i.e. each bus device has the same rights.
- 1.5 Work on the KNX installation bus should only be carried out by specialist electricians with the appropriate training. The specialist contractor should have KNX training certificate and a current ETS license.
- 1.6 All items shall be suitable for operation in ambient temperatures up to 40°C-45°C and relative humidity range between 10 – 95% with no degradation in performance.
- 1.7 The Contractor shall be responsible for provided conduits/ trunking, wiring and all necessary accessories as described in this Specification and shown on the Drawings.
- 1.8 As a minimum, submit the following for approval at the appropriate stages of the works.
 - a. Detailed schedule of equipment and components and manufacturer's data.
 - b. Detailed design drawings.
 - c. Builder's Works requirements.

2 QUALITY ASSURANCE

- 2.1 Equipment manufacturer shall have a minimum of 3 years continuous experience in manufacturing Construction Managerial lighting control products and with good job reference in *(the country)* in the past 3 years.
- 2.2 All devices shall be CE listed specifically for the required loads (i.e., incandescent, fluorescent and magnetic low voltage transformer, etc.). Manufacturer shall provide valid supporting document upon request.

3 PRODUCT SPECIFICATIONS

3.1 Sensors

3.1.1 Push Button Plus, 1/2/4 gang

- i. Application module for KNX system design.
- ii. Push buttons shall be available with 2/4/8 operating buttons, operating and status display and labelling field. The operating display can also be used as an orientation light.
- iii. Push buttons are freely parameterizable as push button pairs or as single push buttons. Each button shall be capable of being programmed to achieve various control functions including, toggling and switching.
- iv. Push buttons is free for plugging on coupling unit.

3.1.2 Push Button Plus, 4 gang with IR receiver

- i. Application module for KNX system design.
- ii. Push buttons shall be available with 8 operating buttons, operating and status display and labelling field. The operating display can also be used as an orientation light.
- iii. The functions of each keys can be triggered using an IR remote control.
- iv. The push buttons are freely parameterizable as push button pairs or as single push buttons. Each button shall be capable of being programmed to achieve various control functions including toggling, switching etc.
- v. Push buttons is free for plugging on coupling unit.

3.1.3 Analogue Input

- i. The unit shall be processed measuring data from analogue sensors.
- ii. Minimum four freely programmable analogy transducers can be connected to the input.
- iii. The unit shall evaluate both voltage signals and current signals as
 - Current signals: 0...20mA DC
 4...20mA DC
 - Voltage signals: 0...1V DC
 0...10V DC

The unit shall be monitored for wire breakage.

3.2 Actuator

3.2.1 Switching Actuator

- i. The relay unit shall allow control of 1/2/4/8/12/16/24 independent loads, equipped with a voltage free, magnetically latched relay per channel.
- ii. No de-rating shall be required for inductive lighting loads.
 - a. 1, 2, 4, 8, 12-fold shall support up to 16A per channel.
 - b. 16, 24-fold shall support up to 10A per channel.
- iii. The unit shall be independent switching of each channel via either make or break contacts.
- iv. Readiness for operation is indicated by a green LED/or as recommended by manufacturer after the application has been loaded.
- v. Each unit shall have the facility for connecting both 'ON' and 'OFF' Remote Manual Override push-button switches. It shall be possible to connect these overrides in parallel to multiple units to allow manual override of multiple units from one push-button location.
- vi. Local ON/OFF toggle buttons shall allow individual channels to be manually overridden at each unit.
- vii. Logic states and relay interlocking features shall be software selectable.
- viii. The individual relays shall be DIN rail mounted within the unit enclosure.

3.2.2 Switching Actuator with Current Detection

- i. The relay unit shall allow control of 2/4/8/12 independent loads, equipped with a voltage free, magnetically latched relay per channel.
- ii. The unit shall support up to 16A per channel. No de-rating shall be required for inductive lighting loads.
- iii. The actuator also has integrated current detection which measures the load current of each channel.
 - a. A possible failure is registered, as is a break in the electric circuit.
 - b. The operating status is shown and controlled by threshold values.
 - c. Pending maintenance work can be planned looking ahead.

3.2.3 Analogue Output Unit

- i. The analogue actuator shall convert KNX telegrams into analogue output signals.
- ii. These analogue output signals should enable to adapt their output variables based on bus information and to participate in control processes.

3.3 System Devices and Accessories

Power Supply / Power Supply with emergency input

- i. The Power Supply shall provide safe extra low voltage DC 30V or as recommended by manufacturer for one line with up to 64 devices.
- ii. With integrated choke to decouple the power supply from the bus, as well as switches to interrupt the power supply and reset the bus users connected to the line.
- iii. It is short-circuit resistant, and features a voltage and current limiter. Excessively high output currents are indicated by a red display (over current).
- iv. The input power supply shall be rated at 20V AC/recommended by manufacturer, frequency 50 Hz.

3.3.1 USB Interface

- i. The USB interface, either flush-mounted or DIN rail type shall allow linking to a PC for addressing, programming and diagnosis of KNX components with USB1.1 or USB2 interfaces.

3.3.2 Logic Module

- i. The logic module is used for logic and controlling functions in KNX system.
- ii. Device module shall be contained logic features as follow.
 - a. 10 logic modules (AND, OR, XOR)
 - b. 10 filter and time modules
 - c. 8 converter modules
 - d. 12 multiplexer modules for lighting control
 - e. 3 freely programmable push buttons
 - f. 3 status LED initiators

SECTION – E – 7

EARTHING SYSTEM

1. GENERAL

The work covered under this section of the specifications consist of furnishing all labour, equipment, appliances and materials and in performing of all operations in connection with providing, installing, connecting, testing the earthing system complete in accordance with this section of specifications and drawings. The earth pits on the drawings are only indicative and these will be located as directed by the Engineer.

2. APPLICABLE STANDARDS AND CODES

- BS 951 - EARTHING CLAMPS
- BS 7430 - EARTHING
- BS 2874 - NUTS,BOLT,WASHER,SCREW & RIVETS FOR USE ON COPPER
- BS 1433 - HARD DRAWN BARE COPPER CONDUCTOR FOR EATHING.
- BS 6346 - PVC INSULATED CABLES.

The maximum values of resistance of equipment earthing systems to the body of earth shall be as follow:

- | | |
|-------------------------------------|-------|
| • General Electrical Earthing | 1Ω |
| • Earthing For Static Discharge | 1000Ω |
| • Earthing For Lightning Protection | 10Ω |
| • Instrument Clean Earth | 1Ω |

3. EARTHING ACCESSORIES

The Earthing system shall be consist of Earth electrodes, Earthing leads, Earth connecting point, Earth continuity conductor and all accessories necessary for the satisfactory operation of the associated electrical system.

a. Earthing by Earth Copper Plate

The earth electrode Copper plate shall consist of 600mm x 600mm x 3mm thick 99.9% high conductivity electrolytic tinned copper plate. The plate shall have four terminals for connecting the earthing leads as shown on the drawings.

b. Earthing by Earth Copper Rods

The earth copper rod shall be installed for Lighting poles as indicated in drawings. The copper rods shall be of 3m length and 20mm dia with high conductivity electrolytic copper. This shall be driven into the ground to the full length as shown in drawing.

c. Earthing Lead

The earthing lead shall connect the earth electrode to earth connecting point or equipment. It shall be round hard drawn bare electrolytic copper of size shown on the drawings. The cost of earthing leads deemed to have been included in the price of earth electrode & no separate pavement shall be made for it.

d. Earth Continuity Conductor

Earth continuity conductor (E.C.C) shall be hard drawn bare copper wire or single core PVC insulated copper conductor cable of sizes indicated on the drawings or BOQ. All thimbles, lugs, sockets, nuts, washers and other accessories necessary for the complete installation of ECC shall be provided by the Contractor without any extra cost. PVC insulated cables when used as E.C.C. shall be green or green yellow.

e. Earth Connecting Points

When copper plates or copper rods are used as earth electrodes, the earthing leads from the plate or rod shall terminate at the earth connecting points which shall be of tinned copper bar, rectangular in shape, having dimensional 500mm x 50mm x 10mm, installed in the wall of the inspection chamber at the ground level. Further connections to respective locations shall be made from this bar by earth conductors of various sizes as shown on the drawings.

f. Inspection Chamber

At the ground level an inspection chamber shall be provided size shown on the drawing. The inspection chamber shall have 50mm x 50mm angle iron frame at the top to accommodate an approved quality heavy duty cast iron or concrete cover with handle. The cover shall have "EARTH BELOW" inscribed on its top. The Contractor shall provide and install the cover flush with the ground level.

4. EARTH INSTALLATION

Complete earthing systems as shown on the drawing shall be installed by the Contractor. The earthing system shall give earth resistance, including resistance of soil, earth leads and E.C.C. equal to less than one ohm, this without ground pits water spraying.

The earthing system shall be loop connected with earthing cables at least 300 mm away from telephone cables. The concept of the main loops and the way they are connected shall be such that equipment / apparatus can be easily removed without requiring a complex disconnection operation nor risking interruption of / or damage to the loop itself. The fastening of the earthing conductors shall be made on a sufficient length so as to prevent crushing or cross section weakening. The parts on which they are connected shall be conveniently cleansed and surface.

Leads sheaths or steel tape armours are not permitted as grounding conductors. The earthing system shall be installed to ensure that when any part of the earthing system is disconnected for the purpose of carrying out periodic testing an alternative path to earth is available.

At all connections of earth continuity conductor to MV/LV Switchboard, LV Distribution Board or any other metallic body, proper size or brass sockets, thimbles or lugs shall be used to

which the copper wire shall be connected by copper brazing. The soldering of copper wire at joints or termination shall not be allowed. All tee-off connections shall be by copper brazing using suitable socket and clamps. After brazing, the jointed surface shall be protected by oxide inhibiting compound of low electrical resistance. For connections to metallic body, the surface shall be thoroughly cleaned before bolting the lug or socket.

The earth continuity conductor shall be in general run in cable trench or in conduits / pipes as shown on the drawings. Where laid along underground cables these shall be laid directly under ground in unpaved areas and in pipes under paved areas.

The earth connecting point shall be installed at locations shown on the drawings. It shall be fixed on wall surface by means of brass screws with nuts, washers and other insulating material as instructed by the Engineer.

The earth continuity conductor of sizes shown on the drawing shall be installed all along the cable runs and connected to the earthing bar / terminals provided in the equipment. The body of all Switchboards shall be connected to earth by specified size of E.C.C. All metal work shall also be connected to earth by specified size of E.C.C.

At any joint or termination, the E.C.C. shall be connected using proper accessories. No connection shall be made by twisting of earth conductors.

▪ **Installation of Earth Electrode (Copper Plate)**

The installation of earth electrode (copper plate), a pit of appropriate diameter and up to the depth of 4 m or (as directed at site) shall be first excavated in the bare ground. The earth electrode shall be installed upright in the pit and shall be surrounded by **mixture of lime and charcoal** around the electrode as shown on the drawings and packed hard. From the plate earthing leads of 2x70mm² bare Cu. Conductor shall be taken to the bus bar in the inspection chamber through 50mm G.I pipe for watering purpose.

▪ **Installation of Earth Electrode (Copper Rod)**

The earthing system by copper rod shall consist of 20mm dia and 3 meter long copper rods. These shall be of 99.9% purity copper. These shall have screw able head to accommodate other rods in series with the help of dowel as is shown in the drawings. The driven head shall consist of a hardened tip. These rods shall be connected to the earthing lead whose other end shall be connected to the earth connecting points to be provided in the inspection chamber. From the earth connecting points earth connection shall be made to individual point as marked in drawing.

▪ **Installation of Earth Electrode where the condition not suitable for Earthing**

Where the rock lie just below the surface or water table are very deep then earth electrode shall be installed through drilling or digging method. Due to certain ground conditions make it difficult to obtain a reliable earth resistance, whilst particular installations may require a very low resistance. In such cases, **Marconite concrete** shall be used as backfill for a conventional earth rod achieve a lower earth electrode resistance.

5. Equipment Grounding

a. Non-current carrying metal parts:

Bond and ground non-current carrying metal parts of electrical apparatus and equipment provided under work of any section of specifications.

b. Grounding of Fence:

All metallic fences shall be grounded by driving earth rods at a distance of 50 meter.

6. Inspection and Test

Earth resistance test shall be made by the Contractor on the complete earthing system in the presence of the Engineer. The test result shall conform to BS 7430 (formerly CP 1013) and BS 6651 (Formerly CP 326). To obtain the desired result more earth rods shall be provided.

SECTION – E – 8

TESTING OF ELECTRICAL EQUIPMENT

GENERAL

Upon completion of the installation the Contractor shall perform field tests on all equipment, material and systems all tests shall be conducted in the presence of the Consultant/client's Engineer for the purpose of demonstrating equipment or system compliance with specifications. The contractor shall submit test protocol for approval atleast two weeks before conducting the test.

The Contractor shall furnish, install and maintain all tools, instruments, test equipment, material, connections, etc and furnish all personnel including supervision and "Standby" labour required for the testing, setting and adjustment of all electrical facilities and their component parts, including putting the same into operation.

All tests shall be made with the proper regard for the protection of the equipment and the Contractor shall be responsible for adequate protection to all personnel during such tests.

The Contractor shall record all test values of the tests made by him on all equipment, giving both "as found" and "as left" conditions. Three (3) copies of all test result shall be given to the Engineer Incharge for record purposes.

The witnessing of any test by the Engineer In charge does not relieve the Contractor of his guarantees for materials, equipment and workmanship as specified in the Conditions of Contract.

INSULATION RESISTANCE TEST

Insulation resistance tests shall be made on all electrical equipment, using a self-contained instrument such as the direct indicating ohm-meter of the generator type Direct current potentials shall be used in these tests and shall be as follows:

Circuit under 230 volts – 500 volts test

Circuit 230 volts to 400 volts – 1000 volts test

The minimum acceptable insulation resistance value will be 5 Mega ohms.

The test equipment for insulation testing will be furnished by Contractor.

Before making connections at the ends of each cable run, the insulation resistance test of each cable shall be made. Each conductor of a multicore cable shall be tested individually to each other conductor of the group and also to earth. If insulation resistance test readings are found to be less than the specified minimum in any conductor, the entire cable shall be replaced and the new cable shall installed/laid.

All switch gear shall be given an insulation resistance measurement test to ground after installation but before any wiring is energized Insulation tests shall be made between open contacts of circuit breakers, switches and between each phase and earth.

If the insulation resistance of the circuit under test is less than that specified above the cause of the low reading shall be determined and removed. Corrective measures shall include dry out procedure by means of heaters if equipment is found to contain moisture. Where corrective measures have been necessary and the insulation resistance reading taken after the correction has been made it should satisfy the requirements specified herein. Repeated insulation resistance test shall be made twice and at least 12 hours apart. The maximum range for each reading on the 3 successive tests shall not exceed 12 hours apart and 20% of the average value. After all tests have been made successfully, the equipment shall be reconnected.

EARTH RESISTANCE TESTS

Each resistance test shall be made by the Contractor on the earthing system, separating and reconnecting each earth connection as may be required by the Engineer Incharge. If it is indicated that soil treatment or other corrective measures are required to lower the ground resistance values, the Engineer Incharge will determine the extent of such corrective measures.

The electrical resistance of the ECC together with the resistance of the earthing lead measured from the connection with earth electrode to any other position in the completed installation shall not exceed one ohm.

Earth resistance test shall be performed as per Electrical Inspector's requirements. Where more than one earthing sets are installed, the earth resistance test between two sets shall be measured by means of Resistance Bridge Instrument. The earth resistance between two sets shall not exceed one ohm.

OPERATING TESTS

Current load measurement shall be made on all electrical equipment.

The current reading shall be taken in each wire and in each neutral wire while the circuit or equipment is operating under actual load conditions. Clip-on ammeters may be used to take current readings.

All light fittings shall be tested electrically and mechanically to check whether they comply with the standard of specifications. Light fittings shall be tested so that when functioning properly no flickering is observed or choke noise is heard.

After any equipment has been tested, checked for operation etc, and is accepted by the Project Engineer's representative the Contractor shall be responsible for the proper protection of such equipment for assurance that subsequent testing of other equipment or systems do not disturb the completed work.

VISUAL INSPECTION

Visual Inspection to verify that the Electrical equipment has been correctly installed in accordance with the design with correctly rated protection devices and bonding that no visible damage exists.

SECTION – E – 9

DOCUMENTS TO BE SUBMITTED

The contractor shall submit following documents at the time of bidding or as per Instruction of the Engineer.

1. Documents and certificate to be submitted for approval, including.
 - Information to be provided with the bid.
 - Document to be provided by the owner.
 - Documentation.
2. Warranty.
3. Packing and delivery.
4. Marking.
5. Testing, including :
 - Type tests.
 - Routine Tests.
 - Special test.
6. Technical data sheet
7. Maintenance and operation manual
8. Training Program

SECTION – E – 10

LIST OF APPROVED MANUFACTURERS/SOURCES OF ELECTRICAL EQUIPMENT

* All Equipment shall be procured from Principal Authorized agents / distributors / resellers

The Bidder shall fill the name of only one manufacturer for each equipment/material on which the tender is based. He shall be bound to supply the equipment from the same manufacturer. In case, the Bidder gives names of more than one manufacturer against any equipment, the Engineer / Owner can ask the Bidder supply the equipment from any one of them.

At the evaluation stage if it is noted that any material offered by the bidder does not meet the specification requirements, the Engineer / Owner reserves the right to ask the bidder to replace his choice of equipment supplier meeting the required quality and specification requirement.

During the execution stage if the material from any supplier is found defective / substandard the Engineer / Owner reserves the right to ask the successful bidder to replace his choice of manufacturer / supplier for that particular equipment.

Any change in manufacturer / supplier shall only be entertained if there is sufficient reason that adhering to the original choice of manufacturer / supplier shall be detrimental to either the project quality or project timeline. Proper approval shall have to be sought for change in the choice manufacturer / supplier at least 1 month before the equipment is to be procured.

Bidder is required to mark the proposed Manufacturer / supplier and country of origin for each item below.

S.No	Equipment	Manufacturer/Supplier	✓	Country of Origin	✓
1	MV Cables	i. Pakistan Cables		Pakistan	
		ii. Newage Cables		Pakistan	
		iii. Pioneer		Pakistan	
		iv. Fast Cables		Pakistan	
2	MV Cables Accessories (Jointing & Termination Kits)	i. 3M		USA	
		ii. Raychem		USA	
3	HT – CT / PT	i. Revalco		Italy	
		ii. Fico		Pakistan	
4	L.V Lighting Control Panel (LCP)	i. Hussain & Company		Pakistan	
		ii. Taj Engineering.		Pakistan	
		iii. Libra Engineering		Pakistan	
		iv. PEL		Pakistan	

S.No	Equipment	Manufacturer/Supplier	✓	Country of Origin	✓
6	LV Circuit Breakers	i. Schneider Electric		France	
		ii. Terasaki (ACBs & MCCBs only)		Japan	
		iii. Siemens		Germany	
		iv. ABB		France	
		v. Legrand		France	
7	C.T, Relays & instruments	i. Schneider Electric.		France	
		ii. Siemens		Germany	
		iii. Fico		Pakistan	
		iv. Revalco		Italy	
8	LV Cables and Wires/ Earthing Cable	i. Pakistan Cables		Pakistan	
		ii. Pioneer Cables		Pakistan	
		iii. Newage Cables		Pakistan	
		iv. Universal Cables		Pakistan	
		v. Allied Cables		Pakistan	
		vi. Fast Cables		Pakistan	
9	UPVC Conduits / Pipes and Accessories	i. Galco		Pakistan	
		ii. Dadex		Pakistan	
		iii. Jeddah Polymer		Pakistan	
		iv. Civic		Pakistan	
10	Cable Glands, Lugs, Terminals and Accessories	i. Cembre		UK	
		ii. Hubbell / Hawke		UK	
		iii. Hensel		Germany	
11	LED Light Fixture	i. Philips		Netherlands	
		ii. Gewiss		Italy	
		iii. Osram		Germany	
		iv. Pierlite		Australia	
12	LED Chip (LED Light Fixture)	i. Philips Lumiled		Netherlands	
		ii. Cree		USA	
		iii. Nichia		Japan	
		iv. Osram		Germany	
13	LED Driver (LED Light Fixture)	i. TCI		Italy	
		ii. Philips		Netherlands	
		iii. Lumotech		Belgium	
		iv. Vossloh Schwabe		Germany	

S.No	Equipment	Manufacturer/Supplier	✓	Country of Origin	✓
14	Lighting Pole	i. Mitas		Turkey	
		ii. Al – Babbain		Saudi Arabia	
		iii. Petitjean		France	
		iv. Jamal Pipes		Pakistan	
		v. Farhan Mechanical Works		Pakistan	
15	Earthing Equipments & Cu. Rod	i. Erico		USA	
		ii. Furse		UK	
		iii. Dehn		Germany	
		iv. Wallis		UK	

ELECTRICAL & ELV Works

SECTION – E - 1 GENERAL SPECIFICATIONS

FOREWORD

This document is to describe the minimum requirements for the equipment and installations and to ensure that the Contractor is fully aware of his duties to perform the required works, in accordance with the terms of the Contract.

1.0 SCOPE OF WORK

The works related to the electrical system which are included in the scope of this Contract are shown on the Drawings, stated in the Particular Specifications, Bill of Quantities and explained in these specifications. The works shall broadly include but not limited to the following:

- | | |
|--|--------------------|
| 1. Low Voltage Switch Boards / Distribution Boards | (Section - E - 2) |
| 2. Low Voltage Cable and Wires | (Section – E - 3) |
| 3. Conduits and Pipes | (Section – E - 4) |
| 4. Wiring Accessories | (Section – E - 5) |
| 5. Lighting Fixtures | (Section – E - 6) |
| 6. Pad Mounted Transformer | (Section – E - 7) |
| 7. Diesel Generator | (Section – E - 8) |
| 8. Earthing System | (Section – E - 9) |
| 9. Cable Tray, Ladder and Trunking | (Section – E – 10) |
| 10. Public Address/Voice Evacuation System | (Section – E – 11) |

All material and equipment supplied by the Contractor shall be new and in all respects conform to the high standards of Engineering design, workmanship, performance and function as here in specified and fully meet the quality level and rugged requirements of the specifications.

The Contractor shall also be responsible to supply any other equipment not specifically mentioned in these documents but which is necessary for proper operation of the works / system, shall be considered to have been so specified and accordingly shall be provided by the Contractor as part of the Contract.

The Contractor shall be solely responsible for ensuring proper functional requirements of various equipment and shall also be responsible for furnishing any additional piece of equipment and for making modification in the equipment as desired and / or approved by the Owner or his representative, to achieve proper coordination with various equipment offered in the bid and also those installed by others.

Approval of the Contractor's supplied equipment / installation works shall not relieve the Contractor of any of his obligations or liabilities under the Contract, except insofar as provided under the conditions of the Contract.

2.0 RULES AND REGULATIONS

The entire electrical installation / work shall be carried out by licensed contractor, authorized to undertake such work under the provisions of Electricity Act 1910 and The Electricity Rules 1937 as adopted and modified up to date by the Government of Pakistan.

All works shall be carried out in accordance with the latest edition of the Regulations of the Electrical Equipment of Buildings issued by the Institute of Electrical Engineers - London, the Contract documents, the Electricity Rules 1937 and bye-laws that are in force from time to time. Any discrepancy between these specifications and any other rules and regulations shall be brought to the notice of Owner or his representative, and his decision shall be final and conclusive.

The Contractor shall be responsible for completing all formalities and submitting the test certificates as per prevailing rules and regulations and shall have the installation passed by the Government Electric Inspector of that region. All requirements of the Electric Inspector and the Electric Company shall be complied with.

3.0 STANDARDS

All works, equipment and materials shall conform to:

On the one hand:

The specification recommended practices, official standards and codes the non - restrictive List of which is given below.

International Electro-technical Commission (IEC)

British Standards (BS)

National Electric Code (NEC)

National Standards

In the event of conflict between standards, the most stringent shall prevail.

Whenever the electrical equipment to be installed, does not hold national standards, the Contractor shall take into account the specific standards chosen by the Owner and make sure that the equipment he has to install, meets these standards.

In addition, even if no mention is stipulated in this specification, it is implied that the equipment be tropicalized, if required, by the conditions of the site of installation.

In any case, the standards and codes to be taken into consideration are those in force at the date of delivery.

4.0 INSTALLATION AND SERVICE CONDITIONS

4.1 Site Conditions

All material and equipment supplied and installed shall be designed, manufactured and tested to meet the following ambient conditions

unless specifically stated otherwise for any material / equipment:

- | | | |
|----|--------------------------------------|-------------|
| a. | Maximum outdoor ambient temperature: | 45 degree C |
| b. | Minimum Indoor ambient temperature : | 0 degree C |
| c. | Maximum relative humidity : | 90 % |
| d. | Minimum relative humidity : | 26 % |

4.2 Service Conditions

Equipment shall be designed and built for continuous service with a minimum of supervision and maintenance.

5.0 MAIN ELECTRICAL CHARACTERISTICS

5.1 Power Supply System

Unless otherwise specified elsewhere, all equipment and material shall be designed to operate and function satisfactorily with the following minimum requirements without any de-rating:

- Voltage 400 $\pm$ 10%
- Phase 3, 4 wire system
- Frequency 50 Hz. $\pm$ 2 Hz.

5.2 Degree of Protection of Enclosures

For indoors, IP54 minimum degree of ingress protection of the enclosures against contact with line or moving parts and against ingress of solid foreign bodies or liquids, shall be selected, in accordance with IEC 60529.

6.0 GUARANTEE

The Contractor shall furnish written grantee which should clearly state that the works he will carry out as well as the materials he will supply, meet with this specification and that compliance thereto constitutes an official clause, added by implication to the general conditions of his offer when signing the Contract.

Guarantee shall also be for replacement and repair of part or whole of the equipment which may be found defective in material or workmanship. The grantee shall cover the duration of Maintenance Period as defined in the conditions of the Contract. This guarantee shall not relieve the Contractor of his obligations and he will fully be responsible for the repair or replacement of any defective material in time, so as not to cause any undue delay in carrying out the repairs and/ or replacements.

The Contractor shall acquaint himself fully with the existing conditions and limitations at site and all works necessary to complete the project under the Contract, to be carried out by the Contractor.

7.0 EXCEPTIONS TO SPECIFICATION

Any exception or deviation from this specification or the codes and standards shall be listed separately in the Contractor's "List of Deviations". Any exception, which shall not be listed, shall not be considered later.

8.0 AVAILABILITY OF SPECIFICATIONS, DRAWINGS AT SITE

The Contractor shall assume at his own cost the permanent availability of this specification and drawings on site where applicable.

9.0 DISCREPANCIES IN TENDER DOCUMENTS AND DRAWINGS

The Contractor shall carefully examine the documents and drawings and if he finds any discrepancies or omissions from the specifications, bill of quantities or drawings, or is in doubt as to the meaning, he shall at once notify the Owner or his representative for receiving his instructions before proceeding with the works. If such defective or modified work is carried out by the Contractor on his own, he shall rectify the same at his own cost.

10.0 MEASUREMENT OF WORKS

The quantities set out in the bill of quantities are the estimated quantities and they shall not be taken as actual and correct quantities of work to be executed by the Contractor. The Contractor shall carry out actual measurement of works at the site.

11.0 INSTALLATIONS DETAILS

The locations, routings, installation heights, detail etc. for electrical equipment are indicated on the drawings. If any information is not stated on the drawings or wherever modifications are required the Contractor shall obtain prior instructions from the Owner or his representative.

12.0 DRAWINGS AND DATA

The Contractor shall provide dimensional outline drawings, arrangement drawings and technical data for the equipment offered, for the approval of Owner or his representative.

13.0 PRIOR APPROVAL OF SHOP DRAWINGS, MATERIALS AND EQUIPMENT

The Contractor shall provide shop drawings for the electrical installations showing the exact routes of all underground cables and ducts, the exact run of all conduits and trunking, draw-in and junction boxes, the number and size of wires in each conduit, the final connection arrangements at distribution boards and the details of ducts for the approval of consultant / Owner's representative before commencing any portion of the works. All such working drawings shall be submitted in suitable number of copies as indicated in the particular conditions and within the periods stipulated below:

a. **Cable entry ducts into Stations:**

Working drawings shall be submitted within two weeks of handing over the site.

- b. All other working drawings shall be submitted to the Engineer against signed receipt and dated within two months of signing the Contract. Should however the Contractor be obliged to install electrical conduits prior to this period then he shall submit the relevant working drawings at least two weeks prior to the proposed date of commencement of the work. The Contractor shall submit the program indicating the dates on which coordination in different sections will take place, together

with the submission of the working drawings. The Engineer shall arrange to return to the Contractor at least one week prior to the commencement of concreting of the section, his comments or approval of the working drawings.

The Contractor shall supply detailed specifications, dimensional drawings, etc., of equipment that he proposes to supply and install.

Where this Contract requires the approval of Engineer to material and goods, the Contractor must seek to obtain this approval within eight weeks after signing of the Contract. No extension of time will be granted for non-availability of material or goods if this clause is not complied with. Approval of the Engineer does not relieve the Contractor of placing his orders in due time for the materials he needs to complete the Contract on time. The approved samples shall be retained on site for comparison with commodities used in works and removed when no longer required.

14.0 MATERIAL ORIGIN AND QUALITY

The material and equipment shall be purchased from Consultant / Owner's agreed suppliers.

The consultant / owner shall retain the right to at any time demand the indication of origin of the materials, and to eventually refuse products, the origin of manufacturing of which have not been previously agreed to without consideration of quality.

On specific agreement of the Owner, the materials may be delivered progressively to the field, but in such a manner as to allow sufficient time for their reception.

When choice of manufacturer is allowed for any particular commodity the Contractor shall obtain the whole quality required to complete the work from one manufacturer or obtain approval of any change in source of supply. He shall produce written evidence of sources of supply when requested to do so by the Engineer.

15.0 IDENTIFICATION OF EQUIPMENT

For each piece of equipment, identification label shall be fitted in front of the casing. The label shall have block letter 7mm high, black on white back ground of trifoliate and fixed with screws.

16.0 MARKINGS

The contractor shall provide "Danger Boards "and" Shock Charts "wherever required to comply with the requirements of local Electricity Rules and according to normal practice.

17.0 FACTORY TESTS

All equipment supplied by and installed as part of the Contract such as distribution boards and like shall be fully tested at the manufacturer's works to the requirements of appropriate standards called for later in the particular specification.

The Contractor shall inform the Engineer in writing about the date and time of

test of each equipment at least two weeks in advance. The witnessing of test by the Owner or his representative shall not absolve the Contractor from his responsibility for the proper functioning of the equipment and for furnishing the guarantees referred to in Clause 6.0. All test results in the form of certificate of test / test record certificates, signed by all the witnesses, for each item in the scope of Contractor's supply shall be supplied to the Engineer within seven days of the test date, and in any event before delivery to the site.

All expenses for carrying out the tests and witness by the Owner or his representative shall be borne by the Contractor and deemed to have been included in the tender bid.

18.0 STORAGE

The Contractor shall store the equipment in such conditions that it can not be damaged, i.e., in a dry warehouse. As particular concerns; fragile components, these shall be stored on shelves in their original packing, fitted with identification labels so as to avoid unnecessary manipulation or handling.

The Contractor shall handle, store and fix each commodity in accordance with the manufacturer's recommendations. He shall inform the Engineer if these conflicts with any other specified requirement and submit copies of manufacturer's recommendations to the Engineer when requested to do so.

19.0 LABOR AND STAFF OF CONTRACTOR

The Contractor shall provide / furnish and arrange for:

- Skilled and unskilled labor required for performing the works in accordance with the technical specifications and drawings within the agreed time schedule.
- Supervisory technical staff with appropriate experience and requisite expertise to ensure quality of work performed.
- Supervisory administration and clerical staff to ensure smooth functioning of the activities at site.
- Construction equipment, meggers, tools, etc.

The Contractor shall supply all labor, materials and equipment necessary for the installation of low voltage distribution boards, cables, lighting and power equipment, together with all other apparatus shown on the drawings and as detailed in the Particular specification.

20.0 SMALL INSTALLATION MATERIAL

The Contractor shall supply all small installation and consumable materials such as nuts, bolts, washers, shims, angles, leveling materials, insulation tape, solder, PVC strap-on or heat shrinkable type cable tags, cable ties, bushes, sealing compound, Avometer, electrical testing and measuring instruments, etc., and all such other material not listed in BOQ, required for complete installation as intended by the specification and scope of works.

21.0 INSTALLATION INSTRUCTIONS - GENERAL

The Contractor shall set out the works himself as per specifications and drawings and shall properly position the equipment on specified foundation /

location. In general, the manufacturer's instructions for installation shall be followed. Any defect or faulty operation of equipment due to Contractor not following the manufacturer's instructions shall be corrected and repaired by the Contractor at his own cost.

22.0 ASSOCIATED CIVIL WORKS

The expression 'Associated Civil Works' shall mean civil work to be carried out by the Contractor under the direction of the Engineer in connection with the Electrical Service.

The Contractor shall prepare accurate drawings giving details of all holes, fixings, bases and other civil work requirements and shall be responsible for their accuracy. The cost of preparing shop drawings shall be considered to have been so specified in the tender price.

The following is a summary of the work to be carried out by the Contractor:

- a. The cutting and forming of holes for conduits or pipes, or conduit or pipe fixings through walls, floors, ceilings, partitions, roofs, etc., and making good after the work is sufficiently advanced.
- b. The building of concrete and / or brick ducts in floors, walls, etc.
- c. The formation of concrete bases, etc., for equipment
- d. Excavation forming for underground services of ducts and courses and then covers it.
- e. The cutting or forming of chases, recesses, etc., in floors, walls, etc., for conduits and fittings in and making good.
- f. Excavation for and laying of cable carrying pipes.
- g. The building in of brackets and supporting bars or other form of conduit or pipe suspensions.
- h. The painting of all pipes, tube and conduits etc. after fixing unless specified to the contrary.
- i. The providing and building in of sleeves through slabs and walls.

In general all required holes through walls, floors and beams for pipes and ducts will be left out by the Contractor during the process of building.

Where conduits, pipes or fittings are fixed to concrete or woodwork by means of saddles or clips, the Contractor shall himself execute the work necessary and the cost of such work shall be considered to have been so specified in the price.

Cutting, fitting, repairing, patching or plastering and finishing of carpentry work shall be done by craftsmen skilled in their respective trades, when cutting is required it shall be done in such a manner as not to weaken structure, partitions or floors. The holes required to be cut must be directed without breaking out around the holes. Where patching is necessary in finished areas of building, the Engineer shall determine the extent of such patching or refinishing.

23.0 TESTING – GENERAL

Upon completion of installation, at least seven days notice is to be given of intention to perform any test. The Contractor shall perform all static, semi-dynamic (by simulation), and dynamic field testing on all the equipment and systems.

All tests shall be conducted in the presence of the Engineer for the purpose of demonstrating equipment or system compliance with specifications. The Contractor shall submit for Engineer's approval complete details of tests to be performed describing the test procedure, test observations and expected results.

The Contractor shall furnish all tools, instruments, test equipment, materials, etc., and all qualified personnel required for the testing, setting and adjustment of all electrical equipment and material including putting the same into operation.

All tests shall be made with proper regard for the protection of the personnel and equipment and the Contractor shall be responsible for adequate protection of all personnel and equipment during such tests. The cost of any damages or rectification work due to any accident during the tests shall be the sole responsibility of Contractor.

The Contractor shall record all test values of the tests made by him on all equipment. Four copies of all test data and results certified by the Engineer shall be given to the Engineer for record purposes. These shall also include details of testing method, testing equipment, diagrams, etc.

The witnessing of any tests by the Engineer does not relieve the Contractor of his guarantees for materials, equipment and workmanship, or as any obligations of Contract.

In addition to installation testing, the Contractor is to carry out operation testing of all sections and is to clean, set, calibrate and fully commission, demonstrate and hand over to the Owner the entire Contract works in a thoroughly complete and operational state to the satisfaction of the Engineer.

The acceptance - provisional or final- shall be made by the Owner. This reserves him the right to be represented or assisted by a representative or an organization (whether official or not) of his choice, which may decide on his behalf any repairs deemed necessary resulting from lack of observations of this specification, or of the rules and standards. In addition, he may judge the quality of the works and the materials supplied.

This remains in force in case of sub-contracting.

The Contractor shall formally engage his direct responsibilities to the Owner or his representative, and likewise, shall assume all responsibility for work performed by sub-contractors and materials he has supplied and installed.

23.1 Insulation Resistance Test

Insulation resistance test shall be made on electrical equipment by using a megger of 1000 volts for circuits between 250 and 500 volts. The insulation resistance of distribution boards, cables, etc., shall be as per IEC, IEEE, BSS and Pakistan Electricity Rules.

The distribution boards shall be given an insulation resistance measurement test after installation, but before any wiring is connected. Insulation tests shall be made between open contacts of circuit breakers, switches and between each phase and earth.

If the insulation resistance of the circuit under test is less than specified value, the cause of the low reading shall be determined and removed. Corrective measures shall include dry-out procedure by means of heaters, if equipment is found to contain moisture. Where corrective measures are carried out, the insulation resistance readings shall be taken after the correction has been made and repeated twice at 12 hours interval. The maximum range for each reading in the three successive tests shall not exceed 20% of the average value. After all tests have been made, the equipment shall be reconnected as required.

23.2 Earth Resistance Test

Earth resistance tests shall be made by contractor on the earthing system, separating and reconnecting each earth connection as may be required by the Engineer. If it is indicated that soil treatment or other corrective measures are required to lower the ground resistance values, the Engineer will determine the extent of such corrective measures.

The electrical resistance of the E.C.C. together with the resistance of the earthing lead measured from the connection with earth electrode to any other position in the completed installation shall not exceed one ohm.

Earth resistance test shall be performed as per Electrical Inspector's requirements. Where more than one earthing sets are installed, the earth resistance test between two sets shall be measured by means of Resistance Bridge Instrument. The earth resistance between two sets shall not exceed one ohm.

23.3 Switchgear

Each circuit breaker shall be operated electrically and mechanically. All interlocks and control circuits shall be checked for proper connections in accordance with the wiring diagrams given by the manufacturer.

The Contractor shall properly identify the phases of all switchgear and cables for connections to give proper phase sequence.

Trip circuits shall be checked for correct operation and rating of

equipment served. The correct size and function of fuses, disconnect switches, number of interlocks, indicating lights and alarms shall be in accordance with approved manufacturer drawings. Nameplates shall be checked for proper designation of equipment served. Protective relays shall be tested and set at site prior to commissioning of the equipment.

23.4 Special Systems Tests

The special systems such as telephone, intercom, etc., shall be tested according to the procedures laid down in the respective sections of the technical specifications. However, any specific tests recommended by the manufacturer shall also be carried out as approved by the Engineer.

23.5 Complete Tests

After any equipment has been tested, checked for operation, etc., and is accepted by the Engineer, the Contractor shall be responsible for the proper protection of that equipment so that subsequent testing of other equipment do not cause any damage to the already tested equipment.

24.0 ELECTRICAL CONNECTION

Electrical connection for each station/building shall be supplied by other but necessary arrangement coordination to be done by this Contractor.

25.0 SHOP DRAWINGS/ AS BUILT DRAWINGS AND SERVICE MANUALS

A record shall be kept both in hard and soft copies as the work proceeds of any work not in accordance with the working drawings, and upon completion of the work, the Contractor shall prepare the following drawings and forward them to the Engineer for approval:

- a. Duplicate prints of as built single line diagram of the main and sub main distribution network, indicating all cables, their size and type, and the rating of all protection devices such as circuit breakers, fuses, etc.
- b. Duplicate prints of as built/shop drawings of Lighting, Power and Public Address, as applicable.
- c. Duplicate prints of as fixed control and wiring diagrams for the equipment installed as part of the Electrical Contractor works.

After these drawings have been approved, the Contractor shall supply two prints on paper of each and insert these in the operating and maintenance manual specified below.

The Contractor shall submit to Engineer for approval a sample of manufacturer instructions for installation, testing, commissioning, operation and maintenance manuals including manuals of spare parts and tools of the equipment. Upon acceptance, the Contractor shall supply three copies to the Engineer for forwarding to the Owner. These manuals should be in properly bound form. At least two copies of the documents shall be submitted in original. The installation instruction shall be submitted two weeks

prior to commencement of installation of each equipment, and operation and maintenance instruction at the time of commissioning. If the Contractor fails to provide the documents, the Engineer shall withhold issuance of requisite certificates and deduct suitable amount from the payments to the Contractor.

26.0 WORK COMPLETION

The Contractor shall further make good, repair, replace all defective works and clear away on completion and leave all installations in perfect working order and to the satisfaction of the Owner or his representative.

27.0 PAYMENT

No separate payment shall be made for work involved within the scope of this section unless specifically stated in the Bill of Quantities or herein.

SECTION - E - 2 LOW VOLTAGE SWITCHBOARDS / DISTRIBUTION BOARDS

PART 1 - GENERAL

1.01 REFERENCE

Conform to General Requirements for Electrical Services of Division 16.

1.02 DESCRIPTION OF WORK

Supply and installation of main low voltage switch boards (MDB), sub main distribution boards (SMDB), final distribution boards (DB) and related accessories.

This specification section covers the design and fabrication of low voltage switch gear including all items of equipment and materials necessary to complete the assembly and the information, documents and data required to be supplied by the supplier.

Any separate panels shall be as detailed hereafter. Separate panels shall comply with the requirements of this specification section.

1.03 QUALITY ASSURANCE

Design, manufacture, testing and method of installation of all apparatus and materials furnished under requirement of these specifications shall conform to latest publications and standard codes.

Product selection for restricted space: Drawings indicate maximum dimensions for the equipment, including clearance between the equipment and adjacent surfaces and items. Switchgears having equal performance characteristics and complying with indicated maximum dimensions may be considered.

1.04 CODES AND STANDARDS

The assemblies and the associated equipment shall conform to the requirements of the latest edition of the following standards and codes where applicable:

Low Voltage switchgear and control Gear assemblies	: IEC 61439-1,2
Circuit breakers	: IEC 947-1, BSEN60947-2, BSEN 60898
Isolators/switch disconnectors	: IEC 60947-1, IEC 60947-3
Current transformers	: IEC 60185
Voltage transformers	: IEC 60186
Measuring instruments	: IEC 51, IEC 414
Contactors	: IEC 60947-1, IEC 60947-4
Overload relays	: IEC 60947-1, IEC 60947-4
Control relays	: IEC 337-1, IEC 60947-1, IEC 60947-5
Indication lamps, Push buttons, Switches	: IEC 60947-5-1, IEC 337-1, IEC-60536

Tropicalisation	: IEC 68-2-30, IEC 68-2-1 & 2, IEC 68-2-11
Automatic transfer switching	: IEC 947-6-1
BSEN60051/IEC 51	Direct acting indicating analogue electrical-measuring instruments and their accessories.
BSEN60079/IEC 79	Electrical apparatus for explosive gas atmospheres.
IEC 112	Method for determining the comparative and the proof tracking indices of solid insulating materials under moist conditions.
BS5992/IEC 255	BS5992/IEC 255
BS88/IEC 269	Low voltage fuses.
BS5685/IEC 521	Class 0.5,1 and 2 alternating current watt-hour meters.
IEC 664	Insulation coordination for equipment within low-voltage systems, including clearances and creepage distances for equipment.
IEC 688	Electrical measuring transducers for converting AC electrical quantities to analogue or digital signals.
BSEN60947/IEC 947-3	Low-voltage switchgear and control gear. Part 3: Switches, Disconnectors, Switch-Disconnectors and Fuse-Combination units.
BSEN60947/IEC-947-4	Low-voltage switchgear and control gear. Part 4: Contactors and Motor-Starters.
BS 6231/IEC 502	PVC Insulated cables for switchgear and control gear wiring
BSEN 61008	Earth leakage circuit breakers
BSEN 61009	Earth leakage circuit breakers

Applicable local laws and regulations.

All panel boards shall be partially Type tested against short circuit as a minimum as per the latest IEC61439 and manufactured only by manufacturer having ISO 9001 Certificates. The Contractor shall also submit test certificates such as ASTA or as issued by any other independent testing authority confirming the declared short circuit ratings of Switch Boards and circuit breakers.

All mains and submain panel boards shall undergo the following test before dispatching and a test certificate shall be forwarded for the same.

- A. Primary injection test for all circuit breakers and meters.
- B. Secondary test for all protective relays.
- C. Millivolt droptest
- D. Insulation test
- E. Function test

All such tests shall be witnessed by the Engineer or it shall be carried out by an independent testing authorities.

The contractor is responsible for complying with all codes, which apply to the equipment. Any special certification requirements or inspection by other authorities arising from the above shall be arranged by the contractor and the costs for the same included in this quotation.

The equipment to be provided by vendor must be in complete compliance with this specification and reference codes. Exceptions or deviations "if any" shall be listed separately, with the quotation for THE CONSULTANT's approval. Any exception, which is not listed, shall not be considered.

Project Conditions:

- A. Verify dimensions by field measurements.
- B. Determine suitable path for moving switchgear into place considering project conditions.
- C. Verify clearance requirements. Locate switchgear to meet installation tolerances.
- D. Revise locations and elevations from those indicated as required to suit project conditions.

1.05 Submittals

A. Manufacturers Technical Data

During the time of the contract and before substantial completion of the electrical installation, submit to the consultant three(3) copies of descriptive literature, technical data, maintenance recommendations(from the equipment manufacturer), catalogues etc

B. Test Reports

Provide test reports prepared in accordance with K-electric requirements to the consultant. Provide other tests reports necessary to establish the adequacy, quality, safety, completed status, and suitable operation of each system.

C. Installation Instructions

Submit the complete manufacturers installation instructions of all the products used.

D. Calculations

Forward the following calculations and data:

Calculations and charts proving that discrimination in the breaker characteristics is achieved. Detailed short circuit level calculation to select the short circuit rating of the various switchboards. Bus bar sizing calculation for each switchboard. Calculation for Temperature rise inside switchboards

E. Shop drawings

The contractor shall furnish the following drawings and documents along this submittal for approval:

- a. Dimensioned drawing showing outline of the switch boards arrangement and position of important external features. These drawings shall show masses, crane lift necessary for untanking and size of lifting lugs or eyes.
- b. Single line diagram showing all auxiliary devices.
- c. Original catalogues for various proposed components.
- d. Drawings of nameplate and all termination arrangements.
- e. Drawing giving typical mechanical and electrical details of the voltage control apparatus.
- f. Details of cable terminations and fittings.
- g. Foundation plan, including foundation loading.
- h. Schematic and connection diagrams covering all equipment pertaining to the switch board.
- i. Type and special test certificates as applicable
- j. Approved test certificate / test report
- k. Schedule of Accessories and Fittings
- l. Technical Manual giving installation, operation and maintenance instructions
- m. Schedule of recommended spare parts.

PART 2 - PRODUCTS

2.01 MAIN LOW VOLTAGE SWITCH BOARD (MDB)

The specification hereunder shall be applied to all panel boards referred on the drawings (power layout, single line diagrams as MDB.

- A. The switchboards shall be partially Type Tested against short circuit as a minimum and comply with IEC 61439, Multicubicle type FBA, **Form 4b Type 4, Construction.**
- B. The switchboards shall be rated 400V three phase and neutral 4 wire 50HZ with neutral solidly grounded. The equipment shall be suitable for operating on a system having a fault level of 50 KA rms symmetrical.

The minimum short circuit rating of MDBs shall be 50KA for 1 second.

- C. The Contractor shall submit valid test certificate for short circuit protection such as ASTA or as issued by any other independent testing Authority to the consultant for approval.

- D. Refer to the single line diagram for rating and type of feeder required.
- E. Provide meters and CTs as shown in the single line diagram.
- F. Provide permanent lifting means on top of shipping sections.
- G. Include an integral roll-along lifting device for any switchgear equipped with draw out devices. Mount lifting device on top of switchgear.
- H. Electrical characteristics
- | | |
|---------------------------------------|--|
| Rated operating voltage | : 690V |
| Rated insulation voltage | : 1000V |
| Rated current | : 4000 A or 6300 A as per tender documents |
| Rated short circuit withstand current | : 50 KA, 1 Sec |
| Rated peak withstand current | : 105 KA |
- I. Special Tools
- The contractor shall provide a complete set of all special tools and devices necessary for the operation and maintenance of the complete assembly.
- The contractor shall provide a wall mounted panel to accommodate these tools and devices.
- J. The switchgear assembler should have a valid ISO 9001 certification.
- K. In case of local assembly the authorized / approved assembler shall strictly follow the guidelines and standards laid down by the manufacturer.
- L. The contractor shall provide fault level calculations to substantiate proper selection of all devices.
- M. The contractor shall carry out routine tests at their works with the valid testing equipment calibrated by reputed laboratory.
- N. The assemblies shall be of the dead – front, multi – cubicle type forming an enclosed F.B.A with air insulated switching devices. Each incoming or outgoing circuit-switching device shall be housed in its own enclosure. The switchgear shall be completely compartmentalized and metal enclosed in accordance with Form 4b separation described in IEC 61439. Assemblies shall be freestanding. All switchboards and MCC shall be single fronted and not double – front.
- O. All air circuit breakers shall be with drawable type. The incoming air circuit breakers shall have manually and electrically operated spring charge mechanism while the outgoing air circuit breakers shall be manually operated.
- P. All equipment and materials shall be new.

- Q. The assembly, including the framework, wiring, earth bar, etc., shall be suitable in all respects for extension at both ends such that only the minimum of work will be required to make such extensions.
- R. The switchgear shall be painted inside and out. Unpainted galvanized coating of internal metal work will not be acceptable.
- S. A space of 100mm shall be provided at the bottom of each panel.
- T. The panel shall be of uniform height of not more than 2200 mm.

2.02 CONSTRUCTION

- A. The degree of protection shall be IP-42 for indoor units.
- B. The switchboard shall be fabricated, welded; grinded, finished with angle iron framework and clad with 14 SWG MS sheet, to form a rigid, free standing, flush mounting fronted assembly. The sheet metal shall be coated with a thermosetting powder of any epoxy resin base modified by polyester resin, which provide perfect finish and excellent protection against corrosion (standard "all climate" protection). The thickness of powder coating shall not be less than 120 microns. The color shall be to RAL 7032 /9002 and to Consultant approval.

The switchboard shall be:

- a. Provided with a metal sill frame made of structural steel channels section properly drilled for mounting the switchgear along with necessary mounting hardware. Hardware shall be zinc plated and passivated.
 - b. Provided with labels on the front and rear indicating the switchgear designation.
 - c. Provided with cable entry facilities at bottom with 3mm thick removable gland plates and necessary cable glands. For 1 core cable these plates shall be nonmagnetic.
 - d. Provided with gaskets all round the perimeter of adjacent panels, panel and base frame, removable covers and doors.
 - e. Provided with bus-bar running at the top all along the Switchgear in a separate sheet steel enclosure.
- C. Operating devices shall be incorporated only in the front of the switchgear with a hinged door.

Only the handles of control and selector switches, push buttons, knobs and cutouts for lamps and meters shall be arranged on the front doors of the respective compartments to permit operation without opening the door. Protective relays shall be mounted on the front door of the

compartment. All cutouts shall be provided with gaskets for the purpose of dust proofing.

- D. Current transformers shall not be directly mounted on the buses. Current transformers shall be mounted on the fixed portion of the compartment.
- E. Suitable barriers shall be placed between circuit breakers and all control, protective and indication circuit equipment including instrument transformers. External cable connections shall be carried in separate cable compartments for power and control cables.
- F. After isolation of the power and control connections of a circuit, it shall be possible to safely carry out maintenance in a compartment with the bus bars and adjacent circuits live.
- G. The switchgear shall be divided into distinct vertical sections each comprising:
 - a. A completely metal enclosed bus bar compartment running horizontally.
 - b. Individual feeder modules arranged in multi-tier formation. It is essential that the modules are integral multiples of the basic unit size to provide for flexibility in changes, if any, at site.
 - c. Enclosed vertical bus-bars serving all modules in the vertical section for safety isolation of the vertical bus-bars, insulating barrier with cut outs shall be provided to allow the power stab contacts to engage with vertical bus-bars.
 - d. A horizontal separate enclosure for all auxiliary power and control buses, as required, shall be located so as to enable easy identification, maintenance and segregation from the main power buses. Tap off connections from these buses shall be arranged separately for each vertical section.
- H. Each vertical section shall be equipped with thermostatically controlled space heaters.
- I. Open metal sheet shall be provided between two adjacent vertical sections running to the full height of the switchgear except for the horizontal bus-bar compartment. However, each shipping section shall have metal sheets at both ends.
- J. All equipment associated with a single circuit shall be housed in a separate module compartment of the vertical section. The compartment shall be sheet steel enclosed at the sides and the rear with the withdrawable units in the position or removed. However, for front cable entry type switchboards, a plate cover with a slot to permit wiring connections shall be provided on the side corresponding to the cable alley
- K. All doors shall be provided with concealed type hinges and captive screws.

- L. All out-going breakers shall be fitted on prefabricated appropriate mounting plates and access to their operating toggles shall be provided through an appropriate front cover, fixed to the front frame.
- M. The cable connection shall be made in a separate compartment. The access shall be possible through hinged covers.
- N. The cubicle shall be divided into modules with a minimum of 15% of empty modules for extension.
- O. Cables entries/outgoings shall be as per site requirements.
- P. ACBs shall be draw-out with ratings, breaking capacity etc. as mentioned elsewhere in this specification and contract drawings.
- Q. Out-going MCCBs shall be Fixed type, operated by door interlocked rotary handles with ratings breaking capacity etc. as given elsewhere in this specification.
- R. The draw out contact shall be only between copper/copper alloy faces, which are silver-plated.
- S. All live parts shall be provided with suitable automatic shutter to cover all live parts when the section is in withdrawn position.
- T. No cast iron or cast aluminium shall be used in any part of the assembly which is subjected to mechanical stress.
- U. All incoming and outgoing switching devices shall have provision for locking in the 'off position.'
- V. Where the F.B.A is required to bridge one or more civil work expansion joints in the substation construction, this requirement shall be detailed on the civil drawings.
- W. Degree of Protection.

IP 20 minimum shall apply within an isolated compartment or cubicle while the remainder of the assembly is live. Metallic barriers shall provide this protection. Unless otherwise approved this requirement shall apply to bus-bar shutters and to devices energized from external supplies, such as motor heater auxiliary switches.

- X. Incoming and sectionalizing units

Incoming and sectionalizing units shall be air circuit breakers and shall be mounted in separate panels.

Air circuit breakers shall be four-pole or three-pole type as indicated in the single line diagram for three phase and neutral systems. They shall be provided with

"In Service/Out of Service/Test Point" positions and suitable locking devices shall be provided for the "Out of Service" and "Test Point" positions.

A dedicated compartment shall be included for metering on the incomers.

Supplier shall supply details for incoming units and bus-bar standard earthing arrangements.

Y. Outgoers

They shall be ACB or MCCB with type and ratings as indicated in the contract drawings and as specified in the relevant section of this specification.

Suppliers shall provide a minimum 160mm space between the base of the switchgear and the underside of the lowest outgoers.

All incoming and outgoing circuit breakers shall be provided with a release to trip the breaker, instantaneously if closed onto a fault.

All compartments shall occupy the full cubicle width; a semi module compartment or vertical division between compartments is not acceptable.

Supplier shall ensure that the number of outgoing feeders in any vertical section of switchboard shall be such that there is adequate space in the cable alley for all power, and all control cables entering the panel. The number of feeders shall not exceed 8 numbers for each vertical panel.

Z. Cable and Wire Terminations and Terminals

All internal control and auxiliary wiring shall terminate in suitable spring loaded, clamp type terminals and shall be provided with a permanent, easily read numbering system at both ends in accordance with the wiring diagram. Wires shall be identified by means of numbered and or lettered sleeves.

Formal blocks shall be arranged and positioned to afford easy access for carrying out external cabling, testing, inspection and maintenance.

Cable Glands shall be of the double sealed compression type with position armor bond suitable for XLPE and PVC insulated cables.

AA. Mechanical Indications

All main circuit devices other than contactors shall be provided with mechanically operated "on" and "off" indicators which shall be positively driven in both directions and shall be visible from the front of the assembly.

BB. Safety Shutters

Where shutters are provided to maintain IP 20(minimum), they shall automatically cover all bus bar and cable spouts or isolating contacts whenever removable or withdrawable units are removed.

The safety shutters shall be automatically opened and closed by action of the removable or withdrawable unit movement. A positive drive to the shutters shall be provided in both directions.

They shall be capable of being padlocked in the closed position.

CC. Interlocks

All units shall be provided with a complete set of electrical and mechanical interlocks to prevent incorrect operation and to provide safety for personnel in addition to any external interlocks specified for operational reasons.

On removal of withdrawable units, mechanical interlocks shall be provided to prevent the following operations and any other operations which could cause danger or damage:-

- a. The unit being closed unless it is correctly located in the service, isolated or earthed positions or unless it is removed from the fixed part of the assembly.
- b. The unit being withdrawn from or inserted into the feeder spouts or isolating device when it is in the closed position.
- c. The unit being moved to any position other than that selected by means of the mechanical selector.
- d. The unit being withdrawn or inserted into the fixed part unless it is in the correct state for withdrawal or insertion.
- e. The unit being closed in the service position unless all auxiliary circuits between fixed and removable parts have been completed.
- f. Means shall be provided to prevent opening of cubicle doors or covers before disconnection of supply to exposed live parts within.

DD. Interlocks and Transfer Functions

The general philosophy of the required inter-trips and interlocks shall generally be as indicated hereunder. The vendor shall submit all logic diagram and interlocking line diagram to THE CONSULTANT for approval.

The main switch board incoming transformer feeders, and the bus section circuit breaker shall be provided with the required electromechanical interlock for auto transfer incase of failure of an incoming supply facilities shall be provided for manual transfer.

The various interlocking schemes shall generally as indicated on the drawings and to THE CONSULTANT approval.

- EE. Nameplates shall be engraved on traffolite/ PVC sheet, with Black letters on white background. Nameplates for main breaker, tie breaker, section and outgoers modules identification and for the entire switchboard shall have letters not smaller than 13 mm high. Nameplates for branch breakers, switches, push buttons, control devices, pilot lights and metering shall have letters not less than 3 mm high. All Main nameplates shall be mechanically fixed with non-ferrous metal screws.
- FF. Warning signs on doors and access panels shall be engraved traffolite with white letters on red background.
- GG. Control contacts, auxiliary contacts, relays and small or light mechanisms shall be enclosed and protected, and shall be accessible for repair or adjustment.
- HH. Engraved trifoliate /aluminum mimic of the SLD shall be provided on the front face of the switchboard. The same shall be mechanically fixed with non-ferrous metal screws.
- II. Anti condensation heaters shall be provided within the assembly.

2.03 BUSBARS

- A. The bus-bars shall be TPN+E (full neutral and half earth). Earth bar shall run through the entire length of the switchboard. The metal frames and all components shall be connected to the earth bar.
- B. The bus-bar shall be of uniform cross section throughout the length of the switchgear and shall be of hard drawn high conductivity tinned copper.
- C. Bus-bars shall be provided with at least the minimum clearances in air as per applicable standards for a 500V, 3 phase system.
- D. The complete bus-bar system shall be certified for a fault level as indicated on the drawings, certificate for a typical bus-bar system assembled by the switchgear assembler shall be submitted to THE CONSULTANT for approval.
- E. Bus-bars shall be totally enclosed within sheet steel compartments to provide optimum safety against accidental contact. The bus-bar compartments shall be properly marked with danger signs.
- F. Horizontal and predrilled vertical bus-bar, make modification and extension very easy in addition to the above characteristics.
- G. The vertical bus-bars shall be accessible through hinged doors.
- H. The bus-bars shall be PVC sleeved with high die electric strength (450 V/mm). The maximum operating temperature at a design temperature of 55 deg. C shall not exceed 90 deg. C for normal operating and 200 deg. C for short circuit conditions. The bus-bar dropper shall be rated at 120 % of the current carried by the bus-bar with a minimum of 800 A rating.

- I. MDB manufacturer to provide bus bars extension all the way up to flanged end of busway inside MDB.

2.04 SUBMAIN DISTRIBUTION BOARD (SMDB-FREE STANDING)

A. Description

- a. The distribution panel(s) shall be of the free standing cubicle multitier type incorporating 3 phase, neutral and earth insulated tinned copper busbars, all necessary CTs, and the like as required.
- b. Each cubicle shall be equipped with thermostatically controlled heaters which shall be 'on' all the time and ventilation means wherever shown in the SLD.
- c. Switchboard shall be designed to operate on a 400/230V 3 phase and neutral 50HZ supply and shall have a short circuit rating as noted in drawing for 1 second, for the SMDB's, switchboards shall be constructed in accordance with IEC 61439-2 multicubicle type FBA **FORM 2b Type 2**.
- d. Sub Main Distribution panel(s) shall be equipped with all necessary circuit breakers and components with enough spare outgoing for any future use.

B. Busbars

- a. The busbars shall be made of hard drawn high conductivity tinned copper and rated for continuous operation. The main bus bar rating shall be the same throughout the entire length of the switchboard and a provision shall be made in the busbars system to allow for expansion and contraction caused by temperature variation.
- b. The busbar shall be sized taking into consideration the ambient temperature and the specified temperature rise.
- c. The neutral busbar shall have the same size as the phase busbars while the earth bar shall have a minimum size of half the phase busbar.

C. Breakers

- a. All breakers shall be fixed type and all circuit breakers of the same type and rating shall be entirely interchangeable.
- b. The cubicle shall be front operated with a mechanical ON/OFF position indicator and shall be designed and tested in accordance with relevant standards.
- c. The main incoming supply shall be complete with a flush mounted ammeter for each phase, CTs, phase to phase voltmeter. Each meter shall have a phase selector switch and indication lamps.

D. Enclosure

- a. The switchboard shall be constructed of minimum 2mm thick electro-galvanized steel coated with high solid enamel polyester electrostatic spray and oven baked 16SWG. There shall be adequate channel frames, drilled or slotted for ease of assembly, to support cable tails, clamps and terminations within the cubicles.

The busbars shall run in a separate compartment with the partition shall be made of Aluzinc or of similar material as the enclosure of at least 1mm thickness. All entries and openings shall be vermin-proof. All live conductive parts either on the incoming or outgoing side shall be shielded in such a manner that they cannot be accidentally touched when the doors are open.

- b. The degree of protection of the Switch Board enclosure should be IP-42
- c. The contractor shall provide all necessary means of ventilation and forward the necessary calculation in order to ensure that maximum temperature rise within the panel will not exceed 35 deg at the operating ambient temperature of 55 deg C.

2.05 SUB MAIN DISTRIBUTION BOARDS (SMDB-WALL MOUNTED).

A. General

MCCB distribution boards shall comply with IEC 61439-2 **Form 2b, type 2**
Enclosures:

- a. MCCB distribution boards must be totally enclosed.
- b. The degree of protection according to IEC 439.1 shall be IP 42 minimum for indoor installation and IP 55 for outdoor installation.
- c. The enclosure shall be manufactured from minimum 1.5 mm thick 16SWG electro-zinc coated sheet steel with Epoxy polyester powder finish and color to COMPANY approval.
- d. A hinged door fitted with lock and key has to be opened for operating the switchgear. Access to the cabling space and to the switchgear shall be obtained by removing a front cover bolted fastener.
- e. Ample-wiring space shall be provided. Detachable blank gland plates shall be provided at the top and bottom.
- f. Anti condensation heater shall be provided wherever shown in the SLD.

B. Breakers:

- a. Incoming breakers shall be isolator and out-going breakers shall be MCCBs of fixed type. Breaking capacity of the MCCBs shall be in line with the prospective fault level of the installation but shall not be less than fault level calculation. Ratings and capacity shall be as given elsewhere in this specification.
- b. Short circuit calculations shall be submitted to the engineer for approval.
- c. Breaker selection shall be made to achieve maximum discrimination between the upstream and downstream breakers.

C. Electrical Characteristics:

- a. Rated insulation voltage : 600V (AC)
- b. Maximum rated current of bus-bars : up to 800 A or as mentioned on drawings.
- c. Rated short time withstand current of bus-bars shall be as shown on the single line diagram.
- d. The short circuit capacity of the distribution boards shall be 25 kA minimum and shall be rated to withstand the short-circuit level of the position it is installed. A short circuit level calculation shall be submitted and the short circuit level of the distribution board shall be upgraded accordingly.

2.06 DISTRIBUTION BOARDS

A. Description

- a. The specification hereunder shall be applied to all panel boards referenced on the drawings/load schedules as DBs. The distribution board shall be flush / surface mounted split busbar type and shall be provided with standard extension box to allow cable glanding if required. The distribution board shall be surface mounted when installed within the electrical room/service rooms.

Distribution boards shall be provided with an isolator incomer with common ELCBs for group of lighting circuits and common ELCBs for group of power circuits for each section of MCBs for each power circuit as shown on schedules.

- b. As a standard item, all MCB boards shall be provided with permanent circuit identification charts to the approval of the engineer.
- c. MCBs shall comply with IEC – 898 and RCBOs shall comply with BSEN 61009. ELCBs shall comply with BSEN 61008.
- d. DBs inside electrical rooms shall be surface mounted type fixed onto a U channel support.

B. Enclosures

- a. The MCB Distribution Boards shall be surface/flush mounted type. The enclosures within Electrical rooms must be surface mounting type. Powder

coated rustproof sheet steel units 16SWG, complete with circuit breakers providing thermal overload and magnetic short-circuit and earth fault protection as shown on the drawings. The enclosure protection shall be IP 31, while the complete assembly shall comply with IEC – 439-1.

- b. Surface wall mounted DBs shall be fixed on U channel support and not direct to the wall.

C. Busbar

- a. The MCBs shall be mounted on either 3 phase or single phase or split busbars as appropriate. All spaces which are not provided with breakers shall be covered with blank plates.
- b. A final sub-circuit neutral assembly and an earthing bar assembly shall be available to facilitate the connection of neutral conductors and protective conductors respectively.

D. Breakers

- a. Miniature circuit breakers and earth leakage circuit breaker and shall be provided as indicated on the load schedules.
- b. The short circuit rating for the MCBs shall be 6KA for DB's.
- c. All circuit breakers shall be factory calibrated to ambient temperature of 40 deg. C.

2.07 DISCONNECT SWITCH

- A. Disconnect switches (isolators) shall be manufactured to IEC and British standards.
- B. Disconnect switches shall be heavy duty (AC23) with operating handle interlocked with the switch cover, in general purpose rust proof aluminium enclosure and to IP44 finished in gray stove finish.
- C. Switches shall be quick make, quick break action. Provision shall be made for padlocking in either the "On" or "Off" position.
- D. Switch blades shall be fully visible when in the "Off" position.
- E. Operating handles shall be interlocked to prevent doors from being opened when switch is closed. Provision shall be made to defeat this interlock with a screwdriver.
- F. Fuse clips shall be designed for HRC BS 88/IEC 269 fuses without adapters and shall reject standard code fuses.
- G. Switches mounted outside, in damp or dusty locations and unconditioned areas shall be supplied in weather resistant enclosures IP 65 made of aluminium with double wall construction.

- H. Sample and catalogues with installation details shall be submitted for approval by THE CONSULTANT prior to ordering.
- I. Provide a disconnect switch ahead of all motors, starters and electrical equipment where shown on the drawings and where required to meet Code regulations and jurisdictional authorities, whether the equipment is supplied or installed under the Electrical Division or any other division.
- J. All disconnect switches shall be provided with tag to THE CONSULTANT approval to indicate equipment connected to the switch. The feeding circuit reference and the related distribution board number.

2.08 AIR CIRCUIT BREAKERS

A. General

- a. The circuit breakers shall comply with IEC947-2, 3pole or 4pole as mentioned in the single line diagram. However the incomer and bus coupler ACBs shall be of 4 poles.
- b. The breaking capacity performance certificates shall be available for category B to the above mentioned standards. The test shall be carried out with a breaking performance during operation (Ics) equal to the ultimate breaking capacity (Icu).
- c. All circuit breakers can be reverse fed without reduction in performance.
- d. Breaker shall be equipped with a grounding device to solidly ground the framework before the main disconnecting contacts are engaged and to maintain the grounding until after the contacts have separated.
- e. Breaker trips shall be completely self-powered with no external control power source required. If external control power is required, 125V D.C. batteries and charger shall be provided. Batteries to be Sealed Maintenance Free type.
- f. Breakers shall be provided with overload, short circuit and earth fault protection and have the following functions:
- g. Adjustable long time delay trip.
- h. Adjustable short time delay trip.
- i. Instantaneous trip,
- j. Ground fault trip. For incomer ACB only.
- k. Breakers shall be suitable for operating at 55 deg. C ambient temperature and shall be tropicalised.

B. Construction

- a. The air circuit breaker ratings shall be as shown on the single line diagram.
- b. All air circuit breakers main contact shall be encased in a reinforced polyester casing and offer double insulation from the operators on the breaker front face. The circuit breaker also shall offer total insulation between the control part and the power part.

C. Operating Mechanism

- a. The operating mechanism shall be the O-C-O stored energy spring type motor/manually operated with a closing time of less than or equal 80 ms.
- b. Each breaker shall be provided with 3 nos. normally open and 3 nos. normally closed potential free spare auxiliary contacts rated 10A at 240 V AC.

D. Arc Chutes

Arc chutes shall be common on the whole range and removable on site to allow inspection of arc chutes and main contacts.

E. Auxiliaries

All electrical auxiliaries including the motor spring charging mechanism shall be field adaptable without adjustment or the necessity for any tool (except a screwdriver).

F. Trip Units

The trip units shall be micro-processor based type and use digital programming technique for highest protection accuracy against overload, short circuit and earth fault. They shall be integrated as part of the circuit breaker. The trip unit shall have a wide adjustment range to allow flexibility of the setting on site. The trip unit shall measure the true RMS value of any waveform of current. The trip unit shall be equipped with a push to reset mechanical indicator, for anti-pumping function.

G. Control Unit

The control unit shall be microprocessor based type and shall make it possible to display the electrical quantities relevant to the protected line, and the control of electrical devices through power relays housed in the release case.

The control unit shall also provide the following :

Maintenance indications providing the wear and tear of the main power contacts of the breaker etc.

H. Dialogue Unit

The dialogue unit shall be microprocessor based type and shall give information on electrical quantities, alarms and the circuit breaker condition. Besides it shall receive the operational commands for the circuit breaker sent by centralized system.

I. Auxiliaries and Accessories

- a. 1 ammeter and volt meter with selector switch.
- b. Operation counter
- c. ON/OFF/Fault/Control Circuit fault indication light with lamp test facilities.

2.09 MOULDED CASE CIRCUIT BREAKERS (MCCB)

Moulded case circuit breakers shall conform to the latest editions of BS EN 60947-2.

The MCCB's shall have a minimum service short circuit capacity similar to the panel board where the same is installed.

Three pole breakers shall have a common trip with a single operating handle and designed so that any overload in one pole automatically causes all poles to open. Breakers shall be trip free and each shall have a trip indication independent of ON or OFF positions.

Wherever shown on the drawings MCCBs shall be provided with earth leakage alarm relay or earth leakage relay of fixed/adjustable sensitivity.

A. MCCB From 100 To 800 A or as mentioned on drawings

- a. The moulded-case circuit breakers shall be designed for both vertical and horizontal mounting, without any adverse effect on electrical performance. It shall be possible to supply power either from the upstream or downstream side.
- b. The moulded-case circuit breakers shall provide class II insulation (according to IEC 664 standard) between the front and internal power circuits.

B. Construction

- a. For maximum safety, the power contacts shall be insulated in an enclosure made of a thermosetting material from other functions such as the operating mechanism, the case, the trip unit and auxiliaries.
- b. The operating mechanism of the moulded-case circuit breakers shall be of the quick make, quick-break type with fault tripping overriding manual operation. All poles shall operate simultaneously for circuit breaker opening, closing and tripping.

- c. The moulded-case circuit breakers shall be front operated by a toggle or handle that clearly indicates the three positions: ON, OFF and TRIPPED.
- d. The moulded-case circuit breakers shall be equipped with a "push to trip" button in front to test operation and the opening of the poles.
- e. Where required, motor operated mechanism, shunt trip, under voltage release, auxiliary switches up to four changes over contacts and a tripped signal contact shall be provided. Each of these units shall incorporate a pre-wired terminal strip, which is accessible from the front of the breaker without removing the cover.

C. Current Limiting

The moulded case circuit breakers shall be capable of greatly limiting currents. For short circuits, the maximum thermal stress it shall be limited to

$10^6 \text{ A}^2 \text{ s}$ for ratings up to 250A.

$5 \times 10^6 \text{ A}^2 \text{ s}$ for ratings between 400A and 630A.

A : Amps and S : Seconds

These characteristics will allow high cascading performance with moulded-case or miniature circuit-breakers.

D. Auxiliaries and Accessories

- a. The addition of motor mechanism or a rotory handle shall in no way affect circuit breaker characteristics:
- b. Only three stable tripping mechanism positions (ON, OFF and TRIPPED) shall be possible with the motor mechanism.
- c. Suitability for isolation shall be provided by positive contact indication (ON and OFF) in front of the motor mechanism module.
- d. The moulded case circuit breakers shall be designed to enable safe on-site installation of auxiliaries such as voltage releases (shunt and under voltage releases) and indication switches.
- e. The addition of a motor mechanism, module or a rotory handle, etc., shall not mask or block device setting.
- f. It shall be possible to equip the moulded case circuit breakers with devices indicating faults without tripping the circuit breaker.

E. Protection Function General Recommendations

- a. Moulded case circuit breakers with ratings up to 250A shall be equipped with inter changable Thermal-magnetic trip units.
- b. Moulded case circuit breakers with ratings over 250A shall be equipped with electronic trip units. The trip units shall not augment overall circuit breaker volume.

- c. Electronic trip units shall comply with appendix F of IEC 947-2 standard (measurement of RMS current values, electromagnetic compatibility, etc.,)
- d. Electronic and thermal-magnetic trip units shall be adjustable and it shall be possible to fit lead seals to prevent unauthorized access to the settings.
- e. Protection settings shall apply to all circuit breaker poles.

2.10 MINIATURE CIRCUIT BREAKERS

- A. MCBs shall comply with BS EN 60898.
- B. MCBs shall be 35mm symmetrical rail mounted type and available in one, two, three or four poles version.
- C. MCBs can be reverse fed without reduction in performance.
- D. Construction
 - a. The operating mechanism shall be mechanically trip free from the operating handle so as to prevent the contacts from being held closed against short circuit conditions. It shall be of the "automatic resetting type".
 - b. The individual operating mechanism of each pole of a multi-pole MCB shall be directly linked within the MCB casing and not by the operating handles.
 - c. The operating handle shall be of the toggle type.
 - d. Each pole shall be provided with bi-metallic thermal element for overload protection and magnetic element for short circuit protection.
 - e. Terminals shall be of the tunnel type (IP20) in order to minimize the risk of direct contact.

2.11 METERING

- A. Meters (indicating instruments) shall be provided as shown in the schematic diagram.
- B. All meters shall be moving iron type, minimum of 72 sq. mm square shape and 90 deg. scale.
- C. All meters (indicating instruments) shall be of class 1.5.
- D. Instruments shall temperature compensated to operate between -25 deg. C and + 55 deg. C and shall be tropical version.
- E. All meters shall comply with IEC 51.

2.12 CURRENT TRANSFORMERS

- A. Current transformers shall comply with IEC 185.
- B. The conditional ratings of current transformers shall correspond with the switchboard rating and shall be such as to maintain the overall metering

accuracy as is necessary to operate relays within the tolerances specified by the manufacturer.

C. Current transformers secondary ratings shall be:

1. for protection 1A
2. for metering 5A

D. Current transformers shall have the following accuracy as a minimum, for protection Class 5P (Except for REF Protection which will have PS class CT)

E. for indication Class 1

F. for metering Class 1

G. The manufacturer shall ensure that the current transformers are such that the relays will operate correctly when set at any point within their ranges.

H. Current transformers secondary wiring shall be earthed on one side through a removable link. Where current transformers are connected in star, the star point shall be earthed through a removable link.

I. Shorting links shall be provided for each current transformer.

J. Current transformers shall be cast resin insulated.

2.13 VOLTAGE TRANSFORMERS

A. Voltage transformers shall comply with IEC 186.

B. Voltage transformers shall be suitable in rating and accuracy for their functions, loads and duties.

As a minimum they shall have following accuracy,

Protection applications Class 5P

Indication and metering applications Class 1

C. The primary and secondary circuits of the voltage transformers shall be protected by fuses and the secondary winding shall be earthed at one point through a removable link.

D. Voltage transformers shall be cast resin insulated.

E. The manufacturer shall provide MCBs with auxiliary contacts or alternatively 4-pole MCBs on the secondary side of the voltage transformers.

2.14 CONTACTORS

A. All contactors shall comply with IEC 947-1, IEC 947-4.

B. Duty category for lighting contactors shall be AC1 and for inductive load shall be AC3.

C. Contactors shall be protected against direct finger contact, mechanical life shall be 15 to 20 million operating cycles. Shall be suitable for 1200 operating cycles per hour.

D. The contactors shall be of 3 pole construction capable of handling high rush currents and suitable for operating up to 55 deg. C ambient temperature without any derating.

E. Coils shall operate between 85% to 100% of the nominal voltage.

2.15 EARTH LEAKAGE CIRCUIT BREAKERS (ELCBS)

Current operated earth leakage circuit breakers shall be in accordance with BSEN 61008 providing the functions of isolation, switching and earth leakage protection of electrical circuits.

The ELCB's shall have a residual current operated electro mechanical release.

The ELCB's shall incorporate a filtering device to eliminate unwanted tripping due transient voltage.

A test push button is to prove operation.

A trip free mechanism is required to ensure that the unit cannot be held closed against an earth fault.

The tripping device is connected directly to the secondary of the current balance transformer.

No amplifiers or rectifiers are to be used.

The breaker shall be double pole when used for single phase and 4 poles when used for three phase circuit protection.

The ELCB's shall have 30mA or 100mA sensitivity as indicated in the drawings.

2.16 OVERLOAD RELAYS

These are to be used in conjunction with motor starters to provide protection against overloads, phase sequence, phase failure (single phasing) and under voltage conditions.

The relays shall be selected such that the full load current of the equipment protected falls at the centre of the relays adjustment range.

Incase of Star Delta starter, the overload relays shall be placed on the main's contactor.

2.17 CONTROL RELAYS

Shall be of the encapsulated plug-in type and incorporate visual indication that the operating coil is energized.

Bases for relays shall be mounted horizontally, to ensure relay is vertical above the base when the control cabinet is in its intended location, with screw type terminals, suitable for receipt of spade type crimped/soldered lugs.

Adjustable timer delay relays used for the star delta starter shall ensure precise reproducibility of the timing function. The relay shall have a linear setting scale over a 350 deg. rotation by means of knurled knob with timing guide marks.

The relay shall be equipped with two electrically separated time delayed contact one normally open and one normally close.

2.18 INDICATION LAMP

These are generally used to indicate main's presence, run, trip, fault and to give fault alarm or indicate any other function.

Indicator lamps shall be of the low voltage 24 volt transformer with twin LED lamp type and accord with the signaling colours laid down in BS. 4099. Minimum lens diameter shall be 12.5mm and all lenses on a panel shall be of a matching size and appearance and removable from the front for lamp replacement.

Terminations shall be screw grip to receive spade typing crimped/soldered lugs.

2.19 SELECTOR SWITCH

They shall be of the complete rotary cam type rated to suit item controlled and fitted with pointer type switching knob. Terminations shall be screw grip to receive spade type crimped/soldered lugs.

Hand off auto selection switch shall have three positions with centre position off and shall be key operated wherever necessary.

Selector switch when used along with the voltmeter it shall have 8 positions, i.e phase to phase, 3 phase and 2 off position.

2.20 ACCESSORIES

- A. Furnish the following accessories,
- B. Set of extension rails, if required
- C. Hoisting device for removing breakers
- D. Set of test plugs
- E. Levering out device, if required
- F. Manual maintenance closing lever, for electrically operated breakers
- G. Set of special tools and hardware

2.20 VARIABLE FREQUENCY DRIVES

- A. General Description

This Specification describes the requirements for the 400V Variable Frequency Drive Controllers (VFD). The 400V Variable Frequency Drive Controllers shall be designed and provided in accordance with this Specification and the attached data sheets. The proposed Manufacturers installation requirements should be complied by the Manufacturers as part of the Contract including shielded power cables (if required), enclosure for VFD's, earthing requirements, etc. to achieve EMC Compatible installation. All details shall be furnished as part of the submittal.

B. Scope of Supply

The scope of supply includes the design, manufacture, testing and delivery of the 400V VFDs as described above. The VFDs shall comply with EMC directives and provide with filters. All VFDs shall be communicating type using LON / Modbus.

C. Supplied By Contractor

Equipment unloading and storage at the Job Site.

D. Codes and Standards

- a. All equipment shall be designed, manufactured and tested in accordance with the latest edition of the applicable:

NFPA 70

IEC 146

EN Standard/CE marked for EMC directives:

Emissions

Immunity

EN 50081-1

EN 50082-1

EN 50081-2

EN 50082-2

EN 55011 Class A

IEC 801-1, 2, 3, 4, 5, 6, 8

EN 55011 Class B

EN 50178

- b. EN 60204-1

- c. The manufacturer shall furnish the product as listed and classified by underwriter's laboratories as suitable for the purpose specified and indicated.

E. Environmental Conditions

- a. The VFD product line shall be capable of operating normally in an environment with an ambient temperature range of 0 °C to 50 °C with a relative humidity of up to 95% (non-condensing). The enclosed current rating shall be derated by 10% for each 5 °C above 50 °C not exceeding 60 °C.
- b. The product line shall be capable of being shipped and stored in an environment with an ambient temperature range of 0 °C to 65 °C.
- c. The nominal operating altitude shall be less than 1000 m above sea level.

F. Product Delivery and Handling

- a. Ship controllers in convenient sections crated and protected, bearing in mind the hazards of transportation.
- b. All necessary bus connections, wire jumpers, bolts, nuts, etc. shall be suitably packed and identified to facilitate field assembly.

G. Products

a. General

- b. The variable speed drive controllers' technical requirements shall be in accordance with the data sheets. Seller shall be responsible for ensuring that under all operating conditions:
 - The controllers and their characteristics shall be compatible with their respective driven production motor and the plant control system. Seller shall obtain speed (frequency) range required and maximum frequency permitted for each type of controller from the load equipment supplier.
 - The VFD shall be suitable for use with high efficiency Design B, 400 V motors.
 - The total harmonic distortion (THD) voltage in the plant electrical and local systems shall not exceed 5% and no individual harmonic shall exceed 3% during normal plant operation.
 - Computerised harmonic analysis studies to IEEE Standard 519; copies of the studies shall be provided with the proposal.
 - The VFD shall be fully digital pulse width modulated type (PWM) using latest generation IGBTs with isolating contactors and line reactors.

c. Design Requirements

- I. The VFD controllers shall be suitable for operation on 400 Volt $\pm 15\%$, 3 phase, 50 Hz input power supply and 0-400 Volt, 3 phase, 0.5 to 400 Hz output. No transformer shall be used on either the input or output of the VFD.
- II. Each controller shall comprise:
 - Enclosure with filters and gaskets construction, mounted on steel sills.
 - Incoming supply terminals complete with cable lugs.
 - Padlockable line disconnect switch with bolt on HRC fuses in each phase.

- 110% overload capacity above motor service factor demand (115%) for 30 minutes.
- Short circuit and current limit protection.
- Surge (TVSS) protection wherever shown in the SLD.
- Stop / Start contactor to ensure when the motor is not running, no voltage is present on the motor power terminals wherever shown in the SLD.
- Wireways with removable gland plates.
- Incoming power system isolation transformer, if required, with thermal sensing in each phase, and filters to limit on the plant 400V bus THD to 5%; no single harmonic to be more than 3%.
- Drive operation man machine interface (MMI) keyboard.
- Stepless non reversing minimum and maximum motor speed adjustments, adjustable ramp up rates, minimum/maximum speed limits for pump motors. Adjustments to be password protected.
- Man / Auto select switch via keypad, with locking via password in both positions (see Note).
- Local/Remote selector switch via keypad with locking via password in both positions (see Note).
- "Drive Ready" with remote signal.
- Stop and start pushbuttons via keypad, in remote mode.
- Speed control: Local / Remote / Automatic via keypad.
- Motor speed indication via LED display.
- Motor On / Off indication via LED display.
- Emergency stop pushbutton, local at controller and local to plant provision.
- Drive status and failure diagnostic feature via LED display. Feature to log, time and date the last 30 fault conditions.
- Indication of output to drive current on each phase.
- Isolated I/O control signals.

- Motor multi-function protection, providing short circuit (51), overvoltage (59), undervoltage (27), thermal (49), stalling (49S) and phase unbalance (46) protections, complete with ground fault (51G) protection device to trip the incoming supply.
- Bolted and shrouded bolted type terminals for terminating load cables.
- Weidmuller or Wieland type terminal blocks shall be provided to connection of external wiring and cables.
- Interposing relays as required.
- 110V AC control voltage or manufacturers standard.
- Microprocessor based electronic self-diagnostics and fault detection system.
- Each cubicle shall be provided with an earthing bus, complete with two connectors for connecting to the plant earthing system. Drilled holes shall be provided for connecting cable earth conductor.
- VFD controllers shall be provided with a lamaroid engraved nameplate, minimum size 150mm x 75mm, engraving details to be provided by Purchaser.

In "Man" mode, two modes shall be functional: Local or Remote. In "Local" mode, motor shall be started from Start/Stop pushbuttons via controller's keypad. In "Remote" mode, motor shall be started from pushbutton station located near motor (if required).

III. Performance

The VFD shall have the following features as a minimum:

- Minimum efficiency of 97% at maximum load and speed.
- Minimum line side displacement power factor of 0.95 to 1.0 lagging at all speeds and loads.
- Adjustable motor frequency of 0 to 400 Hz.
- Separately adjustable acceleration and deceleration ramps from 0 to 999 seconds.
- Rotating motor restart feature.
- Capable of running without a motor connected for set-up and testing.

- Skip frequency reject point to prevent operating of the equipment at a resonant speed.
- Ride through for power outage of at least 2 seconds duration
- Load loss detection
- Overload protection
- Auto economizer
- The flying start feature operable with or without encoder feedback

IV. Discrete Operation

Inputs

- Start
- Stop

Outputs

- Ready to start
- Running
- VFD general fault alarm status
- VFD Auto and Man/Local/Remote operation status

V. Analog Operation

Inputs

- Speed control signal

Outputs

- Speed signal feedback
- Phase currents (percent)
- Frequency (percent)

VI. Verification of Interface

Vendor shall demonstrate functional testing and operational verification of the control interface with the Building Management System via Modbus, Bacnet, LON, or equal as required.

d. Inspections and Factory Test

- I. Controllers shall be inspected at all stage of manufacture in accordance with the Seller's Quality Assurance Program and shall be completely assembled in the works. Seller shall provide a production schedule, which shall give details of the production processes. Seller shall provide a QA
- II. Manual, which shall detail the inspections, testing to referenced standards, and burn in at full load at an ambient of 50 °C, for a minimum of 8 hours. All deficiencies shall be corrected before shipment.

H. Painting

All metal surfaces that are to be painted or coated shall be cleaned to an equal of a commercial finish as defined in the Steel Structures Painting Council's manual - SSPC-SP6-63, modified to exclude wet sandblasting and painted to manufacturer's standard finish. Internal surfaces shall be painted white.

I. Nameplates

Nameplates shall be provided for each VFD controller.

2.21 MOTOR STARTERS

A. Description

Starters shall be manufactured and type tested in accordance with IEC 947-4 and IEC 947-4-1

All motors shall be provided with heavy duty contactor type motor fuseless starters selected for coordination type 1 in accordance with IEC 947-4 generally complying with the following and protected through circuit breaker.

- a) 4KW direct on line starting
- b) 5.5KW to 25KW Star Delta starting
- c) 25KW and above reduced voltage electronic soft or VFD as appropriate as indicated.

Each starter panel shall be provided with a main incoming Non Auto MCCB / isolator capable of carrying the full load current.

Each starter shall comprise as a minimum:

- a. On load triple pole MCCB with two normally open and one normally closed auxiliary switches wherever shown in the SLD. The MCCB to be mechanically interlocked with the starter component door and capable of breaking the motor starting current and of making onto a fault at the motor terminals.

Provision to be made for padlocking the MCCB in the 'OFF' position.

- b. Three pole contactors to be fitted with required normally open and required normally closed auxiliary contacts to obtain the specified starter type.

All the auxiliary contacts to be wired down to the starter terminal block.

- c. One triple pole thermal over current relay incorporating over current, phase sequence and single phase protection with adjustable trip settings.

External mechanical hand reset to be provided.

- d. One control circuit MCB or fuse and one copper link.

- e. Each starter shall be fitted with one set of local start/stop push buttons and a local/remote/auto selector switch or hand/off/auto switch as required. Each starter control wiring terminal block shall include control terminals for connection of remote push buttons, auto circuits and local and remote emergency stop push buttons.

- f. Where more than one motor with a duty/standby or duty/backup functions used, the starter control wiring shall be arranged to automatically change duty upon the fault tripping of the selected motor. A duty/standby or sequence selector switch shall be provided.

- g. Each starter shall be fitted with twin led indication lamps indicating:

1. Motor running (green)
2. Motor Overload Tripped (red)

- h. Each starter shall be fitted with an ammeter and selector switch for motors 30 KW and above.

- i. Each starter to be equipped with labels giving drive designation, plant number and control operation.

- j. Each starter control wiring shall include control terminal and control relays as necessary to achieve any interlocking specified elsewhere or to achieve any control or monitoring through the BMS where specified.

- k. Adjustable time delay devices for Star Delta Starters.

- l. Earth leak relays/ Breakers as required.

Starter units for manual operation shall have push buttons for starting and stopping, together with auxiliary contacts for remote indicator lights where specified. Starter units arranged for automatic operation shall have hand/off/auto controls and remote push buttons.

All Star Delta starters shall be provided with mechanical and electrical interlocks for star delta contactor assembled to prevent short circuiting.

B. Enclosure

Panels shall be constructed of a minimum 1.6mm thick electro galvanized steel coated with high solid enamel polyester electrostatic spray and oven baked and protected to IP 54.

Front access shall be arranged for all panels with hinged lift off doors. Dust and damp proof gasket around the edge and fitted with lockable cam type chromium plated handle mechanically interlocked with the starting MCCB.

The enclosure for the motor starters are divided into two types as follows:

- a. Single starter panel.
- b. Motor control centre.

Single starter panel

- a. This specification shall be applied for starter panels used for starting single equipment with a maximum of two motors.
- b. All equipment shall be mounted on sheet steel mounting plate with screws into tapped holes and all live parts shall be shrouded to a minimum IP54.
- c. The minimum short circuit rating for the different components shall be 25kA. However, the contractor shall forward a short circuit calculation and upgrade the same if found necessary.

Compensated Equipment

Any motorized valve or damper controlled via a compensated system, shall be arranged such that a manual selector switch is provided to override compensated selection and enable manual opening/closing or on/off control, as appropriate. Any compensator unit mounted within the control cabinet shall remain in the manufacturer's purpose made enclosure and be installed strictly in accordance with the manufacturer's recommendations.

The panels shall contain devices for automatic restart of units after power failure where required.

2.22 MOTOR CONTROL CENTERS (MCC)

- A. Motor control centers shall be of similar construction to the main low voltage switchboard in addition shall comply with the following specification:
- a. Motor control centers shall be in accordance with IEC 947-4-1 with type 1 coordination.
 - b. All power and control devices shall be mounted in separate compartments. All power and control wiring shall be segregated. Separate color-coded wires shall be used for power and control wiring; the same shall be properly ferruled.
 - c. Control wires shall be of flexible copper not less than 1.5 sq. mm.
 - d. Chiller sequence controller shall be provided.
 - e. Automatic controls for pump duty stand/by, duty selection, interlocking with chillers shall be provided.
 - f. All motors shall be provided with phase failure, under voltage, phase sequence over current and earth fault protection wherever shown in the SLD.
 - g. Run/Trip indication shall be provided for all pumps with lamp test facility.
 - h. On/Off switch for chiller's control panel shall be provided.
 - i. Hand/Off/Auto selector switches and On/Off push buttons shall be provided for all motors.
 - j. The degree of protection of the switchboard enclosure shall be IP 54 (minimum).
- B. Outgoers

Motor starters and contactors shall have a utilization category of AC-3 (starting of squirrel-cage motors, switching off motors during running) and AC-4 for motors with inching or reversing duties.

Motor starter components i.e. breakers, contactors, relays etc. shall be selected in accordance with IEC 947 947-4-1 type 1 coordination.

Ammeters shall be fitted to all starters for motors greater than 30.0kW. On-off fault indication of contractors shall be fitted on the front of the starter compartment with a red light for "ON", green light for "OFF" and an amber light to indicate motor overload or fault conditions.

Suppliers shall provide a minimum 160mm space between the base of the switchgear and the underside of the lowest outgoers.

All incoming and outgoing circuit breakers shall be provided with a release to trip the breaker, instantaneously if closed onto a fault.

All compartments shall occupy the full cubicle width; a semi module compartment or vertical division between compartments is not acceptable.

Supplier shall ensure that the number of outgoing feeders in any vertical section of switchboard shall be such that there is adequate space in the cable alley for

all power, and all control cables entering the panel. The number of feeders shall not exceed 8 numbers for each vertical panel.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. After installation and leveling, render the entire switchboard rodent proof by any means of steel plates,
- B. Provide full length rubber mat in front of switchboard
- C. Installation of switchboard shall be fully in accordance with THE CONSULTANT requirements.

Switchgear and distribution boards shall be surface mounted/free standing type and shall be mounted on the building structure by means of suitable mild steel straps or angle iron frames. Where distribution boards or switchgear are required to be directly attached to brickwork etc., the fixing shall be by means of grouted in bolts, or bolts of the expansion type.

Any live metal in the distribution board shall be screened with insulation material, so that circuit breakers can be replaced without any danger to the operator.

- D. The circuit breakers shall be situated to allow wiring to be carried out with sufficient slack to enable them to be removed for inspection without disconnecting any circuit wiring.
- E. All main, submain and final distribution boards shall have a spare capacity and shall also be provided with enough spare breaker as shown on the drawings.
- F. All panel board and distribution boards shall consist of adequately rated circuit breakers. Circuit breakers shall be temperature compensated at the manufacturer's works to give the design current rating at 50 deg. C. Non-compensated breakers will not be approved and a formal certificate will be required from the manufacturer confirming that the breakers have been suitably temperature compensated.

The contractor shall supply and install all panel board with the related voltmeters, ammeters and energy meters of a type that meets consultant's approval.

Where single core cables enter or leave any item of metal clad switchgear, distribution gear, etc., the cable cores shall all pass through the same aperture in the enclosure or case of the unit concerned, to avoid the setting up of eddy currents. Where separate holes are provided by the manufacturer for the cables, the holes shall either be cut out to form a continuous slot, or alternatively the holes shall all be joined together with saw cuts through the solid metal separating the holes. In all cases end plates shall be of non-ferrous metal.

A special termination arrangement shall be provided to consultant's approval at the submain and main panel boards wherever the cable size exceeds the breaker terminal capacity.

3.2 TESTS AT WORK

- A. Routine tests to standards shall be carried out. Evidence that type test have been carried out provided they are relatively to the configuration of the equipment offered, may be acceptable to THE CONSULTANT and shall be made available.
- B. A full visual check and electrical functional test shall be carried out on all apparatus and every circuit. All wiring shall be inspected. It shall be verified that the FBA is fully in accord with the requisition. Circuit breakers shall be closed and tripped at their rated minimum and maximum trip and close supply voltage. Primary and secondary injection tests shall be done on protection relays and CT circuits and indicating and metering instruments. All labels shall be checked.
- C. The test procedure shall be as follows:
 - a. Visual inspection to verify degree of protection creepage and clearance distances.
 - b. All conductors and cables are checked for proper routing and all devices for proper mounting.
 - c. Check effectiveness of all mechanical devices, e.g. handles, locks, interlocks, operating devices, etc.
 - d. Check panel conformity to drawing requirements.
 - e. Megger test all main circuit through to final terminals. Insulation resistance shall exceed 10 megohms. Record all measurements.
 - f. Flash test all main circuit at 2.5 KV for one minute. Record leakage current.
 - g. Repeat megger test to verify insulation resistance has not been affected by the dielectric test.
 - h. Continuity tests of each circuit.
 - i. Function test of all circuit breakers switches, contacts, etc. and every circuit to verify correct operation.
 - j. Primary and secondary injection tests of all relays, CT's and indicating and metering instruments.
- D. Prior to energizing the switchboards, perform the following checks on site:

- a. Operate the equipment through all design functions, including remote operation, actuation of alarm and indicating devices, mechanical and electrical tripping and closing and operation of the protective devices.
- b. Insulation resistance measurements on the buses, phase to phase and phase to ground, with all breakers in the fully connected position and contacts open.
- c. Control circuit insulation resistance to ground.
- d. Inspect all relays and protective devices, and verify settings in accordance with the manufacturer's instructions or the information in the Coordination study.
- e. Inspect current transformers and relays for correct polarity of connections and the installation of jumpers on unused current transformer circuits.
- f. Simulate the operations and check the logic of interlocks.
- g. Manually close and trip each breaker checking and adjusting the main contact alignment and wiring action in accordance with the manufacturer's instructions.
- h. Check the phasing on each side tie breaker, before closing.
- i. Test protective relay operation for incomer air circuit breakers.

E. Routine Tests

- a. Following routine tests are to be carried out by the switchgear assembler,
- b. Inspection of assembly including inspection of wiring and electrical operation
- c. Dielectric test:
Checking of protective measures and of the electrical continuity of the protective circuits.
- d. Verification of insulation resistance.

Power Factor Improvement Plant

The power factor improvement plant shall be used for improving the power factor of the system. The plant shall have automatic as well as manual operation capability.

The power factor improvement plant shall be aligned with main LT switch board and it shall be a part of that LT switchboard as shown on the drawing. The capacitors shall be suitable for three phases, 415 volts, 50 Hz system and shall be self cooled, designed for indoor use in tropical climate for maximum ambient temperature of 45 degrees centigrade and relative humidity 90%. The capacitors shall be in the form of banks divided for 12 stages, 6 stages and 4 stages. Each capacitor bank unit shall be either 50 KVAR or 25 KVAR. The total KVAR capacity shall be as indicated on the drawings. Each capacitor unit shall be complete with discharge resistors and internal fuses and shall be connected with control panel with proper size of single core PVC insulated cables.

The panels shall be supplied complete with a set of 3-phase, full capacity, isolated tinned copper bus bars, interconnections, risers, designation labels, cable sockets, holding down bolts, wiring with cleats and ferrules, earthing sockets and studs, etc. Each control panel shall comprise.

1 No. Multi stage power factor correction relay for automatic/manual control.

1 No. 3-phase, 4 wire, 415 volts, unbalanced load power factor indicator.

1 No. Auto-off-Manual selector switch

1 No. Current transformer with 5 amps secondary current, having suitable output burden and accuracy.

3 Nos. Instrument protection fuses.

Following equipment shall be provided for every 50 KVAR capacitor bank:

1 No. 125 amps, triple pole 415 volts air break contractor with auxiliary contacts (2 NO+2 NC) Contractor shall be suitable for AC 3 duty.

1 Set of 2 Nos 125 Amps H RC back-up fuses with base and carrier.

1 Set of ON and OFF push buttons.

1 No. Red lamp for "On" indication of the contractor.

Requirement of Capacitor Banks

According to IEC-83 1 -1 and 831-2.

Fully insulated, terminals to be shielded by a cover.

Dielectric: Plastic poly-propylene, impregnated.

Electrodes: Aluminium coating vacuum metalized.

Safety features: Self healing. Over pressure tear-off fuse.

Withstand switching operations safely.

Maximum in rush current 200 times rated current.

Loading capacity: 1.1 times rated voltage. 1.3 times rated current at delta max.

Overloading capacity 1.5 times rated output at delta max.

Acceptable tolerances - 5/+ 10% of rated output at rated frequency.

Static life expectancy > 100,000 operating hours.

Test Specifications: Terminal versus terminal with an AC voltage 2.15 times rated voltage for 10 seconds duration. Terminals to casing with an AC voltage of 3 KV for 10 seconds duration.

SECTION - E - 3 LOW VOLTAGE CABLES AND WIRES

1.0 SCOPE OF WORK

The work under this scope consists of supplying, installation, testing, connecting and commissioning of all material and services of low voltage cables and wires and the accessories as specified herein or shown on the Tender Drawings and given in the Bill of Quantities.

The Contractor shall discuss the electrical layout with the Engineer and coordinate at site with others for exact route, location and positions of electrical lines and equipment.

The LV cables and wires with accessories shall also comply with the General Specifications for Electrical Works, Section E- I and with other relevant provisions of the Tender document.

2.0 GENERAL

All multicore and single core wires for light circuits, socket outlets and circuits operating upto 250 volts shall be 300 / 500 volts grade. All single core sheathed cables shall be of 450 / 750 volt grade and upto 50sqmm and above shall be of 600/1000V. Power cables for main feeders, main to sub main feeders, power equipment, etc., armoured or unarmoured shall be of 600 / 1000 volts grade.

Armouring of cables shall be done with appropriate size galvanized steel wire as per codes.

The conductors shall be stranded or solid, high conductivity, soft annealed copper. Conductor of single core cables shall be circular, whereas of multicore cables may be circular or shaped according to standard practices and codes. The PVC insulation shall be extruded with a PVC compound having good flexibility, resistance to aging and ability to withstand the ambient temperatures as given in General Specifications for Electrical Works, Section E-1 of these specifications. Cable should be capable of running 125% of full load current without any damage.

3.0 STANDARDS

LV Cables and Wires shall comply with Section – E -1, Clause 3.

Particular reference shall be made to:

BS 6004 / 6346	PVC insulated cables for lighting and power.
BS 6746	PVC insulation for electrical cables.
BS 6360	Copper conductors
BS 6500	Insulated flexible cords.
BS 5467	XLPE insulated armoured cables for electrical supply
BS 6724	XLPE insulated armoured SINGLE CORE PVC INSULATED COPPER sheathed cables
BS 7211	SINGLE CORE PVC INSULATED COPPER Insulated non armoured cables / wires.

Any other standard referred to in above standards or these specifications.

4.0 MATERIAL

4.1 General

The power, lighting and control cables shall be furnished and installed in accordance with the routes and requirements shown on the drawings.

All cables shall have phase identification colours on insulation of each core. The colour code for three phase circuits shall be red, yellow and blue for phase conductors and black for neutral conductor. Where insulated earth conductor is installed, it shall have green colour insulation.

Single phase circuits shall have insulation of red colour for phase / line, black colour for neutral and green colour for earth conductor.

All DC circuits shall have insulation of red colour for positive, black colour for negative and green for earth conductor.

The ends of each length of multicore armoured or unarmoured cables shall be properly marked for clock-wise and anti clock-wise sequence of core colors.

4.2 Cables for Conduit Wiring

All cables / wiring in concealed or surface mounted PVC or GI conduits shall be single core PVC insulated of specified grade and size, unless specifically shown on the drawings or given in BOQ.

4.3 Cables on Surface / Concrete Trenches

Cables for distribution system to be installed on surface, in cable ducts, in concrete trenches or on trays shall be single or multicore PVC insulated and PVC sheathed of specified voltage grade and size, unless specifically shown on the drawings or given in BOQ.

4.4 Underground Installation

Cables for laying directly underground shall be PVC insulated, PVC sheathed and armoured with galvanized steel wire. Cables fully installed in underground ducts / pipes and mechanically protected from end to end shall be PVC insulated and PVC sheathed unless specifically shown on the drawings or given in BOQ.

4.5 Cable Accessories

All cable accessories shall be provided for the complete cabling and wiring system without any additional cost unless specifically mentioned in BOQ. These shall include but not limited to the items such as saddles, clamps, fixing channels, connectors, cable joints (where necessary and approved by the Engineer), clips, lugs, tapes, solder, identification tags, bushes, glands, etc.

5.0 INSTALLATION

5.1 General

When the laying is effectuated by others, the contractor shall test the cable characteristics insulation and continuity, at all phases of these and communicate them in a report to the Engineer, as per recommendations of the standards according to which the cable is manufactured.

The cables shall be spaced by categories along their entire length as well as upon penetration into buildings and in their interiors, according to their following rated voltages:

- 30 cm at least between a cable carrying 1 KV - 30KV and other cables.
- 20 cm at least between a cable carrying voltages between 50V - 500V, and any power or control 10 cm at least between a cable carrying voltages lower than 50V and telephone or these possible being grouped.

All installation material, labour, tools and accessories for cable installation shall be furnished by the Contractor. The cable and accessories shall be installed as described in accordance with these specifications, drawings and manufacturer's instructions.

5.2 Conduit Wiring

The wiring through conduit shall be started only after the conduit system is completely installed and all outlet boxes, junction boxes, etc., are fixed in position. The filling rate inside the conduits shall not exceed 50 %. Cables directly embedded in the masonry are not accepted.

The wires shall be pulled in conduit with care, preferably without the use of any lubricant. Where necessary and if approved by the Engineer, the cable manufacturer's recommended lubricant may be used. Where several wires are to be installed in the same conduit, they shall be pulled together along with the earth conductor. All wires of same circuit shall be run in one conduit.

The wires shall not be bent to a radius less than 10 times the overall diameter of the wire, or more if otherwise recommended by the manufacturer.

The wiring shall be continuous between terminations and looping-in system shall be followed throughout. Any joint in wires shall not be allowed. The use of connectors shall only be allowed at locations where looping-in is rendered difficult. The consent of the Engineer shall be required for using connectors. The connector shall be of suitable rating having porcelain body with sunk-in screw terminals. The connector shall be wrapped with PVC insulation tape after its installation. A minimum of 150 mm extra length of cable / wire shall be provided at each termination to facilitate repairs in future.

5.3 Cables on Surface

All cables for installation on surface of wall, column, ceiling, trenches, etc., shall be fixed to the surface by means of galvanized steel clips, secured to a steel channel using suitable stud plate, nuts and washers.

The erection of cables and position of support shall be agreed by the Engineer on site, having taken into consideration the accessibility of all such routes. These shall be so arranged that cable crossing one another be minimized if cannot be avoided.

Cables shall be fixed throughout their length by means of approved saddles, clips, etc., at every 600 mm vertically and 900 mm horizontally.

Cables and equipment fixed to a building fabric, i.e., brickwork, concrete, etc., shall be fixed by means of appropriate fixing devices, i.e., Raw bolts, Hilti fixing devices, etc., or alternatively by means of suitable fixing devices cast at site, e.g., concrete inserts.

Contractor shall be responsible for all drilling of steel work, brick work and masonry where necessary for fixing clamps and brackets for supports.

Cables shall not be pulled into conduit until the conduit system has been completed, cleared and free from obstruction and sharp edges.

It shall be ensured that conduit system is clear before cable is drawn in. cables shall be put into conduits in such a manner that there will be no cuts or abrasions in the cable insulation, protective braid and jackets. There shall be no link in the conductors.

Distance of saddles shall be used for installation of cables in defined condition of the surface of wall etc.

Grease or other injurious lubricants shall not be used in pulling cables. The use of talc or non injurious lubricants is permissible, if desirable.

The number of wires installed in any conduit shall be such that the resulting space factor does not exceed 50 %. Spliced wires shall not be pulled through conduits.

All conduit wiring shall be carried out in the loop - in principle from outlet box to outlet box and in no circumstances shall joints be used except in fixed base connection blocks housed in outlet boxes.

The vertical clearance between two adjacent cables at any point is 50 mm minimum. Common mounting, channels are to be furnished for cable along the same route. The Contractor can offer alternate cable fixing arrangement, which shall be approved by the Engineer before commencement of installation.

The wall crossings where the outdoor cables penetrate in the building shall be carefully obstructed by means of polyurethane foam. The Contractor shall be fully responsible for the perfect tightness of these

cable penetrations.

5.4 Underground Cables

The Contractor shall plan and take special care to prevent any damage to existing under ground facilities such as under ground piping, cables, foundations, etc. The Contractor shall notify the Engineer of any obstruction encountered and shall provide protective support or removal of such obstructions as instructed by the Engineer. Excavation adjacent to existing facilities, such as foundations manholes, ducts, under ground pipelines and paving shall be braced and / or shored properly to protect those facilities during excavation and construction.

Sufficient slack shall be left in cables for this purpose that cut lengths of cables shall allow about 3% more in the measured lengths between terminations.

Cables, whether installed under ground or in concrete trenches, shall not be bent to a radius less than 10 times the diameter of the cable or as recommended by the cable manufacturer, whichever is higher.

All cables shall be marked at least at each end, switch gear and equipment termination, where cable enter or leave under ground cable trenches or channels, where cable rises from one level to another, at 30M intervals with predetermined identification numbers, by means of proprietary non-deteriorating type, PVC, heat shrinkable, strap-on type or equivalent, for the identification of cable and circuit. These shall be indelibly marked with cable number and securely fixed to the cable. Where conductors are left to be terminated by another party or left to be connected later, they shall be identified. The earth continuity conductor shall be laid in the trench with the cables.

Cables entering the buildings shall also be laid in protective pipes. The protective pipe ends, after installation of cables, shall be plugged water tight by means of polyurethane foam / bituminized Hessian or equivalent method as approved by the Engineer.

5.5 Cable Termination and Joints

Cables shall be terminated in a safe, neat and approved manner at the associated equipment, included that erected by others.

Compression type connectors (lugs) shall be of the correct size and approved type for the conductors concerned. Compression tools shall be supplied for specific use and shall be maintained in good order. After compression the conductor and terminal shall form a solid mass ensuring good conducting properties and mechanical strength. The compression jointing system used throughout the installation must be approved by the Owner or his representative before use.

The Contractor shall be responsible for all drilling and if necessary, tapping entries where these have not been provided by others.

When preparing cables prior to fitting glands, the gland manufacturer's instructions for cable preparation shall be observed. In all cases where armoured cables are used, care shall be taken to ensure that the lay of the armour is maintained after the gland is completely fitted.

Termination and joints shall be suitably insulated for the voltage of the circuits in which they are used.

Every compression joint shall be of a type, which has been the subject of a test certificate as described in BS 4579.

Cable ends, which are not terminated immediately after cutting, shall be sealed effectively to prevent ingress of moisture and shall be protected from damage until termination.

For all cables above 6 sq. mm in section, if a substantial mechanical clamp is not provided a compression type lug or socket shall be provided. At all equipment, cable shall be installed and terminated so that no strain is imposed on the cable or gland and due allowance made to counter the effect of vibration. At all termination an ample length of 'tail' shall be left.

Where joints in cable conductors and bare conductors are required, they shall be mechanically and electrically sound and they shall be accessible for inspection. Joints in non-flexible cables shall be made either by soldering or by means of mechanical clamps or compression type socket, which shall securely retain all the wires of the conductors.

Any joint in flexible cable shall be effected by means of cable coupler. Cable couplers and connectors shall be mechanically and electrically sound and shrouded in metal, which can be earthed. Where the apparatus to be connected require earthing every cable coupler shall have adequate provision for maintaining earth continuity.

Cables of AC circuits, installed in PVC or steel conduit shall always be so bunched that the cables of all phases and the neutral conductor (if any) are contained in the same circuit. The outdoor apparatus shall normally be connected by means of cables with conduit termination down to about 30 cm below ground level or concrete foundation. The conduit shall be firmly secured down to their penetration into the trench or channel.

SECTION - E - 4 CONDUITS AND PIPES

1.0 SCOPE OF WORK

The work under this scope consists of supplying, installation and commissioning of all material and services of the complete Conduits and Pipes as specified herein and / or shown on the Tender Drawings and given in the Bill of Quantities.

The Contractor shall discuss the electrical layout with the Engineer and coordinate at site with others for exact route, location and positions of electrical lines and equipment.

The Conduit and Pipes with accessories shall also comply with the General Specifications for Electrical Works, Section E- I and with other relevant provisions of the Tender document.

2.0 GENERAL

The extent of works shown on the drawing does not indicate the exact position of conduit and pipes. The Contractor shall ensure exact location and route of conduit and pipes in coordination with other services drawings, as per site requirements and as directed by the Engineer.

The quality and material for the accessories of conduits and pipes such as sockets, elbows, bushings, bends, inspection / pull boxes, round boxes, etc., necessary for the completion shall be similar to that of conduit or pipes. All the accessories shall be supplied by the Contractor without any extra cost and deemed to have been included in the price of conduits / pipes.

3.0 STANDARDS

Pipes and Conduits shall comply with Section - E-1, Clause 3.

Particular reference shall be made to:

BS 31	Steel Conduit and accessories
BS 1378	Galvanized Iron Pipes and accessories.
BS 3595	PVC Pipes and accessories.
BS 4607	PVC Conduits and accessories.

Any other standard referred to in above standards or these specifications.

4.0 MATERIAL

4.1 PVC Conduits, Pipes and Accessories

The PVC conduits and accessories for lighting and power circuits shall be furnished by the Contractor as shown in the drawings or given in BOQ. The PVC bends shall have enlarged ends to receive conduit without any reduction in the internal diameter at joint. Manufactured smooth bends shall be used where conduit changes direction. Bending of conduits by heating or otherwise will be allowed in special situations only, for which the consent of the Engineer shall be required. The use of sharp 90 degree bends and tees will not be allowed for concealed

wiring.

The round PVC junction boxes for ceiling light or fan points shall have minimum dimensions of 64 mm diameter and 64 mm depth. The junction boxes for wall light points shall have minimum dimensions of 57 mm diameter and 40 mm depth. Round junction boxes shall be provided with one piece bakelite cover plate fixed to the box by means of galvanized screws.

The PVC pipe shall be rigid and shall be minimum B-Class, unless otherwise stated on Drawings or Bill of Quantities. Where pipe changes direction, manufactured smooth bends shall be used. For jointing of pipe, all precautions and procedures recommended by manufacturer shall be followed.

4.2 Steel Conduit and Accessories

All conduits shall be of heavy gauge 16 SWG steel, manufactured and tested in accordance with latest relevant standards.

The conduit shall be protected by two base coats of red oxide anti-rust paint and finished in first quality black enamel paint. The coating shall be of heavy enamel, which shall not flake or crack during installation and handling. Each conduit length shall be furnished with threaded ends and a threaded coupling at one end. Soft metal bushes shall be provided at conduit termination to prevent damage to cable during pulling operation.

Junction boxes shall be 100 mm square, having minimum depths of 38 mm or 65 mm as required for accommodating the number of wires. The junction box shall be 16 SWG sheet steel provided with anti-rust paint and finished in heavy black enamel paint. The cast Iron outlet boxes for light points shall be round having 50 mm diameter and 63 mm depth. The above dimensions are given as minimum only, and the exact size shall be determined by the Contractor keeping in view the ease of Installation and maintenance. All outlet boxes and junction boxes shall be provided with one piece bakelite cover plate of suitable design.

4.3 Galvanized Iron Pipes and Accessories

The G.I. pipes shall be galvanized from inside and outside by hot dip galvanizing method. The pipes shall be free from stains, burrs or any other defect. The accessories for G.I. pipes shall be galvanized from inside and outside. The conduit shall be NPT threaded, with at least 5 complete threads and assembled with TEFLON tape. Installation of GI pipes shall be properly coordinated with structure and architecture.

4.4 Inspection Boxes / Pull Boxes

The rectangular inspection boxes or pull boxes shall be of 16 SWG heavy gauge, sheet steel having nipples welded to box at entry holes to receive PVC conduit with force fit. The box shall be painted inside and outside with black enamel paint over a base coat of red oxide

primer paint. The minimum length of inspection box shall not be less than six times the cable manufacturer's recommended bending radius of the cable. All concealed type pull boxes shall have a white plastic sheet of appropriate size fixed to the box by means of galvanized screws.

4.5 Adaptable Boxes

Adaptable boxes shall be made of 16 SWG sheet steel box, painted and finished to the same quality as the light Distribution Board. The boxes shall be 50 mm in depth for conduits up to 25 mm diameter, 63 mm in depth for conduits up to 40 mm diameter and 87 mm in depth for conduits up to 50 mm in diameter. For conduits more than 50 mm in diameter, the minimum depth shall be two times the diameter.

4.6 Conduit / Pipe Accessories

Bushes, plugs, glands, etc., shall be of brass and all male bushes shall be of long thread pattern. Covers for boxes shall be screw fixed and finished as the boxes. Gaskets shall be fitted only when finish is galvanized unless otherwise specified.

4.7 Cable Trunking

Where required, wiring shall be run in hot-dipped galvanized (after fabrication) sheet steel cable trunking of the specified gauge complete with all fittings and accessories, manufactured and installed in accordance with BS 4678/NEMA. The trunking shall be constructed with return flanges. Trunking covers shall be secured by anchored turn-buttons and locking bars and minimum length of individual sections shall be 2.44-m. The trunking shall be suspended/supported from the structure at maximum 2-m intervals with straps and hangers fabricated from minimum 6-mm dia HDGF bars, or supported by angle-iron brackets.

Conduit drips from the trunking shall also be supported with hangers. Factory made connectors shall be used at joints.

Junctions (tee and 4-way) in multi-compartment trunking shall be double depth to avoid reduction in cabling space. Cable in vertical runs shall be supported by pin racks, prongs or bridging pieces. Fire barriers shall be provided at each floor level. Allowance for expansion shall be incorporated.

Bonding links shall be provided at each joint and secured by screws, nuts and shockproof washers. The bonding links shall make contact with the metal of the trunking of fitting, and continuity shall not depend on contact through the screws, nor on removal on site paint finish from ferrous metal.

5.0 INSTALLATION

5.1 PVC Conduits - Concealed

The conduit shall be installed concealed in roof, wall, column, etc.

At all joints and bends, PVC jointing solution as manufactured by Pakistan PVC Limited or approved equivalent must be used to strengthen and to seal the joint.

Manufactured smooth bends shall be used. Bending of conduits by heating or otherwise will be allowed in special situations only, for which the consent of the Engineer shall be required. The use of 90 degree bends and tees will not be allowed.

The conduit shall have a minimum of 38 mm cover of concrete. In the reinforced cement concrete (RCC) work, the conduit shall be laid before pouring of concrete. Under no circumstances shall chases be made in the RCC structure for concealing conduit and accessories, after pouring of concrete. The concrete shall be supported on top of bottom reinforcement of slab and shall be firmly secured by tying to the reinforcing steel in order to avoid being disturbed during pouring of concrete.

All outlet boxes to be firmly supported and installed such that they finish flush with the soffit of slab of beam.

Where conduits have to be concealed in cement concrete (CC) work after concreting, or in block masonry, chases shall be made with appropriate tools and shall not be made deeper than required. The conduit shall then be fixed firmly in the recess and covered with cement concrete mixture to have to at least 32 mm cover before plastering. The work of curing in the cement concrete work or block masonry work shall be coordinated with the civil work. The Contractor shall obtain approval from Engineer for the route, to suit the site conditions before starting chasing and cutting.

The termination of conduits at or near the Switchboard / Distribution Board is shown diagrammatically on the drawing. The exact final locations of the termination shall be coordinated with the Switchboard / Distribution Board to be installed. Any extension of conduit near the Switchboard / Distribution Board to suit the site condition shall be made without any extra cost. 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 termination of concrete, 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.

The entire conduit system shall be installed and tested before wiring is carried out. Any obstruction found shall be cleared by use of cutting mandrel or other approved device and the conduit shall be cleaned out before the installation of cable.

Pull boxes / Adaptable boxes shall be provided in conduit runs wherever required to facilitate pulling operation. The drawings are

diagrammatic and do not indicate the position and spacing of pull boxes or adaptable boxes. However, these shall meet the following requirements:

- Pull boxes.
For straight runs the spacing shall not be more than 30 meters.
For runs with one 90 degree bend, the spacing shall not be more than 15 meters.
- Adaptable boxes.
For conduits up to 25 mm diameter, the boxes shall be 50 mm in depth.
For conduits up to 40 mm diameter, the boxes shall be 63 mm in depth.
For conduits up to 50 mm diameter, the boxes shall be 87 mm in depth.

Wherever the conduit lengths cross the expansion joint either along the column or slab, suitable arrangement shall be provided so that when the conduit lengths in the expansion joint are stressed, the conduit neither develops any cracks nor breaks down.

Bending, off setting and similar operations shall be performed through the help of proper bending tool to give a perfect bend of required angle without Desha ping of conduit to the least.

5.2 Steel and G.I Conduit

The minimum size of conduit shall be 25 mm.

The use of solid or inspection elbows, bends or tees will not be permitted and 120 degree bends shall be limited to one between any two drawn-in boxes.

Conduit coupling joint shall not be used where conduit enter spout entry boxes. Conduit running, joints shall not be used where conduit enter conduit boxes or spout entry boxes.

Equipment that is required to be removed for maintenance shall be provided with conduit unions in all conduits that enter such equipment. The use of conduit nipples shall be avoided as far as practicable.

All conduits shall be cut square and reamed at the end. All conduit ends and the inside of conduits shall be clean and free from burrs.

Where bushed spouts or tapped holes are not provided at conduit termination, the conduit shall be terminated in a flanged socket and a smooth bore brass hexagon bush, with a lead washer fitted between the flanged socket and the equipment or box.

All exposed threads and parts where the galvanizing has become damaged shall be thoroughly cleaned and painted with galvanized paint. the exposed conduit ends shall be capped to protect threads from being damaged before installing cables.

Repair painting shall take place before any making good on site or buildings is carried out. The entire conduit system shall be checked for continuity. Any observation found shall be removed without damaging the installation.

The conduit system shall be installed empty with an 16 SWG steel wire drawn through the conduits for pulling of cables. Joints in underground conduits shall be avoided or reduced to the absolute minimum.

Where adjustable dies are used they shall be so adjusted that threads cut with them shall be the same depths as machine made threads.

The use of manufactured bends shall be avoided and instead smooth bends shall be provided by using approved type of bending tools.

Flexible steel conduits shall be installed at all points locations where flexible connection is required, as directed by the Engineer. The flexible conduits when used, shall be protected by external PVC sheath, resistant to oil damages.

G.I. pipes for under ground installation shall be given bituminous paint coating and wrapped with suitable paper or cloth before installation.

5.3 Fixing of Conduits and Fittings

Conduits in process units and on steel work with "U" bolt type fixings.

Conduits in buildings shall be fixed with galvanized distance saddles. Where a number of conduits follow a single route they may be fixed to mild steel brackets.

Conduits shall be supported on both vertical and horizontal runs as follows:

- Conduits size 20 mm and 25 mm maximum spacing of fixing 1000 mm.
- Conduit sizes larger than 25 mm spacing of fixing 1500 mm.

All conduit boxes that support fittings shall be securely fixed. All conduits shall be fixed 150 mm before and after every right angle or off set. All conduit fittings and equipment shall be fixed true and line able. 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
20 mm (3/4")	Not less than 130 mm.
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.

Under ground conduit stud-up or kick pipe through concrete envelope shall be extended a minimum of 150 mm above grade and adequately braced to prevent shifting during concrete pouring work. The concrete envelope shall extend at least 76 mm above grade.

Under floor conduit installation shall be at a minimum depth of 120 mm from finished floor level. The G.I. pipes / conduits shall be installed at a minimum depth of 1000 mm measured from the top of size to the finished road level.

5.4 Location of Conduits and Fittings

Before conduits are installed, confirmation shall be obtained that the conduit may be installed in that position.

Particular attention shall be given to the location of conduits to prevent the infringement of headroom and access ways.

Conduits shall be located to avoid obstructions, furnaces, hot lines and other places of high temperature.

Conduit shall not be located than 150 mm (6") where it runs parallel to or crosses hot surfaces. Under ground conduit runs shall be kept to minimum in both number and length. Conduits shall not be recessed in fair brick work.

Draw boxes shall be so positioned to enable the cables to be drawn in easily. The boxes shall not be located in the comers or other such locations and shall be positioned to avoid tight bends, bending and cable kinks.

Conduits shall not generally be installed having a greater length 12,000 mm (40 feet) between draw-in boxes.

Conduit entries shall wherever possible be located in the bottom of boxes and equipment etc.

SECTION - E – 5 WIRING ACCESSORIES

1.0 SCOPE OF WORK

The work under this scope consists of supplying, installation and commissioning of all material and services of the complete switches, switch sockets, etc., and miscellaneous items as specified herein and / or shown on the Tender Drawings and given in the Bill of Quantities.

The Contractor shall discuss the electrical layout with the Engineer and coordinate at site with others for exact route, location and positions of electrical lines and equipment.

The wiring accessories shall also comply with the General Specifications for Electrical Works, Section – E - I and with other relevant provisions of the Tender document.

2.0 GENERAL

The locations of the wiring accessories such as sockets, switches etc. are tentatively shown on the drawings. The Contractor shall ensure exact positions and locations of wiring accessories in coordination with other services drawings, as per site requirements and as directed by the Engineer. The Contractor shall be responsible for proper functioning of wiring accessories after installation and Commissioning.

3.0 STANDARDS

Wiring accessories and miscellaneous items shall comply with Section - E-1, Clause 3. Particular reference shall be made to:

- BS 67 Ceiling roses.
- BS 1363:1984 13A fused plugs and un-switched socket outlets
- BS 116 Two and three terminal ceiling roses.
- BS 2135 Capacitors for radio interference suppression
- BS 3676 Switch for domestic and similar purposes.
- BS 4934 Safety requirements for electric fans and regulators.
- BS 5060 Performance of circulating fans and their regulators.

Any other standard referred to in above standards or these specifications.

4.0 MATERIAL

4.1 Switches

Switches for controlling light and fan points shall be single pole, rated for 10 Amp, 250 VAC. The body of switches shall be made of poly carbonate / urea with face plate suitable for flush mounting on sheet steel outlet box. The switches shall be gang type having silver tipped contacts and operate with snap action.

For locations where switches and fan speed regulators are installed together, single switches shall be grouped and fixed on 3 mm thick plastic sheet screwed to a sheet steel box of appropriate dimensions. The fixing of plates on outlet boxes shall be means of flat head counter

sunk galvanized screws with the head of the screw finish flush with the surface of the plate. Except for switches controlling light points, all single switches for fans, sockets, etc., shall have identification symbols on the operating levers.

Two way switches shall be used to control lights from two different locations as shown on the drawings.

4.2 Switch Socket Outlets

Switch socket units shall be of flat pin type and conform to BS 1363, 13A for universal switched socket outlets. 2 and 3 Pin rated for 10 Amps. and 3 Pin rated for 15 Amps. Supply as specified in the bill of quantities.

Sockets shall be moulded type having white plastic face plate or as per architect approval, suitable for mounting on a sheet steel box of appropriate dimensions. Switch sockets shall have shrouded live contacts such that the earth pin is engaged to socket earth before making with the live contacts. Where specified, the switch socket unit shall have spring loaded dust tight cover for mechanical protection.

Placement of Socket outlet for branding / advertising / and signage shall be properly coordinate with architectural and other relevant drawings.

4.3 Sheet Steel Boxes

The outlet boxes for installation of switches, fan speed regulators and socket outlets shall be 16 SWG sheet steel having appropriate dimensions. The boxes shall have suitable knockouts or welded nipples for receiving the conduits. An earth terminal shall be provided for connecting at least three earth wires of 4 sq. mm. The outlet boxes shall be given two coats of anti-rust red oxide and one coat of enamel before installation. The boxes shall be suitable for mounting flush with the surface of wall or on the surface of wall as may be required. The boxes shall not be less than 75 mm x 75 mm (3" x 3"). All boxes shall be water tight where installed in the vicinity of liquids.

4.4 Ceiling Rose

The ceiling rose shall be suitable for 5 Amps. 250V AC. It shall have white plastic moulded base plate, copper or brass terminals for connecting at least two wires of 2.5 sq. mm size. The ceiling rose shall have a cover with cable inlet hole for multicore PVC insulated and PVC sheathed cable.

4.5 Fans

4.5.1 Bracket Type

The bracket type fans shall be suitable for mounting on the wall and suitable for operation semi-horizontally. These shall operate satisfactorily on 250 volts, single phase, 50 Hz, A.C. supply with + 10 % tolerance.

The sweep of the fan shall be as given in BOQ/drawings.

The fans shall comply with BS 380 as far as constructional requirements, range of fan speed regulator, starting, radio interference, silent operation and temperature rise are concerned. For testing, BS 848 as amended shall be complied with.

4.5.2 Exhaust Fan

The exhaust fans shall be three blade types, mounted on the steel/plastic structure of its own, which will be fixed to the structure by means of suitable grouted foundation bolts. The fan shall be suitable for operation on 250 VAC with + 10 % tolerance.

The sweep of the fan shall be as given in Schedule of Quantities/drawings. Fans shall be direct driven and supplied complete with electric motor, back draft dampers and anti-vermin screen. The bearings shall be ball, roller or sleeve type of permanently lubricated and sealed type. Wheels shall be heavily and rigidly constructed and accurately balanced both statically and dynamically and free from objectionable vibration or noises.

The fans shall comply with BS 380 as far as constructional requirements, range of fan speed, speed regulator starting, radio interference silent operation and temperature rise is concerned. For testing BS 848 as amended 1 960 shall be complied with.

SECTION - E – 6 LIGHTING FIXTURES

1.0 SCOPE OF WORK

The work under this scope consists of supplying, installation and commissioning of all material and services of the complete light fixtures as specified herein and / or shown on the Tender Drawings and given in the Bill of Quantities.

The Contractor shall discuss the electrical layout with the Engineer and coordinate at site with other services for exact route, location and positions of light fixtures.

The light fixtures with accessories shall also comply with the General Specifications for Electrical Works, Section - E-1 and with other relevant provisions of the Tender document.

2.0 GENERAL

The description of light fixtures stated on the drawings Lighting fixtures schedule, and relevant material are described in this section. The determination of quality is based on certified photo-metric data covering the coefficient of utilization, light distribution curves, construction material, shape, finish, operation, etc.

The Contractor shall submit two samples of each and every light fixture specified and obtain approval of the Owner before purchasing. The quality and finishes of local make light fixtures (if mentioned in BOQ) shall be same as that of standard manufacturer. The accessories such as ballast, lamp / starter holders, starters, lamps, ignitors, etc., for all type of light fixtures shall be of approved make as mentioned.

All fixtures shall be finished in standard colour schemes as mentioned in the manufacturer's catalogue for respective fixtures, unless specifically stated in the Specifications, Drawings or Bill of Quantities or directed by the Engineer.

3.0 STANDARDS

Lighting fixtures shall comply with Section E-1, Clause 3.

Particular reference shall be made to:

- IEC 81 Tubular fluorescent lamps.
- IEC 82 Ballast for tubular fluorescent lamps.
- IEC 155 Starters for fluorescent lamps.
- IEC 400 Lamp holders and starters holders for fluorescent lamps.
- IEC 566 Capacitors for use in TL, HP Mercury and LP sodium vapour.
- IEC 598 Luminaries.
- BS 3677 Discharge lamp circuits.

Any other standard referred to in above standards or these specifications.

4.0 MATERIAL

4.1 LED Light Fixtures

The light fixture shall be as stated on drawings and bill of quantities. The light fixture shall be finished in standard colors unless otherwise stated on drawings or directed by Engineer/Architect. All LED light fixtures shall be of international standard and quality. The type of fixtures with manufacturer catalogue reference is given on the fixture schedule and in Bill of Quantities. Equivalent fixture may be acceptable provided that the Contractor submits for review all necessary data indicating photo-metric curves to show that the fixture proposed are of the same type, construction and quality.

The lamps for light fixtures shall be Light Emitting Diodes with driver and shall be supplied and installed according to the wattage as indicated on drawings.

Weather proof light fixture shall comprise of cast aluminum body and gasketed clear glass cover secured to the body by means of galvanized nuts / screws to give a weather proof and water tight fit. The gasket shall be weather resistance type.

The LED light fixtures shall be supplied complete with driver and all accessories as per light fixture schedule and shall be installed in accordance with manufacturer's recommendations and sound engineering practice.

5.0 INSTALLATION

5.1 General

The mounting heights of light fixtures are indicated on the drawings, and position of fixtures according to the mentioned scale or as directed by Engineer at Site/Consultant.

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. All fixing accessories such as ceiling rose, flexible cord, lamp holder, suspension rod; pipe or chain with suitable canopy, etc., shall be provided and installed.

The wiring between terminal box and the fixture shall be carried out with 3 core 0.75 sq. mm and 1 sq. mm copper conductor, PVC / PVC cable respectively for circuits protected by 10 amps and 15 / 20 amps MCBs. The wiring inside light fixture body shall be done with heat resistant cables or PVC insulated cable in heat resistant sleeves as approved by the Engineer.

Glasses, shades, reflectors, diffuses, etc., must be in a clear condition after installation.

All light fixtures shall be earthed by an earth wire connected to the earth terminal in the fitting.

5.2 LED/CFL Light Fixtures

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The LED and CFL light fixture shall be installed on the surface of ceiling or wall by means of nylon plugs and galvanized steel screws, such that their back finish flush with the surface for exposed conduits and flush with outlet box for concealed conduit system. Wherever convenient, screws for fixing light fixtures shall be screwed into the holes of the outlet box. The light on false ceiling shall be installed in accordance with manufacturer's recommendations and in coordination with ceiling installation.

The light on false ceiling shall be installed in accordance with manufacturer's recommendations and in coordination with ceiling installation.

5.4 Outdoor Lighting

For illumination around Stations during dark hours, light fittings in various arrangements shall be provided in accordance with these specifications. The items not shown on drawings or called for, but which are necessary for a complete working system as required, these shall also be provided and deemed to have been considered as such.

The Contractor shall essentially use the standard products of a manufacturer, regularly engaged in the manufacture of the product and shall meet the requirement of the specifications.

5.5 EXIT & SAFETY Luminaire

All Exit luminaires shall have pictogram legends as per UL, EN50171 or markings as per local civil defense requirements with viewing distance of 24 meters. The luminaire shall be built according to EN 60598.

5.6 EMERGENCY LUMINAIRE

All luminaries shall meet following requirements:

Self-Contained for 3 hr back up UL standard only.

Supply voltage 230V DC

The luminaire shall comply with the requirements of EN60598

Electronic ballast shall comply with the requirements of EN60298/60294

EMC or EMI protection to EN55015

Ambient Temperature – 40 °C.

5.7 Electrical Rooms, AHU Rooms, Stores, etc

It shall be non-maintained type, self-contained with 8 watt 3 hr back up fluorescent lamp with addressable low loss electronic ballast which can communicate with central control module. Luminaire housing shall

be Polycarbonate. Luminaire shall be suitable for wall / ceiling mounting, with rectangular shape and rated to IP54.

5.8 False Ceiling areas

It shall be non-maintained type, self-contained with 8 watt 3 hr back up fluorescent lamp with addressable low loss electronic ballast which can communicate with central control module. Luminaire housing shall be Polycarbonate. Luminaire shall be suitable for wall / ceiling mounting, with rectangular shape and rated to IP20.

SECTION-E-7

THREE PHASE PADMOUNTED 11,000/415 VOLTS TRANSFORMER**1.0 SCOPE**

- 1.1** This specification covers the following distribution transformer designed for mounting on concrete pad at ground level for installation in underground supply systems.

- i. 200 KVA, three phase, 11,000/415v volts distribution transformers.

2.0 DESIGN AND LAYOUT

- 2.1** The pad mounted transformer shall consist of an oil impressed natural cold transformer, two sets of triple pole type load interrupter switches. One set of three nos. HRC 11 KV fuses and equipment for LT feeders, all mounted in suitable metal enclosure. The pad mounted transformer shall be suitable for outdoor installation on a concrete foundation.

- 2.2** The pad mounted transformer shall be fed through 11 KV cables which shall loop in and out of the pad mounted transformer. The incoming and outgoing cable shall be connected to 11KV load interrupter switches.

- 2.3** The equipment in the LT compartment shall be installed according to the particular requirements in the purchase order.

If the supply is to a single or limited number of consumers and the number of feeders taken out does not exceed three, one LT circuit breaker and found numbers of LT Busbars shall be installed. Feeders shall be taken from LT busbars as per K-ELECTRIC design.

- 2.4** The pad mounted transformer shall be divided into three separate compartments as below:

- i. The first compartment shall contain the main transformer which shall be self-contained and made as complete and it shall be oil filled transformer.
- ii. The second compartment designated as HT compartment shall contain two sets of three pole load break switches of two fuses suitable bus bars, insulators, connectors and mounting equipment.
- iii. The third compartment designated as "LT Compartment" have shall contain the busbars, support insulators. LT breakers and lugs for outgoing feeders.

- 2.4.1 Access to the HT & LT compartment shall be obtained from separate doors which shall have opening handles and locks.

3.0 SERVICE CONDITIONS

3.1 Climate Conditions

- 3.1.1 Atmosphere Conditions: It may be assumed that the air is not normally heavily polluted by dust, smoke, aggressive gases, vapour or salt spray. However, at certain times of the year, severe dust storms may be experienced.

3.1.2 Ambient Temperature

Maximum	50°C
Maximum mean over any 24 hours	45°C
Main in any year	30°C
Minimum	minus 10°C

- 3.1.3 Relative Humidity may range upto 100%.

The maximum ambient temperature and humidity, however, do not occur simultaneously. During the monsoon, high humidity may persist for many days at a time. Installation upto 1000 above sea level.

3.2 Supply System

- 3.2.1 The pad mounted transformer shall be suitable for installation in the three phase underground 11 KV distribution system of the following characteristics:

Nominal system voltage	11 KV
System highest voltage	12 KV
Frequency	50 Hz
Maximum Symmetrical short circuit current	12.5 OR 25 KA

- 3.2.2 The neutral of the 11 KV systems is solidly grounded at the power transformer and the neutral wire which is solidly earthed is also run in the some parts of the system.

4.0 GENERAL REQUIREMENTS

4.1 Dimensions

- 4.1.1 The dimensions of the overall enclosure shall generally be as per K-electric design. The overall dimensions may be increased to achieve better clearances subject to approval of K-ELECTRIC.

The equipment shall generally be mounted to suit cable connections as per K-ELECTRIC design.

- 4.1.2 The depth of the compartments shall be such that all equipment can be accommodated with adequate clearances. The specified clearances to ground specified in clause 4.2.2 shall be obtained with the load interrupter switches in the open position.
- 4.1.3 The load interrupter switches shall be mounted at a minimum height of 600mm from ground level. This space is required for making terminations of the 11 KV cables by means of stress relief cones.
- 4.1.4 A minimum center to center distance of 130 mm with insulating barriers shall be maintained between vertical insulator columns.
- 4.1.5 LT bus bars shall be mounted as per K-ELECTRIC design

4.2 Insulating and Clearances

- 4.2.1 The enclosures for HT compartment and associated HT equipment including switches, bus bars, fuse and transformer winding shall be suitable for the following insulation level:-

- Lightning impulse withstand voltage 95 KV
- 1 minute power frequency withstand voltage 34 KV

- 4.2.2 The following clearances shall be maintained in the HT compartment of the enclosure:-

- Phase to phase clearance in air
180mm
- Phase to ground clearance in air
100mm

- 4.2.3 The following clearances shall be maintained in the air for LT compartment of the enclosure:-

- Phase to phase 50mm
- Phase to earth 25mm

- 4.2.4 Equipment Mounting

The load break switches and the fuses in the HT compartment shall be mounted on brackets welded in the enclosure.

- 4.2.5 Necessary brackets and mounting rails shall be provided for LT compartment. The rails shall be holes and slots in them for mounting of equipment for a range of dimensions. No equipment is to be directly mounted on the walls.

4.2.6 Earthing

Provisions shall be made for earthing at three separate places. One connector shall be provided for solidly earthing the LT neutral. This connector shall be of the bolted type as per K-ELECTRIC design and shall be adjacent to the main LT neutral bulbar. It shall be capable of receiving 6-12mm dia stranded conductor. The connector shall be made of brass and shall be tin plated.

- 4.2.7 One connector shall be provided on one side of the transformer tank to earth the transformer. The connector shall be of the bolted type and shall be capable of receiving a 6-12mm dia stranded conductor. A similar connector shall be mounted in the enclosure inside the HT compartment.

- 4.2.8 All metal parts of the installation shall be bonded so as to be effectively earthed. Doors shall be connected together and to the body of the enclosure by means of flexible cooper straps and the hinges shall not be relied upon for earthing. The arrangement shall be as per K-ELECTRIC design.

4.2.9 Protection Coordination

The total clearing time-current characteristics of HT fuse shall be as such to coordinate with the thermal/magnetic characteristics of the LT breaker or LT fuses, as required. The following curves shall be supplied on the same log-log paper to verify the coordination.

- a. HT fuses for 200KVA transformer and 400 Amps LT breakers

5.0 HT COMPARTEMENT

5.1 General

- 5.1.1 The HT compartment shall contained six Nos. of HT load break switches or two sets of three phase switches as specified in **clause 9.1** for incoming and outgoing lines, bus bars and all necessary insulators and mounting hardware. The 11KV bushing of the transformer shall extend in to this compartment. Access to this compartment shall be through a door.

- 5.1.2 All fitting in the HT compartment including bus bars, load interrupter switches, fuse carriers, and the fuses shall be designed to withstand the thermal and mechanical effects of short time current as under:-

Short time 1 sec. current symmetrical	15KA
Rated short time (1 sec) current peak value	37KA

5.2 Fuse Carrier

- 5.2.1 The HRC fuses shall be mounted vertically in two contact clips, one contact clip shall be mounted on the transformer bushing directly and other on a post insulator spaced so that the center to center distance of the contact clips shall is 328mm. The clips shall ensure a good electrical contact and mechanical grip of the fuse and shall be silver plated. This shall be so designed that fuse cannot come out inadvertently or as a result of short circuit current.
- 5.2.2 The bullet shall be made of fiber reinforced plastic (polyester resin) of fiber glass tube.
- 5.2.3 The design of the puller shall be such that the fuse may be gripped tightly independent of the pressure exerted on the handle by the operator. The manufacturer may offer alternative design subject to approval by K-ELECTRIC.
- 5.2.4 A switch stick shall be provided with each transformer of dimensions as per K-ELECTRIC design to operate HT switches. The switch stick head shall be made of galvanized steel having min tensile strength of 22kg/Sq mm. The handle of the switch stick made of fiber reinforced plastic (polyester resin) or fiber glass tube.
- 5.2.5 Handles of fuse puller and switch stick shall be tested to withstand voltage of 300KV per meter length for 5 minutes. The dielectric strength shall be not less than 14 KV/mm thicknesses.
- 5.2.6 Provision shall be made with each transformer for storing the switch stick and the fuse puller securely in the HT compartment. Suitable independent clamping arrangement shall be made for both the items.

5.3 Insulators

- 5.3.1 The insulators shall be made of good commercial grade wet process porcelain.

5.3.2 The entire surface with exception of a firing surface shall be smoothly glazed and shall be free from imperfections. The standard color of the glaze shall be brown.

- | | | |
|------|--|--------|
| i) | Minimum leakage distance | 300mm |
| ii) | Dry arcing distance | 150mm |
| iii) | Cantilever strength | 400Kg |
| iv) | Tensile strength | 1000Kg |
| v) | Dry one-minute power frequency withstand | |
| | | 45kV |
| vi) | Lightening impulse withstand voltage | |
| | | 95kV |

5.3.3 The insulators made of epoxy resin and confirming to the electrical and mechanical characteristics of clause 4.3.3 may be offered in lieu of porcelain insulators subject to approval of K-ELECTRIC.

5.3.4 The insulators shall be marked with:

- i) Manufacturer name and trade mark
- ii) Year of manufacture
- iii) Mechanical breaking load

The marking shall be legible and durable.

5.4 Insulation Barriers

5.4.1 The following insulation barriers of 6mm thickness shall be as per K-ELECTRIC standards.

- i) Vertical barriers between each phase on incoming and outgoing sides of 11kV supply.
- ii) Vertical barriers between each high tension fuse.
- iii) Horizontal barriers on the top of the HT compartment.

5.4.2 The barriers shall be rigidly fixed so that no inadvertent displacement or swinging is possible.

5.4.3 The barriers shall be made of a durable rigid and non hygroscopic insulating material, the detail of which shall be supplied by the manufacturer.

5.5 Bus work

5.5.1 The 11KV connections shall be made by means of insulated bus bars of tubular or round conductors of high conductivity copper. The minimum cross-section of such conductors or bus bars for connecting the load interrupter shall be least 120 sqmm.

The connections to the HRC fuses and the transformer HT bushing may from bus bars of at least 35 sqmm cross-sections as per K-ELECTRIC design. The bus bars shall be rigidly mounted so that they are able to withstand effects of short circuit.

6.0 LT COMPARTEMENT

6.1 General

- 6.1.1 The LT compartment shall be laid out generally in accordance with K-ELECTRIC design .The compartment shall contain the following equipment.

LT circuit breaker, bus bar with lugs for outgoing circuits and mounting rails for equipment shown in K-ELECTRIC design

- 6.1.2 All the equipment should be laid out in such a way that no parts are exposed. The LT breaker shall be in suitable cover and the bus bars shall be insulated except at the connection point for lugs. Wherever necessary insulating PVC cover may be provided.
- 6.1.3 The rating plate shall be fixed inside the door in accordance with clause 15.
- 6.1.4 Access through the compartment shall be through a water-tight hinged door with a handle and built-in locks.
- 6.1.5 A pocket shall be provided inside the LT compartment door, for keeping maintenance log book.

6.2 LT Bus bars

- 6.2.1 The bus bar shall be made of high conductivity copper of at least 98% IACS conductivity and of rectangular cross-section. The bus bar shall be mounted on insulators placed at suitable intervals so that the rigidly mounted and are able to withstand the effect of short circuits given in clause 11.2. The insulators shall be of dimensions as per K-ELECTRIC design.
- 6.2.2 All bus bars shall be insulated.
- 6.2.3 Minimum sized of the bus bars shall be as follows:-

<u>Transformer Size</u>	<u>Bulbar</u>
200KVA	5 x 40mm

6.3 Aluminum Lugs

- 6.3.1 12 Nos. of lugs conforming to K-ELECTRIC Specification shall be provided with each transformer of Alternative-I as per K-ELECTRIC design.

6.4 Tests

The following tests shall be performed on the new added equipment in addition to the usual specified tests in the LT compartment on a newly offered prototype pad mounted transformer.

- i) LT CTs
 - a) K-ELECTRIC approved CTs will acceptable.
 - b) All routine tests shall be performed according to K-ELECTRIC Specification

7.0 ENCLOSURE

7.1 The enclosure shall be constructed from sheet steel of aluminum thickness of 3mm. The sheet steel shall be welded to steel shape so that the entire enclosure is rigid and self-supporting. All structural joints shall be welded. The top cover may be cross linked for rigidity and to drain off rain water. The entire installation shall be mounted on a rigid base made of angles or channels so that the pad mounted transformer can be transported as a separate rigid self-supporting unit.

A partitioning sheet shall be provided between LT & HT compartments.

7.1.1 Lifting Facilities

Suitable jacking pads shall be provided for jacking the transformer assembly. Suitable lifting eyes shall also be provided for lifting the pad mounted transformer assembly as well as the transformer unit and the enclosure separately by means of slings. The holes of the lifting eyes shall have a minimum diameter of 45mm.

7.1.2 Vents

Vents of suitable dimensions shall be provided as shown in the Drawing No: PDW/DF-201 for adequate air circulation in the HT & LT compartments. Intake baffles shall be made of perforated galvanized steel of 2mm thickness. The diameter of the perforations shall not exceed 2mm and shall be spaced at centre to centre distance of 4mm max. A protective metal sheet 2 mm thick shall be fixed behind the baffles to prevent an intentional or accidental insertion of any foreign objects generally as per K-ELECTRIC design.

- 7.1.2.1 Alternate design, if proposed, shall be subject to approval by K-ELECTRIC.

7.2 Vermin Proofing

- 7.2.1 The enclosure shall be water tight and vermin proof.
- 7.2.2 For this purpose two metal sheets one fixed and the other removable and sliding. With the necessary provision of adjustable slots for cable entry shall be provided to seal off the bottom of the HT compartment.
- 7.2.3 The cable stuffing boxes of aluminum as per K-ELECTRIC design shall be provided for LT cables. The arrangement of stuffing boxes in the bottom plates of the LT Compartment are shown in K-ELECTRIC design.
- 7.2.4 The door of the HT compartment shall be two-leaf folding door. Each leaf shall have a separate internal latch. The door of the LT compartment shall be a single leaf-door.
- 7.2.5 The LT compartment shall have one or two built in locks, the lock shall be operate-able with hexagonal key. Two keys shall be provide for the lock for every pad mounted transformer. The lock shall be made of rust resistant material and shall be designed and constructed to be re-serviceable indefinitely with routine maintenance such as oiling etc. The keys may be of galvanized steel.
- 7.2.6 The HT compartment door shall be opened by two internal latches Access to the latches shall be obtained by first unlocking and opening the LT compartment door. The arrangement may be as per K-ELECTRIC design.
- 7.2.7 The latches shall be so designed that engage with the top and bottom ledges of the door frame and are easy and smooth in operation.
- 7.2.8 At least three hinges shall be provided on each door (total nine in number) .
- 7.2.8 Two shooting bolts (Al-Draz, Url, Kunda) of appropriate size preferably 12 mm with locking arrangement for pad locking facility rust, proof and superior quality may be provided on the doors of panel in addition to the existing locking arrangement. One in the upper half and other in the lower half of the door,

7.3 Painting

- 7.3.1 All interior and exterior surfaces of the enclosure shall be thoroughly cleaned by sand blasting or other appropriate methods to prepare the metal surface for painting.
- 7.3.2 Three coats of paint shall be applied. The first coat shall be a primer of zinc chromate and iron oxide or any other primer

which has equivalent weather resistance and rust inhibiting properties.

- 7.3.3 The second coat shall be based on synthetic resin with suitable properties for resistance to weathering.
- 7.3.4 The third coat shall also be based on a synthetic resin and shall have a hard durable surface and excellent weathering properties.
- 7.3.5 Alternative paint system having equivalent durability and resistance to weathering may be allowed if approved. Full details shall be supplied for approval.
- 7.3.6 The total paint thickness shall be at least 0.12mm finish colour shall be olive green.

7.4 Foundation Holes

Six slots of 20 x 50 mm shall be provided in the base of the enclosure for foundation bolts. The arrangements of the holes shall be as per K-ELECTRIC design. The holes shall be so situated that the foundation bolts are all inside the enclosure.

7.5 Danger Plates

- 7.5.1 An enameled danger plate made in accordance with K-ELECTRIC design shall be fixed on the HT compartment door.

8.0 TRANSFORMER

8.1 General

- 8.1.1 The transformer shall be three-phase, 11/0.415 KV, oil immersed, naturally cooled and sealed type for outdoor installation. The transformer shall be supplied generally in accordance with K-ELECTRIC Specification amended to date and tested according to K-ELECTRIC Specification.
- 8.1.2 The neutral point on LT side shall be brought out separately to the bushings. The HT and LT bushings of transformer shall extend into HT & LT compartment respectively. The transformer shall be capable of being removed from the other compartments as a complete unit.
- 8.1.3 The transformer shall be supplied with first filling and the oil shall conform to IEC-50296 class-I.
- 8.1.4 The transformer shall be painted and finished in accordance with Clause 6.6.

8.2 Ratings and Characteristics

8.2.1 The standard ratings shall be 200 KVA.

8.2.2 Transformer shall be provided with voltage taps of ratio 11,275/11,000/10,725/10,450/10,175/415 volts. The rated output shall be obtained on all taps.

8.2.3 The insulation level shall be as under:-

11 KV Side

Lightning impulse withstand voltage	95 KV
Power frequency withstand voltage	34 KV

415 Volts Side

Power frequency withstand voltage	2.5 KV
-----------------------------------	--------

8.2.4 The vector group shall be Dy 11

8.2.5 Limits of temperature rise shall be as under:

a) Windings as measured by resistance method	50°C
b) Top oil	40°C
c) Core	50°C

8.2.6 The transformer shall be designed to withstand the thermal and mechanical effects of dead short circuit on the LT terminals in accordance with IEC 60076-5.

8.3 Accessories

8.3.1 The following fittings shall be provided with each transformer:

- 1) Rating Plates
- 2) Lifting Lugs
- 3) Oil level indicator
- 4) Earthing terminal
- 5) Drain valve
- 6) Oil filling plug
- 7) Jacking pads
- 8) Pulling eyes

8.3.2 The relative position of the fittings shall be generally as per K-ELECTRIC design.

8.4 Rating Plates and Marking

8.4.1 A terminal marking plate and rating plate showing the information required in K-ELECTRIC Specification shall be provided.

8.4.2 The rating plate of the transformer shall be fixed on the transformer tank. On rating plate indicating P.O. No. Serial No. and rating of transformer shall also be welded with the tank.

8.5 Tests

8.5.1 All transformers shall be subjected to the routine tests at the manufacturer's works in accordance with K-ELECTRIC Specification

8.5.1.1 All the above tests shall be required to be carried out at the manufacturer's works and at the cost of supplier/manufacturer.

8.5.2 A report of all the type tests made on the transformers and their types shall be provided by the manufacturers.

9.0 HT LOAD INTERRUPTER SWITCH

9.1 General

9.1.1 The switches for (15 KA ratings) shall be single pole load break type. The switch shall be generally as per K-ELECTRIC standards.

9.2 Ratings and Characteristics

9.2.1 The switch shall have the following characteristics:

- 1) Nominal voltage 11 KV
- 2) Rated voltage 12 KV
- 3) Rated current 200 amps
- 4) Load interrupting capacity 200 amps
- 5) Rated short time (1 sec) current 15000 amps or 25000 amps
- 6) Rated making current 37 KA for 15 KV rating
- 7) Lightning impulse withstand voltage:
 - i) Across isolating gaps 110 kV
 - ii) To earth 95 kV
- 8) One minute power frequency withstand rms voltage:
 - i) Across isolating gaps 51 kV
 - ii) To earth 36 kV

- 9.2.2 The manufacturer shall indicate the operating life expectancies of load interrupter switch at rated voltage and at 25%, 50%, 75% and 100% of full load current.

9.2.3 Contacts

The contacts at both upper and lower housing shall be silver faced and the design shall be such as to ensure positive contact at both lower and upper housing. The lower contact shall be hinge design to allow the opening of load interrupter switch at about 110 in the open position. Upper contacts shall be of clip type with a reinforcing back up spring member.

- 9.2.3 The temperature rise shall not exceed 40°C for contacts and for other parts when carrying rated current continuously in accordance with IEC publication 60365 "High Voltage Switches".

9.3 Connectors

- 9.3.1 Each switch shall have bolted type connectors at the lower end for receiving 11 KV cables with stranded Copper conductors of 6-15mm dia. These shall be of brass and shall be tin plated. The minimum thickness of the coating shall be 0.03mm.
- 9.3.2 Tin plated spade type terminals shall be provided at the other end of connecting to the bus bars.

9.4 Blades

- 9.4.1 The blades shall be hinged at the bottom and shall be made of electrolytic copper of min. 98% conductivity. It shall be possible to close and open the switch by means of a hook stick and to completely remove and install the blade in the lower housing by means of this hook stick. Suitable eyes shall be provided for this purpose.

9.5 Mountings

- 9.5.1 The support insulators shall be mounted on a galvanized sheet steel base and shall have slots and holes as per K-ELECTRIC design.

9.6 Clearances

- 9.6.1 The centre to centre distance of the post type insulator supports for HT load break interrupter switches shall be 395 mm.
- 9.6.2 Switches shall be so mounted in the enclosure that a clearance of 100 mm is maintained from the blade to earth in all positions.

9.7 Name Plates

- 9.7.1 1) Manufacturer's name and type designation
- 2) Serial No.
- 3) Rated voltage KV
- 4) Lightning impulse withstand voltage KV
- 5) Rated current, amps.
- 6) One second short time current amps.
- 7) Load breaking capacity amps.
- 8) Making capacity amps.
- 9) Weight Kg.

9.8 Standards and Tests

- 9.8.1 The HT load interrupter switch shall be built and tested in accordance with the requirements laid down herein and to IEC 60265.
- 9.8.2 Certified type test reports may be accepted in lieu of type tests.
- 9.8.3 The manufacturer shall supply certificates of all tests carried out and shall certify that switches are identical in material and performance.
- 9.8.4 The operation test shall consist of the tests stated in IEC-60265 and the following:
 - i) The blades of the HT switch shall be capable of being removed and inserted in their housings. To verify this requirement, 70 operations shall be carried out. Each operation shall consist of opening, complete removal of blades and reinsertions in the lower housing and closing by means of a hook stick.

During the above test, no adjustment shall be made and the operation shall be faultless. After this test, no part of the switch shall have been damaged.

10.0 HT FUSES

10.1 Ratings and Characteristics

- 10.1.1 The hermetically sealed high rupturing capacity cartridge fuses shall be used. The total clearing time characteristics shall be such as to comply with the figures give in Table-1.
 - i. Rated currents 10,20, 40 & 50 Amps
 - ii. Nominal voltage 11 KV
 - iii. Rated voltage 12 KV
 - iv. Min. interrupting capacity 1800 Amps,

- v. asymmetrical for 12.5 KA rating or 25000 Amps asymmetrical for 25 KA rating.

TABLE-1**TOTAL CLEARING TIME CURRENT CHARACTERISTICS OF FUSES**

Transformer Rating (KVA)	Continuous Current Rating of Fuses (Amps)	300 Seconds Current Amps. (Min.)	2 Seconds Current Amps. (Max.)	0.1 Second Current Amps (Min.)	Speed Ratio
200	20	40	130	200	4

10.1.2 The fuses shall be capable of satisfactorily opening the circuit under conditions that produce any value of prospective current not exceeding its interrupting capacity at voltages upto its rated voltage operation of the fuse shall not cause emission of flame or powder or endanger an operator in any way.

10.1.3 When carrying rated current, the temperature rise shall not exceed 40°C.

10.1.4 The voltage surge produced by the operation of the fuse shall not exceed 25 KV rms under the condition of operation.

10.2 Construction

10.2.1 The overall dimensions of the fuse shall be as per K-ELECTRIC design.

10.2.2 The case of the fuse shall be made of porcelain fitted over the ends with silver plated caps and shall be hermetically sealed.

10.2.3 The fuse shall be provided with a device to indicate the operation of the fuse.

10.2.4 The fixed contacts for housing the fuse link shall be silver plated. They shall be spring loaded and so designed and constructed that adequate contact is maintained after repeated insertion and removal and after long periods of untouched service. The fuses shall be so held in the fixed contact that they are not unintentionally ejected during normal service and short circuit operation.

10.2.5 Time Current Characteristics

The manufacturer shall supply melting time current and total clearing time current characteristics of the fuses on log-log papers. He shall also supply the cut-off characteristics of the fuses.

- i. Manufacturer's name and type designation
- ii. Current rating amps.
- iii. Nominal voltage KV
- iv. Interrupting capacity. KA
- v. Standard to which manufactured
- vi. Transformer rating in KVA, 11/0.4 KV

10.5 Standards and Tests

10.5.1 The manufacturer shall state the standard to which the fuses are manufactured, subject to approval by K-ELECTRIC. All type and routine tests required in the approval standard shall be carried out.

10.5.2 Certified type test reports may be accepted in lieu of type tests.

10.5.3 The manufacturer shall supply certificates of all tests carried out and shall certify that all fuses are identical in material and performance.

10.5.4 Operation Test for HT Fuses

- i. The fuses shall be capable of removal and insertion easily and this shall be verified by 50 operations of removal and insertion.
- ii. During the above test, no adjustment shall be made and the operation shall be faultless. After this test, no part of the HT fuse shall have been damaged.

11.0 **LT CIRCUIT BREAKERS**

11.1 On triple pole 415 volts air circuit breaker generally in accordance with IEC-60157-1 and the requirements specified herein shall be supplied with each transformer of alternative-I . The continuous current ratings shall be as given below:-

11.1.1 Outgoing circuit in LT compartment shall be provided with two circuit breakers of 200 amps. Rating each instead of three circuit breakers existing of 1 x 200 amps and 2 x 100 amps. Rating in 200 KVA transformer.

<u>Transformer Rating</u>	<u>Circuit Breaker Rating</u>
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200 KVA	400 Amps
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11.2 Rating

11.2.1 The standard ratings of the circuit breaker shall be as follows:-

- i. Rated voltage 415 volts
- ii. Rated frequency 50 Hz
- iii. Rated nominal current 250, 500, 1000 & 1600 Amps
- iv. Rated Symmetrical breaking capacities shall be as follows:-

Rated Current	Symmetrical Breaking Capacity
250 Amps	10,000 Amps
500 Amps	10,000 Amps
1000 Amps	15,000 Amps
1600 Amps	25,000 Amps

v. Rated making capacity

Rated Current	Making Capacity
250 Amps	25,000 Amps
500 Amps	25,000 Amps
1000 Amps	30,000 Amps
1600 Amps	62,000 Amps

- vi. Rated short time current (1 sec.) shall be the same as symmetrical breaking current
- vii. One minute power frequency withstand voltage 2500 volts
- viii. Rated operating duty 0-t-CO-t-CO
 0 –An opening operation
 CO – A closing operation followed immediately by an opening operation
 T – Time interval between two successive operations and shall be 3 minutes unless otherwise specified.

ix. Making and Breaking Capacity

Transformer (KVA)	Circuit Breakers	Making Capacity	Breaking Capacity
200	1x 400 Amps	10 KA	25 KA

11.3 Enclosure

- 11.3.1 The enclosure and all parts of the circuit breaker which are accessible when the HT compartment door is opened shall be

made either of insulating material resistant to heat and moisture or of metal. Metal enclosures shall be solidly, earthed and shall meet the insulation requirements of IEC Publication-60157-1.

11.3.2 The enclosure shall be so made as not to endanger the operator by the effect of gases of arcing.

11.3.3 The enclosure shall meet the protection class IP-54 in accordance with IEC Publication-60157-1.

11.4 Operating Mechanism

11.4.1 The circuit breaker shall be manually operated by a quick make and quick break mechanism which shall operate by compressing springs in the first part of the make or break operation, which springs shall then assist in completing the operation independently of the operator's effort. The operation shall be continuous and the mechanism shall not hold in an intermediate position in any case.

11.4.2 The circuit breaker shall be mechanically trip free.

11.4.3 Distinct breaker position identification shall be provided either by means of the breaker handle position or mechanical on and off indicators.

11.4.4 The operating handles when made of metal shall be either earthed or shall be additionally insulated from the operating shaft for the full insulation withstands voltage.

11.5 Contacts

11.5.1 The contacts shall be heavy duty loaded type and shall be silver faced. The temperature rise of any current carrying part shall not exceed 40°C. Arc chutes shall be provided for extinguishing of the arc.

11.6 Tripping Devices

11.6.1 Each circuit breaker shall be equipped with two direct operating over current releases. One shall be of thermal type and the other shall be of magnetic type. The releases shall be rated at 200, 400 and 1250 amps. For the breakers of 250, 500 and 1600 amps, rating respectively.

11.6.2 The thermal release, when carrying 12% of rated current shall operate and open the breaker within 120 minutes starting from the not state, i.e., with the release at the working temperature corresponding to the current setting.

11.6.3 The magnetic release shall be of the instantaneous type and shall operate with 20 ms of energizing at 300% of rated current.

11.6.4 The calibration setting shall be based on an ambient temperature of 40°C.

11.7 Mechanical and Electrical Life

11.7.1 The circuit breaker shall be capable of make and break operations on no load given in Table-II below without damage:-

TABLE-II

<u>Frame Size (Amps)</u>	<u>Number of Operation Cycles</u>
250	8000
500	6000
1000	7000
1600	8500

11.7.2 10% of the total number of tests shall be close-open operations i.e., with the tripping mechanism energized by the closing of the main contacts.

11.7.3 The circuit breaker shall be capable of carrying its rated normal current of withstanding its rated voltage and of working within the specified operating limits.

11.8 Overload Performance

11.8.1 The circuit breaker shall be capable of 50 make and break operations at 600% of its continuous current, rated voltage and at rated frequency without damage. The rate of operations shall be 4 cycles minimum per minute.

11.9 Rating Plate

11.9.1 The following information shall be marked on the name plate of each LT breaker:-

- The manufacturer's name and trade mark and type designation with Sr. No.
- Rated normal current A
- Rated Voltage V
- Interrupting rating – making & breaking capacity KA
- Rated short time current, KA
- Magnetic settings

11.10 Tests

- 11.10.1 All tests shall be carried out as given in clause 14 of this specification in accordance with IEC Publication 60157-1.
- 11.10.2 Certified type test reports may be accepted in lieu of type tests together with a record of any alteration which have been made to the circuit breakers subsequent to type tests. The tests shall be carried out by a recognized authority.
- 11.10.3 The circuit breakers used for type tests to be carried out by manufacturer shall be identical in all essential details with those to be supplied.
- 11.10.4 All breakers shall be subjected to routine tests by the K-ELECTRIC Inspector at the manufacturer's works.

12.0 L.T AIR BREAK SWITCHES

12.1 General

- 12.1.1 The LT switches shall be single pole, vertically mounted, load break type and shall be supplied generally in accordance with IEC Publication 60408 and the requirements herein specified. The blades shall turn in the plane of the support insulators. The switch shall be provided with arcing contact and arcing chutes, and shall be suitable for utilization category AC-22 of IEC-60408.

ii	Rated Current	a) 500 amps for 200 KVA transformer b) 250 amps for 100 KVA transformer
iii.	Making and breaking capacity (under over load conditions at 110% voltage P.F 0.35 to 0.65)	a) 750 amps for 500 amps switch. b) 375 amps for 250 amps switch.
iv.	Making capacity (under fault condition)	a) 8000 amps for 500 amps switch b) 4000 amps for 250 amps switch
v.	Short time current (IS)	a) 10 KA for 500 amps switch b) 5 KA for 250 amps switch.
vi.	Rated insulation voltage	2500 volts

12.3 Operation

- 12.3.1 The switch shall be manually operated by a quick make and quick break mechanism. The opening and closing operation shall be independent of speed of action of the operator. The

operation shall be continuous and the mechanism shall not be hold in an intermediate position in any case. The switch 'ON' and 'OFF' position shall be indicated either by means of switch handles position or mechanical ON and OFF indicator.

- 12.3.2 The operation handle, if it is made of or completely covered by insulating material, any internal metal parts, which might become accessible in the event of insulating damage, shall also be insulated from live parts for the rated insulation voltage.

12.4 Terminals

- 12.4.1 Tin plated spade type terminals shall be provided for connecting to bus bars. The minimum thickness of tin plating shall be 0.05mm.

12.5 Contacts

- 12.5.1 The contacts at both upper and lower housing shall be silver faced and the design shall be such as to ensure positive contact at both upper and lower housing.
- 12.5.2 Arc chutes shall be provided for extinguishing the arc. The arc chutes shall contain a series of special steel plate mounted in moulded asbestos cement box. The arc chutes shall be removable for inspection of contacts.
- 12.5.3 The temperature rise shall not exceed 40°C for contacts and for other parts when carrying rated current continuously.

12.6 Endurance

- 12.6.1 The no load operating cycle (one closing operation followed by one opening operation) shall be as follows:-

<u>Type</u>	<u>No. mechanical operating cycles</u>
250A	3000
500A	1000

12.7 Name Plate

The following data shall be marked on the name plate of each switch:-

- Rated voltage, V
- Rated current, A
- Making and breaking capacity (over load), KA
- 1 Sec – short time current, KA
- Manufacturer's name and type designation

- 12.8 - Weight, Kg.
 Tests

12.8.1 The load break switches shall be tested in accordance with the requirement laid down herein and IEC 60408.

13.0 TESTS

13.1 Pad mounted Enclosures

13.1.1 Routine Tests

- i. Visual examination
- ii. Verification of dimension

13.1.2 Type Tests

- i. Impulse Test (HT panel only)
- ii. One minute power frequency with stand voltage (HT panel only)

13.2 Connectors

13.2.1 Routine Tests

- i. Verification of dimension
- ii. Determination of tin plating thickness

13.3 Bus bars

13.3.1 Routine Tests

- i. Verification of dimension
- ii. Determination of tin coating

13.3.2 Type Tests

- i. Electrical conductivity test
- ii. Dielectric test for insulation

13.4 Transformer

13.4.1 Routine Tests

All transformers shall be subjected to the following routine tests at the manufacturer's works in accordance with K-ELECTRIC Specifications

- i. Measurement of winding resistance
- ii. Ratio, polarity and phase relationship
- iii. Impedance voltage

- iv. Load losses
- v. No load losses and no load current
- vi. Induced over – voltage withstand
- vii. Separate source over – voltage withstand

13.4.2 Type Test

The following type tests in accordance with K-ELECTRIC Specification shall be carried out:-

- i. Impulse voltage withstand
- ii. Temperature rise
- iii. Short circuit withstand (as may be required by K-ELECTRIC)

13.5 HT Load Interrupter Switch

13.5.1 Routine Test

- i. Visual Inspection
- ii. Power frequency dry voltage
- iii. Contact resistance
- iv. Operation test

13.5.2 Type Tests

- i. Insulation tests
- ii. Temperature rise tests
- iii. Short time and short circuit current tests
- iv. Operation tests
- v. Mechanical endurance
- vi. Making capacity tests (under short circuit condition)
- vii. Making and breaking capacity test (under full load condition)

13.6 LT Circuit Breaker

13.6.1 Routine Tests

- i. Mechanical operation test
- ii. Dielectric tests
- iii. Calibration of releases

13.6.2 Type Tests

- i. Verification of temperature rise limits
- ii. Verification of dielectric properties
- iii. Verification of rated short circuit making & breaking capacities
- iv. Verification of the ability to carry rated short time current

13.7 LT Air Break Switch

13.7.1 Routine Tests

- i. High voltage test
- ii. Operation test

13.7.2 Type Tests

- i. Temperature rise test at rated current
- ii. Mechanical endurance test
- iii. Making & breaking capacity test
- iv. Short time current test

13.8 **LT HRC Fuses**

13.8.1 Routine Tests

- i. Time current characteristics
- ii. Test for temperature rise
- iii. Test for breaking capacity

13.9 **Switch Stick and Fuse Holder**

13.9.1 Type Test

- i. Voltage withstand test
- ii. Operation test

13.9.2 Routine Test

- i. Operation test
- ii. Verification of dimension

14.0 **RATING PLATE**

14.1 The following rating plates shall be fixed on each pad mounted transformers:-

- i. Rating plate for completely assembled transformer as per K-ELECTRIC standards
- ii. Rating and marking plates for transformer as per K-ELECTRIC standards
- i. Rating plate for HT switch as per K-ELECTRIC standards
- ii. Marking of HT fuses as per K-ELECTRIC standards
- iii. Rating plate for LT breaker as per K-ELECTRIC standards

14.2 The rating plate for completely assembled transformer shall be fixed and shall contain the following information:-

- i. Connection diagram indicating the 11 KV incoming and outgoing supply, transformer, fuse and switch connection.

- ii. Rated KVA of transformer.
- iii. Voltage rating of transformer.
- iv. HT load switch current rating.
- v. Current rating and interrupting rating of HT fuses.
- vi. LT breaker current rating.
- vii. Weight of complete unit.
- viii. Manufacturer's name and serial number.

14.3 The rated capacity of the transformer shall be permanently marked on the front in white colour. The minimum height of the lettering shall be 75mm.

15.0 TECHNICAL DATA AND DRAWING TO BE SUPPLIED

15.1 The following information shall be supplied with each bid and failure to supply the same may be subject the bid to dis-qualification.

15.1.1 Pad mounted Transformer

- i. Overall assembly drawing showing front side and plan views with doors closed and with doors open. Sufficient cross sections and parts views shall be given to clearly show all the equipment. All leading dimensions shall be given to clearly show all the equipment and all clearances shall be indicated.
- ii. Details and the mountings of the bus bars lugs, connectors and insulators
- iii. Tapping
- iv. Rated voltage at no load
- v. Rated current
- vi. Impedance voltage, percent
- vii. BIL of 11 KV and LT windings
- viii. Losses
 - 1. Total losses at 100% rated load and 100% voltage
 - 2. Total losses at 75% rated load and 100% voltage
 - 3. Total losses at 50% rated load and 100% voltage
 - 4. Excitation loss at no load and 100% voltage
 - 5. Excitation loss at no load and 110% voltage

The above losses shall be for a reference temperature of 75°C.

ix. Efficiencies

- i. Efficiencies shall be stated for unity and 0.8 lagging power factor and guaranteed to be by test, within the limits of tolerance stated for excitation and load losses for the following conditions:-
 - 1. At 100% rated load
 - 2. At 75% rated load
 - 3. At 50% rated load

x. Efficiencies

- xi. Voltage regulation in percent of no load voltage, at full load and at unity power factor.
- xii. Voltage regulation in percent of no load voltage, at full load and at 0.8 lagging power factor.

xiii. Lights and Dimensions

- a) Weight of oil (Kg)
- b) Weight of transformer alone with oil (Kg)

Weights and Dimensions

- i) Weight of Oil (Kg)
 - ii) Weight of transformer alone with oil (Kg)
-
- a) Set of scale drawings showing outside dimensions when fully erected and exact location of all accessories to a scale of 1/10. Conceptual drawings are not acceptable.
 - b) Fully dimensioned detailed drawings of bushings and all connectors showing the material used and its finish.
 - c) Fully dimensioned detail drawings of all gaskets and joints including cross sections, showing the material used.
 - d) Drawings showing details of coils and core in sufficient detail. The arrangements for mechanical bracing and the cooling channels etc. to be clearly brought out to enable assessment of mechanical strength and adequacy of cooling. The materials used to be clearly indicated.
 - e) Fully dimensioned drawings showing the details and location of all accessories.
 - f) Calculations demonstrating the short circuit performance of the transformer. This is to include also the short circuit current density and temperature rise calculations. Also calculations for short circuit electro-dynamic forces shall be supplied.

15.1.2 HT and LT Load Break Switches

- i) Nominal voltage rating.
- ii) Continuous current rating.
- iii) Short circuit rating.
- iv) Making breaking capacities.
- v) Dimensional drawing of load break switches and connectors.

- vi) Characteristics of post type insulators mentioned in clause 5.3.3 of this specification.
- vii) Dimensional drawing of post type insulator, LT insulators and 1 KV bushing of transformer
- viii) Catalogue/technical literature.

15.1.3 HRC Fuses

- i. Time current characteristics curves
- ii. Rating of fuses.
- iii. Interrupting rating.
- iv. Drawing showing dimensions of the fuse and its mounting arrangement
- v. Catalogue/technical literature of HRC Fuses.
- vi. Interrupting rating.
- vii. Thermal setting range.
- viii. Tripping time current characteristics of LT breaker and time current characteristics of HRC fuses on the same log-log paper.
- ix. Dimensioned drawing of LT connectors and its mounting arrangement.
- x. Catalogues of technical literature of the breaker giving complete technical description of the breaker.

15.1.4 Co-ordination Curves

The coordination curves as required in clause 3.5.1 shall be supplied.

- i) Detailed, full dimensioned drawings showing the enclosure along. The sizes lengths of all sheets, angles and shapes to be shown.
- ii) Detailed dimensioned drawings showing the design of doors hinges locks, latches and handles.
- iii) Drawings showing the dimensions and mounting arrangements of the locks.
- iv) Detailed drawings of the air circulation vents.
- v) Drawing for mounting of top Bakelite sheet in HT compartment.

15.2 The supplier/manufacturer shall supply the following information / Drawing after issue of letter of intent and before the issue of final order.

- i) Drawings showing details of transformer coils and core constructions in sufficient detail of facilitate major repair of K-ELECTRIC.
- ii) Drawing showing detail and location of all accessories.
- iii) Complete instructions and directions for setting the transformer assembly of un-mounted parts, for putting the transformer in service and for operating and maintenance.

- iv) Name place drawings.
- v) Instruction and maintenance manuals for the LT breakers.
- vi) Complete parts lists for the assembly transformers switches, fuses and LT breakers.

16.0 PACKING AND TRANSPORTATION

16.1 In case of supply originating in countries within Pakistan, the packing should be suitable for transportation by rail or road.

16.2 For supplies originating in countries other than Pakistan the packing should be suitable for transportation by sea, and should provide protection for damage due to exposure to the weather in open storage for period extending to about one year. Packing should provide protection against damage in transit, corrosion and fungus growth. The method of packing should be suitable for sea shipment with necessary instructions for handling, erection and maintenance of the equipment.

SECTION-E-8 DIESEL GENERATORS

1.0 SUMMARY

Diesel engine generator sets. Fully imported. The country of manufacturing and shipment of the Generator shall be Europe, USA, or Japan.

Generator supplier shall be local authorized agent of the manufacturer. Authorization certificate is to be provided from manufacturer.

2.0 QUALITY ASSURANCE

Retain NFPA 99 in paragraph below for healthcare facilities.

Quality Standard: British Standard (BS5000, BS5514), IEC60034-1, ISO3046, ISO8528, AS2789, NFPA 37, NFPA 70, NFPA 99.

Emergency Power Supply System: NFPA 110

Safety Standard: ASME B15.1.

3.0 RATING

The diesel engine driven generating set shall have the following rating and electrical characteristics:

- | | | |
|---|---|-------------------------|
| a. Generating Capacity (Prime Power Rating) | : | As indicated in the BOQ |
| b. Voltage | : | 400 Volts, $\pm 5\%$ |
| c. System | : | 3 Phase, 4 Wire |
| d. Frequency | : | 50 Hz, $\pm 2\%$ |
| e. Number Of revolutions | : | 1500 RPM |

4.0 PROJECT CONDITIONS

Environmental Conditions: All material and equipment supplied and installed shall be designed, manufactured and tested to meet the following ambient conditions unless specifically stated otherwise for any material / equipment:

- | | | |
|---------------------------------------|---|-------------|
| a. Maximum Indoor ambient temperature | : | 45 degree C |
| b. Minimum Indoor ambient temperature | : | 0 degree C |
| c. Maximum relative humidity | : | 90 % |
| d. Minimum relative humidity | : | 26 % |

5.0 OPERATION DESCRIPTION

The A.C. diesel engine driven electric generating including base fuel tank set shall be arranged for electric starting by battery power, the set shall stay in stand-by position.

The generator shall have auto mains failure (AMF) system. It shall automatically start and supply power to the load within approximately 0 to 5 seconds of the complete cessation of mains supply failure on one or more phases, or when the voltage is reduced by 20% of nominal, and automatically shut down and re-transfer the load back to the mains supply to stabilize before retransfer of the load takes place, and shall be adjustable over the 1-10 minute range.

6.0 ALTERNATOR SPECIFICATIONS

- a. The alternator shall be prime power rated and be of steel construction. It shall be A.C. brushless type. The bearings shall be grease lubricated or roller bearings.
- b. The rotor shall consist of dynamically balanced salient pole revolving field. The poles shall be equipped with damper windings. The field coils shall be to withstand high centrifugal stresses without developing any damage. Rotor insulation shall conform to Class-H.
- c. The stator core shall be made from high grade laminated silicon steel and carefully tightened to prevent occurrence of magnetic vibrations. The stator windings shall be fully impregnated for tropical climates with high quality oil resistant varnish.
- d. The A.C. exciter shall have permanent magnets in its field ensuring positive voltage build-up. The rectification shall be affected by a suitably rated silicon diode assembly over-hung to the shaft. The rotating rectifier assembly shall be built to withstand vibration and centrifugal forces.
- e. The inherent characteristics of the alternator shall be such to maintain the output voltage under all conditions of load, power factor and temperature, within the limits of $\pm 5\%$ of nominal.
- f. The alternator shall have self contained excitation system with transistorized automatic voltage regulator. The automatic voltage regulator and control gear shall be mounted in a component box on the side of the machine using antivibration mounting. Electrical connections to the voltage regulator shall be taken through a multi-way plug and socket.
- g. The alternator shall be screen protected and drip proof (NEMA2, IP23). It shall have efficient cooling system using centrifugal fans. It shall be provided with a large terminal box for outgoing cable connections.

7.0 ALTERNATOR PROTECTION

Alternator protection shall be incorporated to shut down automatically the set with a visual cum-audio alarm of the following conditions:

Over load / Short circuit current
Over and under voltage.
Over and under frequency
Reverse power
Rotor ground fault protection
Excitation protection
Phase balance protection
Negative Sequence protection

8.0 DIESEL ENGINE SPECIFICATIONS

- a. The engine shall be prime rated 4 cylinder/ in-line, 4 stroke, direct injection, turbocharged air and charged air cooled induction, water cooled industrial diesel engine.
- b. The engine shall withstand a 10% overload for a period of 1 hour (in 12 hours) in accordance with BS 5514, ISO 3046, and AS2789).
- c. The engine speed should be 1500 rpm at 50 Hz.
- d. An engine driven pump shall circulate the lubricating oil under pressure and spin-on full flow filters with replaceable elements shall be fitted.
- e. An inline fuel injection pump and a diaphragm type lift pump with full filters with replaceable element and a fuel solenoid shall be provided. The fuel used shall be Class A2 Diesel.
- f. The air filter type should be dry replaceable element with restriction indicator.
- g. Governing shall be electronic type and conform to BS 649/1958.

9.0 ENGINE PROTECTION EQUIPMENTS

Engine protection equipment shall be incorporated to shut down automatically the set with a visual cum-audio alarm of the following conditions:

- a. Low lubricating oil pressure (Below a safe working value).
- b. High cooling water temperature
- c. Low coolant level
- d. Engine Over speed

- e. With fuel oil level low engine protection system shall develop visual cum-audio alarm.

10.0 GENSET CONTROL PANEL

The control panel shall be electronic solid state type. Automatic start Engine management and instrumentation system module in cubical is installed on individual bracket with anti-vibration isolator, with instruments and graphical icon in LCD display as follows.

- a. Generator running indicator.
- b. Voltage adjuster.
- c. Emergency stop button
- d. Selector Switch with key (STOP / RESET, AUTO, MANUAL).
- e. Manual start button.
- f. Battery voltage monitoring, protection and testing
- g. Common alarm indicator
- h. Data logging
- i. Scroll button for the display on LCD.
- j. Value display on LCD.
 - ✓ Frequency / RPM.
 - ✓ AC voltage Line-Neutral.
 - ✓ AC voltage Line-Line.
 - ✓ AC line current.
 - ✓ Oil pressure.
 - ✓ Coolant temperature.
 - ✓ Engine hours run.
 - ✓ DC battery voltage.
 - ✓ Kilowatt-hours (kWhr).
 - ✓ Kilowatt (kW)
- k. Alarm indication with graphical symbol on LCD with audio and visual flashes.
- l. Status indicator.

11.0 MECHANICAL COUPLING

- a. The Diesel Engine and A.C. brushless Generator shall be coupled with each other by means of flexible coupling complete with all necessary control equipment mounted on a substantially fabricated type steel base.
- b. The generator end shield and the engine flywheel housing faces shall be fully machined with spigots concentric to their shafts. A fabricated steel coupling ring with both faces machined shall be flange mounted to the flywheel housing and generator end shield by steel bolts.
- c. A flexible coupling shall be fitted between the engine and generator to provide the drive and shall be suitable to absorb the transmissions of shock loads.
- d. The distortional flexibility shall be designed to match the distortional characteristics of the system to prevent resonant conditions.

12.0 MOUNTING DESCRIPTION

The combined engine-generator unit shall be bolted to a separate sub-frame which shall be attached to the main frame through 'Resilient Mountings including vibration isolator so providing complete protection from the engine vibration to the control gear, and other set mounted components.

13.0 COOLING SYSTEM

- a. The diesel engine shall be radiator cooled.
- b. A thermostat shall pass the coolant, until a pre-determined operating temperature is reached.
- c. An immersion heater shall be incorporated in the cooling system.

14.0 STARTING SYSTEM

- a. The starting system shall consist of a heavy duty starter motor and starter switch, a set of 12 volt heavy duty lead acid starting maintenance free batteries of adequate capacity, all arranged for automatic electric starting.
- b. The starter motor shall automatically disengage when the engine shall fire. There shall be three automatic starting attempts before the starting batteries are, should the engine fail to start due to shortage of fuel, etc.
- c. Battery charging shall be automatic provided from a suitable single-phase full wave rectification static charger. Charger shall be complete with all

necessary relays, cutouts, controls, switches and instruments for automatic charging of batteries.

- d. The batteries shall be housed in a cradle on the main base frame.

15.0 GENSET GROUNDING

The Genset frame shall be grounded at two points by two independent earth protected conductor and it is necessary to bond to a grounding electrode. The genset neutral and body earthing shall be done with PVC insulated cables and connect to grounding electrode. Earthing resistance shall be less than one ohm.

16.0 EXHAUST

A large and efficient critical acoustic type silencer to reduce noise level to a maximum of 25 dB, with a suitable length of flanged flexible exhaust pipe shall be installed. Acoustic panels to be provided on generator room door and radiator exhaust duct to reduce noise level upto 75db at 1 meter.

17.0 FINISH

All sheet steel used shall be zinc coated.

The set shall be painted with good quality primer and finished with high gloss paint.

18.0 ACCESSORIES

The AC diesel engine driven electric generating set shall be supplied with the following accessories and manuals.

- a. One - Kit of engine tools.
- b. One - Set of holding down bolts.
- c. Three - sets of installation drawings.
- d. Three - sets of circuit diagram.
- e. Three - sets of engine maintenance book.
- f. Three - sets of spare parts manual.
- g. Three - sets of generating set instruction manual.

19.0 GENERATOR TESTS

A manufacturer's standard test report/certificate shall be submitted for factory tests at the manufacturing facility.

- a. Operation of automatic starting, control sequence and all protection circuit/sensor.
- b. Prior to acceptance of installation, the equipment shall be subjected to an on-site test with full load for a minimum period of 8 hours, plus one hour at 110% load at manufacturer's facility.

The performance test which shall be carried out on site shall include the following as a minimum:

- a. Load test temperature rise

- ✓ 25 % load ½ hour
- ✓ 50 % load ½ hour
- ✓ 75% load ½ hour
- ✓ 100 % load 1hour
- ✓ 110 % load 1hour

All operating fluids (including fuel, oil, lubricants, coolant etc.) and load banks for the testing shall be provided by the contractor, who shall commission the genset, making all initial adjustment and setting required and test all the control and protection function and circuit. Three copies of the witnessed test report shall be submitted to the Employer.

The contractor shall have the kWh meters sealed and the installation approved by the electrical inspector.

20.0 INSTALLATION

- a. Generally:

The D/G Contractor shall install all equipment so as to avoid the transmission of vibration to the adjoining building.

- b. Erection:

The set must be installed, tested and commissioned at site by a registered and approved D/G Contractor and who has satisfactorily installed sufficient number of Diesel Generator Sets in Pakistan.

e. 21.0 INSTALLATION

- **Shop Drawings:**

- I. Submit 3 copies of shop drawings for approval.
- II. Shop drawings shall be complete, as to be as-built drawings, not general outline drawings used for sales and guide layouts.

- **Interior wiring, terminals and interconnecting wiring,**
 - I. Certified dimensions and weights,
 - II. Submit a composite wiring diagram of the entire emergency transfer system showing all wiring between the engine starting panel, engine generator set and the automatic synchronization panel.
- **Wiring diagrams shall clearly show:**
 - I. Main current conductors,
 - II. Control conductors, with colour and/or number coding.
 - III. Location of relays and apparatus.
 - IV. Description of function, type and catalogue, of all components.
 - a. **Alternator Control Panel:**
 - b. **Submit a schematic line diagram showing:**
 - I. Interlocks
 - II. Protection
 - III. Instruments.
 - c. **Test Reports:**

Submit certified copies of data obtained during factory tests of the engine generator set.
 - d. **Operation And Maintenance Data:**
 - I. Submit 3 copies of a maintenance manual containing the following for all equipment:
 - II. Manuals for the generator set.
 - III. Detailed instruction books.
 - IV. Operator's manuals.
 - V. Maintenance schedules.
 - VI. Parts catalogue.

22.0 SPARES

The contractor shall submit, in the format given below, a detailed itemized price list of manufacturer' recommended spares for the generator, engine and control panel for 1000 hours in the environmental condition.

23.0 Required Spare Parts

Type No.	Description	Qty Set	Rate (Rs)	Amount (Rs)
	<u>Engine:</u>			
	Fuel filter	4 sets		
	Oil filter	4 sets		
	Air filter	1 set		
	Water filter	4 sets		
	Fan belt	1 set		
	Water-pump belt	1 set		
	Alternator belt	1 set		
	Rocker cover gasket	2 sets		
	Gasket	2 sets		
	<u>Alternator & Panel:</u>			
	AVR	1 set		
	Forward diodes	3 set		
	Reverse diodes	3 set		
	Fuses 2 amp	5 Nos.		
	Fuses 6/8 amp	5 Nos.		
	Fuses 10 amp	5 Nos.		

24.0 Additional spare parts:

Supplier to list down the items as per manufacturer recommendation.

SECTION - E - 9 EARTHING SYSTEM

1.0 SCOPE OF WORK

The work under this scope consists of supplying, installation and commissioning of all material and services of the complete earthing system as specified herein and / or shown on the Tender Drawings and given in the Bill of Quantities.

The Contractor shall discuss the electrical layout with the Engineer and coordinate at site with other services for exact route, location and positions of the electrical lines and equipment.

The Earthing system with accessories shall also comply with the General Specifications for Electrical Works, Section E- I and with other relevant provisions of the Tender document.

2.0 GENERAL

The earthing system consists of earth electrodes, earthing leads, earth connecting points, earth continuity conductors and all accessories necessary for the satisfactory operation of the associated electrical system.

3.0 STANDARDS

The latest editions of the following standards / codes shall be applicable for the materials covered within the scope of this specification:

BS 951	Earthing Clamps
BS 1433	Hard drawn bare copper conductor for earthing.
BS 2874	Nuts, Bolts, Washers and Rivets for use on copper.
BS 6346	PVC Insulated Cables.
CP 1013	Earthing

Any other standard referred to in above standards or these specifications.

4.0 MATERIAL

4.1 Earth Rod Electrodes

Drive extensible rods of the same diameter into the ground, either manually or by power driven hammer, to a suitable depth to obtain low resistivity in the particular soil.

Weld earth connectors to the top of the rods, in sufficient number to take all incoming cables.

4.2 Earthing Lead

The earthing lead shall connect the earth electrode to earth connecting point or equipment in the building. It shall be round hard drawn bare electrolytic copper of size shown on the drawings. The cost of earthing leads deemed to have been included in the price of earth electrode & no separate pavement shall be made for it.

4.3 Earth Continuity Conductor

Earth continuity conductor (E.C.C) shall be hard drawn bare copper wire or single core PVC insulated copper conductor cable of sizes indicated on the drawings. All thimbles, lugs, sockets, nuts, washers and other accessories necessary for the complete installation of ECC shall be provided by the Contractor without any extra cost.

The specifications for single core PVC insulated cables used as E.C.C. shall be same as those given in section E - 3 of these specifications. PVC insulated cables when used as E.C.C. shall be green,

5.0 INSTALLATION

Complete earthing systems as shown on the drawing shall be installed by the Contractor. The earthing system shall give earth resistance, including resistance of soil, earth leads and E.C.C. equal to less than one ohm, this without ground pits water spraying.

The earthing system shall be loop connected with earthing cables at least 300 mm away from telephone cables. The concept of the main loops and the way they are connected shall be such that equipment / apparatus can be easily removed without requiring a complex disconnection operation nor risking interruption of / or damage to the loop itself. The fastening of the earthing conductors shall be made on a sufficient length so as to prevent crushing or cross section weakening. The parts on which they are connected shall be conveniently cleansed and surface.

Leads sheaths or steel tape armours are not permitted as grounding conductors. The earthing system shall be installed to ensure that when any part of the earthing system is disconnected for the purpose of carrying out periodic testing an alternative path to earth is available.

At all connections of earth continuity conductor to LV Switchboard, LV Distribution Board or any other metallic body, proper size or brass sockets, thimbles or lugs shall be used to which the copper wire shall be connected by copper brazing. The soldering of copper wire at joints or termination shall not be allowed. All tee-off connections shall be by copper brazing using suitable socket and clamps. After brazing, the jointed surface shall be protected by oxide inhibiting compound of low electrical resistance. For connections to metallic body, the surface shall be thoroughly cleaned before bolting the lug or socket.

The earth continuity conductor shall be in general run in cable trench or in conduits / pipes as shown on the drawings. For under floor runs, these shall be installed in pipe / conduit of appropriate sizes. Where laid along under ground cables, these shall be laid directly under ground in unpaved areas and in pipes under paved areas.

The electrode plate shall be installed at a minimum depth of 5 meters from finished ground level or 1 meter below permanent water level, whichever is less. The minimum horizontal distance between earth electrodes shall be 3 meters. Proper mixture of lime and charcoal in the ratio of 1: 3 shall be made and buried along with the copper plate in the ground to increase the soil

conductivity. The electrode shall be installed as per details shown on the drawings. The inspection chambers shall be constructed at locations approved by the Engineer.

A 50 mm diameter G.I. shall be provided from inspection chamber to earth plate for watering purposes. The pipe shall have 10 mm diameter holes at 500 mm center to center all along the length. At the ground level an inspection chamber with cast iron cover shall be constructed having dimensions as shown on the drawings. The inspection chamber shall have a copper supported on angle iron frame. The cover shall be hinged type, as approved by the Engineer and shall finish flush with the ground level.

The earth connecting point shall be installed at locations shown on the drawings. It shall be fixed on wall surface by means of brass screws with nuts, washers and other insulating material as instructed by the Engineer.

The earth continuity conductor of sizes shown on the drawing and BOQ shall be installed all along the cable runs and connected to the earthing bar / terminals provided in the equipment. The body of all Switchboards shall be connected to earth by specified size of E.C.C. All metal work shall also be connected to earth by specified size of E.C.C.

At any joint or termination, the E.C.C. shall be connected using proper accessories. No connection shall be made by twisting of earth conductors.

SECTION – E – 10

CABLE TRAY, LADDER AND TRUNKING

1.0 RELATED DOCUMENTS

Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

2.0 SUBMITTALS

General: Submit the following according to the Division 1 Specification Sections.

Product data for each component. Show tray types, dimensions, and finishes. Determine the sizes of the cable trays based on the number and size of cables laid on the cable trays plus 20% space for future growth. Cables laid on cable trays shall be spaced twice their overall diameter (consider the largest cable as reference). In case of discrepancy with the contract documents this clause shall prevail, unless approved by the Engineer otherwise.

Shop drawings detailing fabrication and installation of cable tray, including plans, elevations, sections, details of components, and attachments to other construction elements. Designate components and accessories, including clamps, brackets, hanger rods, splice plate's connectors, expansion joint assemblies, straight lengths, and fittings.

Co-ordination drawings, including floor plans and sections drawn to accurate scale. Show accurately scaled cable tray layout and relationships between components and adjacent structural and mechanical elements.

3.0 QUALITY ASSURANCE

Manufacturer Qualifications: Select a firm experienced in manufacturing cable trays which has a record of successful in-service performance.

Comply with the relevant standards of BS, NEMA and NEC.

Single-Source Responsibility: All cable tray components shall be the product of a single manufacturer.

4.0 SEQUENCING AND SCHEDULING

Co-ordination: Co-ordinate layout and installation of cable tray with other installations.

Revise locations and elevations from those indicated as required to suit field conditions and as approved by the Engineer.

5.0 CABLE TRAYS

The cable tray system shall be of one manufacturer and shall include factory made trays, tray fittings, connections and necessary accessories and supports to form a complete tray support system.

The cable tray system shall include the following factory made tray elements. Straight trays and ladders, fittings and horizontal and vertical bends of various angle crosses, tees, wyees, reducers, vertical riser elements, connectors and all

necessary fixing accessories.

Cable trays shall be constructed from mild steel of minimum thickness 16 gauge (1.5 mm). Trays in excess of 300 mm width shall be of minimum thickness 14 gauge (2.0mm).

Insert elements, bolts, screws, pins etc., shall be mild steel cadmium plated.

- a. Tray work shall have oval perforations. Ladder type trays shall be used as required and/or approved by the Engineer.
- b. All trays (straight and fittings) to be heavy duty returned flanged type unless specified otherwise.
- c. Tray component are to be accurately rolled or formed to close tolerance and all edges rounded. Flanges are to have full round smooth edges.
- d. Ladder racks of widths up to and including 300mm shall be constructed from rolled steel sections of minimum thickness 16 gauge (1.5 mm). Ladders in excess of 300 mm width shall be C Section construction with a minimum thickness of 14 gauge (2.0mm). the rungs shall be spaced at a maximum 300 mm.
- e. Unless indicated otherwise on drawings, cable trays shall be used in the range 150 mm to 900 mm wide, in fire preferred standard sizes: 150, 300, 450, 600 and 900 mm.
- f. Other sizes shall be used where specified or previously agreed with the Engineer.
- g. Flanges shall be a minimum of 50 mm deep.
- h. Minimum radius at side rails, horizontal and vertical tees and crosses shall be in accordance with the Manufacturer's standard.

Perforated, heavy duty, return flange type, in 2.5m nominal lengths Hot dip galvanized after completion of bending and drilling, complete with all necessary purpose made bends, tees, supports and the like. Width shall be such as to permit adequate access for installation and maintenance of cables and per the requirements of KESC regulations.

All cable trays, cable ladders and their accessories nut bolts etc. shall be hot dip galvanized to BS 729.

6.0 CABLE TRUNKING

Where required, wiring shall be run in hot-dipped galvanized (after fabrication) sheet steel cable trunking of the specified gauge complete with all fittings and accessories, manufactured and installed in accordance with BS 4678/NEMA. The trunking shall be constructed with return flanges. Trunking covers shall be secured by anchored turn-buttons and locking bars and minimum length of individual sections shall be 2.44-m. The trunking shall be suspended/supported from the structure at maximum 2-m intervals with straps and hangers fabricated from minimum 6-mm dia HDGF bars, or supported by angle-iron brackets.

Conduit drips from the trunking shall also be supported with hangers. Factory made connectors shall be used at joints.

Junctions (tee and 4-way) in multi-compartment trunking shall be double depth to avoid reduction in cabling space. Cable in vertical runs shall be

supported by pin racks, prongs or bridging pieces. Fire barriers shall be provided at each floor level. Allowance for expansion shall be incorporated.

Bonding links shall be provided at each joint and secured by screws, nuts and shockproof washers. The bonding links shall make contact with the metal of the trunking or fitting, and continuity shall not depend on contact through the screws, nor on removal of on-site paint finish from ferrous metal.

7.0 TRUNKING FOR LED PANEL

MS Tube framing (for LED light fixtures) hanged through MS Rods as approved (Epoxy Paint finish) as shown in the drawing & BOQ including cutting, welding, jointing and necessary required hardware's etc. all cutting for light fixtures & other design feature with providing & applying three coats of matt enamel paint of approved make & color shade including one coat of primer coat, filling putty at any height & floor etc., as shown on drawings, relevant standards and direction of the Engineer/Architect.

8.0 EXAMINATION

Examine surfaces to receive cable tray, cable trunking for compliance with installation tolerances and other required conditions. Do not proceed with installation until unsatisfactory conditions have been corrected.

9.0 WIRING METHODS

Use cable tray of complete with manufacturer's recommended covers, barrier strips, dropouts, fittings, conduit adapters, hold-down devices, grommets, and blind ends.

10.0 INSTALLATION

- a. Install cable tray and cable trunking level and plumb according to manufacturer's written instructions, rough-in drawings, the original design, and referenced standards.
- b. Remove burrs and sharp edges of cable trays.
- c. Make changes in direction and elevation using standard fittings.
- d. Make cable tray connections using standard fittings.
- e. Locate cable tray above piping except as required for tray accessibility and as otherwise indicated.
- f. Fire stop penetrations through fire and smoke barriers, including walls, partitions, floors, and ceilings, after cables are installed.
- g. Working Space: Install cable trays with sufficient space to permit access for installing cables.

11.0 GROUNDING

Connect cable trays, cable trunking and cable ladder to ground as instructed by manufacturer. Tighten connectors and terminals, including screws and bolts, according to equipment manufacturer's published torque-tightening values for equipment connectors.

12.0 CLEANING

Upon completion of installation of system, including fittings, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finishes, including chips, scratches, and abrasions.

SECTION-E-11

ADDRESSABLE FIRE ALARM SYSTEM

1.0 SCOPE OF WORK

The work under this scope consists of supplying, installation, testing and commissioning of all material and services of the complete Addressable Fire Alarm system as specified herein and / or shown on the Tender Drawings and given in the Bill of Quantities.

The Contractor shall discuss the electrical layout with the Engineer and coordinate at site with other services for exact route, location and positions of the system.

The Fire Alarm system with accessories shall also comply with the General Specifications for Electrical Works, Section E- I and with other relevant provisions of the Tender document.

2.0 STANDARDS

The latest editions of the following standards / codes shall be applicable for the materials covered within the scope of this specification:

BS 5839, EN approved
NFPA 72

Any other standard referred to in above standards or these specifications.

3.0 OPERATION

The Fire Alarm System shall be analogue addressable type complete with battery standby power.

At locations indicated in the drawings the Fire alarm Control Panel, and automatic detectors including notification and initiating devices shall be installed. In case of any Fire, the manual station shall be operated by pulling down the handle or breaking glass. The actuation of this station shall cause a visual alarm at the fire alarm control and indication unit, duly indicating the location of the respective station/zone.

An authorized person shall immediately visit the effected area and if after investigating, it is deemed necessary, alarm in the whole building shall be initiated from either the alarm switch located beside the fire alarm control panel by inserting a special key or the actuation of any

indication at the Fire Alarm Control Panel. The general alarm shall be initiated by an authorized person after inspecting the affected location.

Circuit shall be so arranged that an open circuit in an initiating or indicating loop shall cause the individual zone and common trouble indication at the fire alarm control panel.

4.0 MATERIAL

4.1 Conduit and Conduit Accessories

The specifications for conduit and conduit accessories shall be same as given for electrical conduit in Section E - 5 of these specifications.

4.2 Fire Alarm Cable

Fire Alarm Cable shall be 2 core 1.5mm shielded twisted pair, fire resistant, PVC insulated 250/440 volts grade cable to be laid in concealed PVC conduit.

4.3 Power Supply

The supply and operating voltages shall be 230 volts, 50 c/s and 24 volts D.C. respectively. The control stations shall be provided with sufficient capacity nickel cadmium battery with charger to operate the complete system for the least 3 hours in case of mains failure.

4.4 Fire Alarm Control and Indication Unit

The fire alarm control and indication unit should be intelligent analogue addressable. Solid State Modular Unit consisting of the following Modules; suitable number of modules shall be used to provide facility for 2 loops. It shall not be possible to remove the key without turning the key to its normal position, thus resetting the alarm contacts.

i. Loop Module

Loop Module shall have multiple of supervised initiating circuit with a trouble and an Alarm Lamp for each loop. Detection circuit wiring shall be two wire Class 'A' and shall power all Detectors (Relay outputs and) voltage output for each zone alarm and voltage output for each zone trouble shall be provided.

ii. Audible Expander Modules

Audible Expander Modules shall provide for supervised control circuit for polarized alarm signaling devices. Loop activated lamp shall be provided for each loop to aid on system testing and trouble- shooting provide (1) (2) (3) indicating circuits.

iii. Power Module

Power Module shall supply the necessary power for the loop module and all Detectors (and shall contain a Battery Charger to charge the batteries) An AC power to Lamp shall be provided to indicate the normal condition of the panel. Individual supervisory lamps shall be provided for AC power failure indication, ground fault detection, and low battery. All controls shall be behind a key-locked door to prevent unauthorized operation. Two supervised control circuits for audible signaling shall be provided as part of this module. Common trouble and common alarm relay and logic outputs shall be provided. The panel cover shall be key-locked to prevent unauthorized access.

4.5 Addressable Manual Break Glass Station

The break-glass manual station shall be operated by pulling down on the handle. When operated, the handle shall remain down with the pre-signal alarm contacts closed until the station is reset. The general alarm contacts shall remain open until after investigation. The general alarm switch shall be operated by an authorized person with a special key.

4.6 Addressable Audible Signal Unit

Fire alarm sounder with strobe shall be red color surface mounted installed where indicated on the drawings. Sound intensity shall be such that an audible signal will be heard clearly throughout the structure when the entire bells ring. The bell shall be connected in multiple cross loop conductors.

4.7 Addressable Smoke Detector:

The Smoke Detector is photo electric type and shall be connected to the specific loop. Base shall be provided with detector.

4.8 Addressable Heat Detector:

The Heat Detector is connected to the specific loop. Base shall be provided with detector.

4.9 Addressable Sounder With Strobe:

The Addressable loop powered sounders with strobe should be used to meet more than 75dB. It should be with base.

4.10 Function of Addressable Fire Alarm Control Panel (FACP)

i. Design

The FACP shall be solid state, modular design with integral static protection. All indicating lamps shall be long-life, low maintenance solid state light emitting diodes (LED).

ii. Enclosure

The FACP enclosure shall be semi-flush mounted. The enclosure shall be hinged from the left and the cover shall have clear windows and locking mechanism to keep the system operating and status switches from being tampered keys shall be made available to fire department and other authorized operating personnel. Finish shall be "FIRE ALARM RED" and "BLACK".

iii. Loops & Identification

All controls shall be labeled, all loop locations shall be identified, and the FACP shall be provided with a set of permanently mounted operating instructions, to avoid confusion. Loop location identification shall be as approved by the Engineer In charge and contain up to three lines of text with 1/8" minimum character heights.

iv. Components of Fire Alarm Control Panel

The FACP shall include as minimum following:

- a. All hardware and software to allow the panel configuration and operation to be changed at the panel. Systems that require off-site programming are not acceptable.

The memory data for panel configuration and operation shall reside in non-volatile, memory provided by battery-backed RAM. Removal of the board shall not cause loss of memory contents.

Switches for panel setup, set reset, manual, evacuation alarm, silence and acknowledge. Individual supervisory LEDs shall be provided for power, run, alarm, trouble, disconnect, low battery and ground fault.

- b. Indicating zones: As indicated on the drawings,

each zone containing smoke detectors shall provide power and monitoring for up to only 50% detectors. (All hardware and software shall be provided to facilitate selection of circuit performance to provide alarm verification for smoke detector circuits with field false alarms. When a detector signals an alarm, the panel shall automatically reset the detector, wait and their double checks to verify the alarm. Each zone shall have a red LED to indicate alarm and yellow or amber LED to indicate a trouble condition.

- c. Indicating Loops: 1 or 2 indicating circuits shall be provided. Each circuit shall provide power for polarized alarm signaling devices. A red LED to indicate the energized state of the circuit and a yellow LED to indicate a trouble condition shall be provided for each circuit. A disconnect switch for each circuit shall be provided to allow the FACP to be tested with sounding alarm signals. When disconnected, the FACP shall indicate both trouble condition and disconnect.

v. Manual Functions

At any time, even without an alarm condition on an indicating circuit, the operator shall provide the following manual capabilities in the FACP by means of switches located behind a key-locked cover:

- a. In case of fire if a general evacuation is needed all bells shall sound. These signals can be initiated from the main panel and secondary switch at manual fire alarm initiating device (break glass unit).
- b. Silence the local audible signal. This shall also cause the LED(s) to cease flashing and to be continuously 'ON'.
- c. Silence the alarm signals.
- d. Reset the FACP, after all initiating devices have been restored to normal.
- e. Disconnect any individual initiating or indicating circuit from the alarm sequence. This action shall light a disconnect LED and cause a trouble condition.
- f. Perform a complete operational test of the system microprocessor with a visual indication of satisfactory communication with each board.
- g. Test all panel LEDs for proper operation without causing a change in the condition on any zone.

vi. System Supervision

- a. Upon application of primary power, or reapplication following power failure, the FACP shall automatically be in a normal supervisory condition.
- b. In the normal supervisory condition, a green "POWER" LED shall be illuminated, indicating the presence of primary power.
- c. A green "RUN" LED shall be illuminated indicating that the microprocessor is communicating with the system and the memory contents are satisfactory.
- d. The following shall be electrically supervised:

All initiating and indicating device circuits.

All plug-in circuit board shall have proper board type in the position. System that use electrical continuity to supervise the presence of plug boards, but that do not assure that board position have been exchanged, shall provide equivalent means for specified supervision, beyond that provided by the locked cover.

4.11 Shop Drawings / Technical Specifications

Prior to installation of any equipment, the Contractor shall submit for approval, shop drawings, cause and effect sheets including riser and terminal wiring diagrams and specifications data sheets. Submittals indicating typical one line riser and typical specification data sheets only will not be acceptable.

The Contractor shall review the total system point to point wiring layout to assure that the correct number and type of wire and conduit sizes are installed.

Upon completion, the Contractor shall provide detailed written operation instructions and three sets of "as built" drawings including plan, layout, conduit runs and wiring diagrams as finally installed.

4.12 Test

Upon completion and at such time as the Engineer incharge may direct, the Contractor shall conduct a total system test where line supervision and each device shall be tested. All the tests shall demonstrate that the system meets the tests shall operating requirements of this specification, that individual conductors of all circuits are free of grounds, shorts and breaks, and that no grounds exist between any piece of equipment in the control unit and the cabinet. All final connections, testing, adjusting and calibrating shall be made under the direct

supervision of a factory trained technician of the system supplier.

4.13 System

The fire alarm control panel (FACP) shall be installed at the Security room at lower ground floor by at a position and height as shown on drawing and as approved at site. The FACP shall match with the wall finish and shall be of neat finish, installed flush or semi-flush with the wall.

The fire alarm riser shall travel in one conduit for straight runs, separate conduit shall be used at branch office through junction boxes.

4.14 Fire Alarm Installation

The Fire alarm system shall be installed as mentioned in the drawings. The system shall be connected, tested and commissioned as per manufacturer's instructions and system integrator certified from principal or manufacturer and in the presence of Engineer Incharge. The wall recessed mounting Fire alarm manual stations shall be installed at a height of 4.5' feet above finished floor level. The connections of the appropriate Contactors of the Fire alarm system shall be made as per manufacturer's instructions.

The mounting height of the sounder shall be above the false ceiling or 7' from F.F. level when false ceiling is not comes. The conduit and wiring of the Fire alarm system shall be as per installation instructions for conduits and wirings given in the relevant section of these specifications. The Fire alarm system conduit shall be laid 15 cms (6") from the electrical conduits and cross the electrical conduit at 90 degree only. The Fire alarm system conduit shall be marked with red colour at terminations in order to distinguish it from other conduit system.

SECTION – E – 12

PUBLIC ADDRESS SYSTEM

1.0 SUMMARY

This Section includes equipment for amplifying, distributing, and reproducing sound signals.

2.0 DEFINITIONS

Retain abbreviation and terms that remain after this Section has been edited.

Channels: Separate parallel signal paths, from sources to speakers or loudspeaker zones, with separate amplification and switching that permit selection between paths for speaker alternative program signals.

Zone: Separate group of speakers and associated supply wiring that may be arranged for selective switching between different channels.

VU: Volume unit.

Emergency Voice Evacuation: Built in EN 54 EVAC system in voice controller shall automatically announce voice evacuation.

3.0 SUBMITTALS

Product Data: For the following:

Adjust list below to suit Project.

Voice Alarm Controller (Preamplifier).

Power amplifiers.

Microphone.

Equipment rack.

Speakers (Wall, ceiling etc).

Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:

Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.

Field quality-control test reports.

Operation and maintenance data.

4.0 QUALITY ASSURANCE

Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

Comply with NFPA 70.

Comply with EN 60849 and 54-16 Standards.

5.0 COORDINATION

Coordinate layout and installation of system components and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

6.0 FUNCTIONAL DESCRIPTION OF SYSTEM

Descriptions below are offered as examples only. Revise this Article to convey

design intent to Contractor and Installer.

System Functions: Include the following:

- Delete functions in subparagraphs below that are not required and edit remaining descriptions to suit Project; add other functions as required.
- Selectively connecting separate zones to different signal channels.
- Selectively amplifying sound among various microphone outlets and other inputs.
- Communicating simultaneously to all zones regardless of zone or channel switch settings.
- Paging, by dialing an extension from any local telephone instrument and speaking into the telephone.

Producing a program-signal tone that is amplified and sounded over all speakers, overriding signals currently being distributed. Reproducing high-quality sound that is free of noise and distortion at all speakers at all times during equipment operation including standby mode with inputs off; and output free of non uniform coverage of amplified sound. In case of emergency built in Emergency Voice Evacuation system shall enable and announce through speakers.

7.0 EQUIPMENT AND MATERIALS

Coordinate features to form an integrated system. Match components and interconnections for optimum performance of specified functions.

Modular equipment type using solid-state components, fully rated for continuous duty, unless otherwise indicated. Select equipment for normal operation on input power usually supplied at 100 to 240 V, 50 Hz.

8.0 VOICE ALARM CONTROLLER WITH SURVEILLANCE FRAME(Preamplifiers)

Comply with TIA/EIA SE-101-A; either separately mounted or as an integral part of power amplifier. En 54-16 complaint.

Output Power	:	2000W.
Total Harmonic Distortion	:	Less than 1 percent.
Frequency Response	:	Within plus or minus 2 dB from 20 to 20,000 Hz or 60Hz to 18KHZ.
Input Jacks	:	Minimum of two. One matched for low-impedance microphone; the other match able to cassette deck, CD player, or radio tuner signals without external adapters.
Minimum Noise Level	:	Minus 55 dB below rated output.
Controls	:	On/off, input levels, and master gain.
MIC in	:	XLR, 6.3m Jack.
EMG Announcement	:	Built-in.
Connectivity	:	RJ45 & Fibre
Transmission	:	128

9.0 SURVEILLANCE AMPLIFIER

Comply with TIA/EIA SE-101-A.

Revise first paragraph below to suit Project.

Mounting	:	Rack mounted.
Output Power	:	2000Watt balanced line.
Frequency Response	:	Within plus or minus 2 dB from 50 to 12,000 Hz.
Minimum Signal-to-Noise Ratio:		60 dB, at rated output.
Total Harmonic Distortion	:	Less than 3 percent at rated power output from 50 to 12,000 Hz.
Output Regulation	:	Less than 2 dB from full to no load.
Controls	:	On/off, input levels, and low-cut filter.
Input Sensitivity	:	Matched to preamplifier and providing full-rated output with sound-pressure level of less than 10 dynes/sq. cm impinging on speaker microphone or handset transmitter.

10.0 COMPONENTS

Parameters listed in this Article are typical values. Performance and product characteristics vary among manufacturers. Revise to suit Project.

Microphone	:	Comply with TIA/EIA SE-105.
Type	:	Dynamic, with cardioids polar or unidirectional characteristic
Impedance	:	150 ohms.
Frequency Response	:	Uniform, 50 to 14,000 Hz.
Output Level	:	Minus 58 dB minimum.
Finish	:	Satin chrome and as required.
Cable	:	C25J.
Mounting	:	Desk stand with integral-locking, press-to-talk switch.
Quantity of Microphones	:	Ten.
Desk Stands		
Equipment Rack	:	Comply with TIA/EIA-310-D. House amplifiers and auxiliary equipment in standard TIA/EIA 19-inch (483-mm) racks.

Group items of same function together, either vertically or side by side, and arrange controls symmetrically.

Power-Supply Connections: Approved plugs and receptacles.

Arrange all inputs, outputs, interconnections, and test points so they are accessible at rear of rack for maintenance and testing, with each item removable from rack without disturbing other items or connections.

Blank Panels : Cover empty space in equipment

		racks so entire front of rack is occupied by panels.
Enclosure Panels	:	Ventilated rear and sides and solid top. Use louvers in panels to ensure adequate ventilation.
Finish	:	Uniform, baked-enamel factory finish over rust-inhibiting primer or as required.
Power-Control Panel	:	On front of equipment housing, with master power on/off switch and pilot light; and with socket for 5-A cartridge fuse for rack equipment power.
Service Light	:	At top rear of rack with an adjacent control switch.
Vertical Plug Strip	:	Grounded receptacles, 12 inches (300 mm) o.c. the full height of rack, to supply rack-mounted equipment.
Maintenance Receptacles:		Duplex convenience outlets supplied independent of vertical plug strip and located in front and bottom rear of rack.
Spare Capacity	:	20 percent spare space capacity in rack for future equipment. Coordinate paragraph and subparagraphs below with Drawings.
Insulation for Wire in Conduit	:	Thermoplastic, not less than 1/32 inch (0.8 mm) thick.
Microphone Cables	:	Neoprene jacketed, not less than 2/64 inch (0.8 mm) thick, over shield with filled interstices. Shield No. 34 AWG tinned, soft-copper strands formed into a braid or approved equivalent foil. Shielding coverage on conductors is not less than 60 percent. Plenum Cable: Listed and labeled for plenum installation.

11.0 CEILING & WALL SPEAKERS

It shall be suitable for speech and Emergency Voice Evacuation reproduction. Flush mounted type with metal grille.

Compliance

BS 5839-8 and EN54 -24 BS 60849 , Compliant.

Max Power	:	6W
Rated Power	:	6/31.5/0.75W
SPL	:	97dB
Rated Voltage	:	100V.

Max Power	:	30W
Rated Power	:	10/20/30W
SPL	:	115dB
Rated Voltage	:	100V.

12.0 BGM SOURCE

The BGM Source shall be high quality consists of DVD/CD player digitally controller FM/AM tuner.

Supports	:	MP3,JPEG.
Tunner	:	AM/FM.
Control	:	Remote.
Source Unit	:	BGM
Power I/P	:	230VAC 50/60Hz
Power Consumption	:	25VA

13.0 MICROPHONE STATION

The call station shall be high quality with minimum 16 zone selectable metal base design. It can make calls to selected zones in PA & Voice Alarm Condition.

Voltage Range	:	24 VDC O VAC
Power Consumption	:	30mA
Nominal Sensitivity	:	85dB SPL
Compression	:	1:20
Distortion	:	<0.6%
Frequency Response	:	100Hz to 16Hz
Selection	:	Chimes any file
Priorities	:	6 having extendable option upto 22
Cable Length	:	As required.
Connectivity	:	RJ45 option
:	:	

14.0 EXECUTION INSTALLATION**Wiring Method**

Install wiring in raceways except within consoles, cabinets, desks, and counters and except in accessible ceiling spaces and in gypsum-board partitions where cable wiring method may be used. Use plenum cable in environmental air spaces including plenum ceilings. Conceal cables and

raceways except in unfinished spaces.

Install exposed cables parallel and perpendicular to surfaces or exposed structural members, and follow surface contours. Secure and support cables by straps, staples, or similar fittings so designed and installed to avoid damage to cables. Secure cable at intervals not exceeding 30 inches (760 mm) and not more than 6 inches (150 mm) from cabinets, boxes, or fittings.

Wiring within Enclosures

Bundle, lace, and train conductors to terminal points with no excess use lacing bars in cabinets.

Control-Circuit Wiring: Install number and size of conductors as recommended by system manufacturer for control functions indicated.

Separation of Wires

Separate speaker-microphone, line-level, speaker-level, and power wiring runs. Install in separate raceways or, where exposed or in same enclosure, separate conductors at least 12 inches (300 mm) for speaker microphones and adjacent parallel power and telephone wiring. Separate other intercommunication equipment conductors as recommended by equipment manufacturer.

Splices, Taps, and Terminations

Arrange on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

Match input and output impedances and signal levels at signal interfaces. Provide matching networks where required.

Identification of Conductors and Cables

Color-code conductors and apply wire and cable marking tape to designate wires and cables so they identify media in coordination with system wiring diagrams.

Wall-Mounting Outlets: Flush mounted.

Floor-Mounting Outlets: Conceal in floor and install cable nozzles through outlet covers. Secure outlet covers in place. Trim with carpet in carpeted areas.

Conductor Sizing: Unless otherwise indicated, size speaker circuit conductors from racks to loudspeaker outlets not smaller than No. 18 AWG and conductors from microphone receptacles to amplifiers not smaller than No. 22 AWG.

Speaker-Line Matching Transformer Connections: Make initial connections using tap settings indicated on Drawings.

Connect wiring according to Division 16 Section "Conductors and Cables."

15.0 GROUNDING

Revise this Article to suit system requirements. Include grounding electrodes for special applications only.

Ground cable shields and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.

Signal Ground Terminal: Locate at main equipment cabinet. Isolate from power system and equipment grounding.

Install grounding electrodes as specified in Division 16 Section "Grounding and Bonding."

16.0 FIELD QUALITY CONTROL

Perform the following field tests and inspections and prepare test reports: Schedule tests with at least seven days' advance notice of test performance. After installing public address and music equipment and after electrical circuitry has been energized, test for compliance with requirements.

Operational Test

Perform tests that include originating program and page messages at microphone outlets, preamplifier program inputs, and other inputs. Verify proper routing and volume levels and that system is free of noise and distortion.

Signal-to-Noise Ratio Test: Measure signal-to-noise ratio of complete system at normal gain settings as follows:

Disconnect microphone at connector or jack closest to it and replace it in the circuit with a signal generator using a 1000-Hz signal. Replace all other microphones at corresponding connectors with dummy loads, each equal in impedance to microphone it replaces. Measure signal-to-noise ratio.

Repeat test for each separately controlled zone of loudspeakers. Minimum acceptance ratio is 50 dB.

Distortion Test: Measure distortion at normal gain settings and rated power. Feed signals at frequencies of 50, 200, 400, 1000, 3000, 8000, and 12,000 Hz into each preamplifier channel. For each frequency, measure distortion in the paging and all-call amplifier outputs. Maximum acceptable distortion at any frequency is 3 percent total harmonics.

Acoustic Coverage Test: Feed pink noise into system using octaves centered at 500 and 4000 Hz. Use sound-level meter with octave-band filters to measure level at five locations in each zone. For spaces with seated audiences, maximum permissible variation in level is plus or minus 2 dB. In addition, the levels between locations in the same zone and between locations in adjacent zones must not vary more than plus or minus 3 dB.

Power Output Test: Measure electrical power output of each power amplifier at normal gain settings of 50, 1000, and 12,000 Hz. Maximum variation in power output at these frequencies must not exceed plus or minus 1 dB.

Signal Ground Test: Measure and report ground resistance at public address equipment signal ground. Comply with testing requirements specified in Division 16 Section "Grounding and Bonding."

Retesting: Correct deficiencies, revising tap settings of speaker-line matching transformers where necessary to optimize volume and uniformity of sound levels, and retest. Prepare a written record of tests.

Inspection: Verify that units and controls are properly labeled and interconnecting wires and terminals are identified. Prepare a list of final tap settings of paging speaker-line matching transformers.

17.0 ADJUSTING

On-Site engage a factory-authorized service representative to provide on-site assistance in adjusting sound levels, resetting transformer taps, and adjusting controls to meet occupancy conditions.

18.0 DEMONSTRATION

Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain public address and music equipment. Refer to Division 1 Section.

LIST OF APPROVED MANUFACTURERS/SOURCES OF ELECTRICAL EQUIPMENT

All Equipment shall be procured from Principal Authorized agents / distributors / resellers

The Bidder shall fill the name of only one manufacturer for each equipment/material on which the tender is based. He shall be bound to supply the equipment from the same manufacturer. In case, the Bidder gives names of more than one manufacturer against any equipment, the Engineer / Owner can ask the Bidder supply the equipment from any one of them.

At the evaluation stage if it is noted that any material offered by the bidder does not meet the specification requirements, the Engineer / Owner reserves the right to ask the bidder to replace his choice of equipment supplier meeting the required quality and specification requirement.

During the execution stage if the material from any supplier is found defective / substandard the Engineer / Owner reserves the right to ask the successful bidder to replace his choice of manufacturer / supplier for that particular equipment.

Any change in manufacturer / supplier shall only be entertained if there is sufficient reason that adhering to the original choice of manufacturer / supplier shall be detrimental to either the project quality or project timeline. Proper approval shall have to be sought for change in the choice manufacturer / supplier at least 1 month before the equipment is to be procured.

Bidder is required to mark the proposed Manufacturer / supplier and country of origin for each item below.

S. No	Manufacturer / Supplier	✓	Country Of Origin
A	<u>Pad Mounted Transformer</u>		
1	a. PEL		Pakistan
	b. Transfopower		Pakistan
	c. Elmetec		Pakistan
2	<u>MV Cables Accessories (Jointing & Termination Kits)</u>		
	a. 3M		USA
	b. Raychem		USA

S. No	Manufacturer / Supplier	✓	Country Of Origin
3	<u>C.T./ P.T., Relays, etc.</u>		
	a. Revalco		Italy
	b. Fico		Pakistan
	c. Schneider		France
	d. Siemens		Germany
	e. ABB		Germany
B	<u>Diesel Generator, Fully imported. (Assembled in USA, Europe or Japan)</u>		
1	<u>i. Diesel Generator Sets</u>		
	a. Caterpillar		USA / UK
	b. Cummins		UK
	c. Teksan		Turkey
	d. SDMO		France
	e. Aksa		Turkey
	f. FG Wilson		UK
C	<u>LOW VOLTAGE (LV) PRODUCTS</u>		
1	<u>LV Switchboards / Distribution Boards / PFI Panels</u>		
	a. Pak Electron Limited (PEL)		Pakistan
	b. Hussain & company		Pakistan
	c. Schneider Electric		Pakistan
	e. Libra Engineering		Pakistan
	f.		
2	<u>Circuit Breakers</u>		
	a. Schneider Electric		France
	b. Terasaki (ACBs & MCCBs only)		Japan
	c. ABB		Germany
	d. Legrand		France
	e. Siemens		Germany
3	<u>Load Break Switches, Changeover Switches</u>		
	a. Socomec		France
	b. Kraus & Naimer		Australia
	c. Gewiss		Italy
	d. Breter		Italy
	e. Legrand		Italy
4	<u>Push Buttons, Switches, Etc.</u>		
	a. Schneider Electric		France
	b. Maruyasa		Japan

S. No	Manufacturer / Supplier	✓	Country Of Origin
5	<u>LV Cables & Wires</u>		
	a. Pakstan Cables		Pakistan
	b. Newage Cables		Pakistan
	c. Pioneer Cables		Pakistan
	d. Universal Cables		Pakistan
	e. Allied Cables		Pakistan
	f. Fast Cables		Pakistan
6	<u>Cable Glands, Lugs, Terminals and Accessories</u>		
	a. Cembre		UK
	b. Hubbell / Hawke		UK
	c. Hensel		Germany
	d. ABB		Italy
7	<u>PVC Conduits and Accessories</u>		
	a. Galco		Pakistan
	b. Dadex		Pakistan
	c. Jeddah Polymer		Pakistan
	d. Civic		Pakistan
8	<u>GI Conduit</u>		
	a. IIL		Pakistan
	b. Steelelex		Pakistan
9	<u>Back Boxes / Junction Boxes</u>		
	a. Hensel		Germany
	b. Clipsal (Schneider Electric)		Australia
	c. Hussain & Co.		Pakistan
10	<u>Switch & Socket Outlets / Floor Boxes</u>		
	a. Schneider Electric		Australia
	b. M.K.		UK
	c. Legrand		France
	d. ABB		Germany

S. No	Manufacturer / Supplier	✓	Country Of Origin
11	<u>FAN & Accessories</u>		
	a. Pak Fan		Pakistan
	b. GFC Fan		Pakistan
	c. Millat Fan		Pakistan
12	<u>LED Light Fixtures</u>		
	a. Philips		Netherland
	b. Gewiss		Italy
	c. Osram		Germany
	d. Pierlite		Australia
	e.		
13	<u>Cable Tray / Trunking</u>		
	a. GIS		Pakistan
	b. Hussain & Co.		Pakistan
	c. Ezzi Engineering		Pakistan
	d. Ashraf Industry		Pakistan
	e.		
14	<u>Contactors</u>		
	a. Telemecanique (Schneider Electric)		France
	b. National		Japan
	c. ABB		Germany
	d. Legrand		France
15	<u>Earthing Material</u>		
	a. Furse		UK
	b. Wallis		UK
	c. Erico		UK/USA
	d. Dehn		Germany
16	<u>Power Factor Improvement Capacitors</u>		
	a. Nokian		Finland
	b. Schneider		France
	c. ABB		Italy
	d. Siemens		Germany

S. No	Manufacturer / Supplier	✓	Country Of Origin
D	<u>LOW CURRENT PRODUCTS</u>		
1	<u>Public Address System</u>		
	a.	BOSCH	UK
	b.	TOA	Japan/Indonesia
2	<u>Exit & Emergency lighting Fixtures</u>		
	a.	Menvier	UK
	b.	Teknoware	Finland
3	<u>Fire Alarm Cable</u>		
	a.	Firecell	Italy
	b.	Prysmian	UK

Vertical Transportation – Elevators

ELEVATORS

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ELECTRIC TRACTION ELEVATORS**PART 1 – GENERAL****1.1 SCOPE**

- A. The specification included in this Section is intended to cover the complete provision and installation of Machine Room Less (MRL) Passenger Gearless Traction Elevators at all Stations of BRT Green Line Service. All work and material necessary to accomplish this installation in a complete and workman-like manner, except that specifically excluded as "Work by Others", shall be provided. This work is to be done in accordance with the requirements of international and local codes, which may govern the requirements of the installation.
- B. Applicable requirements of the following sections of this specifications apply to all work required under this section.
 - 1. Conditions of Contract.
 - 2. General Conditions of Contract.
- C. Work Installed, but Furnished by Others: (Also Refer Clause No. 2.4 G)
 - 1. A life safety, supervised "all building paging" speaker to be installed in each elevator car canopy.
 - 2. A sound-powered firefighters' telephone jack to be installed in elevator car operating station for fire-fighters elevator.
 - 3. Remote CCTV color monitors to display elevator car camera signals and hook up to Cat-6 trail cable run to machine room junction boxes. The Building Contractor shall furnish CCTV color cameras in each of the listed elevators.
- D. Work or Items Furnished, But Not Installed:
 - 1. Three copies of elevator maintenance manuals, operating instructions, wiring diagrams and parts ordering manuals, and lubrication charts are to be furnished. Windows compatible CD or DVD disc containing this information are to be provided.
 - 2. Elevator operating keys (five sets of each key).

1.2 COMPLIANCE WITH REGULATIONS/STANDARDS

- A. Elevator Equipment shall comply with Manufacturer's standards such as BS (EN), JIS or ASME and installation works shall comply with BS (EN) and local authorities' requirement.
1. Applicable International Building Code (IBC) 2003
 2. Requirements of Sindh Building Control Authority Codes, Ordinances and Laws applicable within the governing jurisdiction
 3. Local Codes, Ordinances and Laws
 4. BS 5655 Current Edition
 5. ASME A17.1-20050 Safety Code for Elevators and Escalators
 6. Elevator Inspectors' Manual, ASME A17.2-2004
 7. BS 7671, Requirements for Electrical Installation, IEE Wiring Regulations, 17th Edition
 8. National Electrical Code No. NFPA 70-2002
 9. BS (EN) 81.1, Safety rules for Construction and Installation of Lifts – Electric Lifts.
 10. BS 5588-5, Fire Precautions in the Design, Construction and use of Buildings, Part 5: Code of Practice for Firefighting stairs and lifts.
 11. All lifts to comply with NFPA 101 Life Safety Code.
- B. Permits: Obtain and pay for all local construction permits, commissioning inspections, and the first year's elevator operating permits.
- C. Local codes shall have priority over all other codes in case of difference between codes.

1.3 PRODUCTS

- A. Approved Manufacturers:
1. Gearless Elevators of the following manufacturers and countries of origin are approved. This list is provided for reference only and shall be used as guidelines for the level of skills and quality desired for the project. It shall

not in any way constitute any brand preference by the Client or Consultant.

The country of manufacturing and shipment of the Elevators shall be Western Europe, USA, Japan.

- Otis (USA)
 - Schindler (Western Europe)
 - Thyssen Krupp (Western Europe)
 - Kone (Western Europe)
 - Mitsubishi (Japan)
 - Or approved equivalent from Western Europe, USA or Japan.
- a. Elevator contractor shall be capable of providing maintenance service, including adequate local parts inventory within the city of Karachi.
 - b. Contractor shall be capable of providing 24-hour-a-day emergency service and respond to trouble calls within 1-1/2 to 2 hours and passenger entrapments within 30 minutes of notification.
 - c. Contractor shall employ competent personnel, experienced in elevator maintenance.
 - d. Contractor shall perform all maintenance during specified maintenance period and shall offer contract maintenance service to Owner. Maintenance service shall not be assigned or transferred.
 - e. Elevator contractor shall be authorized sole representative of the manufacturer. Contractor shall provide a certificate of authorization from the principal.

2. Guarantee:

- a. The materials and workmanship of the elevator apparatus installed shall comply in every respect with these specifications. Any defects (not due to ordinary wear and tear) which may develop within two years from date of final acceptance and/or beneficial use of each

individual elevator shall be corrected to the satisfaction of the Architect/Engineer at no additional cost.

- b. The Elevator Contractor shall make any and all modifications, adjustments and improvements to the elevator systems necessary to meet the performance requirements specified in Part 2.2 of these specifications.

1.4 SUBMITTALS AND SAMPLES

- A. Within 20 days after receipt of Notice to Proceed, submit soft copy of Windows CD or DVD and three copies of the shop drawings and required material for review. In general, the following are required:
 1. Shop Drawings: Equipment arrangement, entrances and car enclosures. Provide drawings at the following scale: hoistway sections 1:50; hoistway shaft details 1:50; hoistway and machine room plans 1:20; elevator cars and hoistway entrances 1:20; fixtures 1:10.
 2. Design Data: Indicate equipment lists, reactions, rail loads and stacking plan, door weights, heat emissions, stack effect remediation, ride quality, wind loads, and relevant design information on layouts.
 3. Power Data: Provide Kilowatts load, accelerating current, full-load running current, demand factor and regenerative loads for applicable motors and power conversion units.
 4. Finish Material: Submit samples as per the Architect/Engineer's requirements. Submit 3 samples of the following: 30 cm x 30 cm materials and finishes exposed to view; welded entrance frame detail, engraving (1 word in each size); extruded stainless steel car sill.
 5. Fixtures: Submit cuts and shop drawings and samples of all fixtures including one of each of the following: each type of hall lantern; hall pushbutton; light fixture; car operating panel; color LCD display screen; elevator monitoring CRT, CPU and keyboard, etc.
 6. Manufacturer's Certificates: Submit certificate of elevator performance with As-built drawings and documents. After adjustments, test, and inspections are performed, forward certificate signed by Elevator Manufacturer stating that the equipment and controls provide the level of elevator service and ride qualities specified. Include certification that

elevator hoistway doors, frames, transom panels, hardware and accessories comply with specified fire rating requirements.

1.5 MAINTENANCE

A. The Contractor shall provide maintenance service for 24 months, which shall include the following:

1. Preventative maintenance on all equipment described herein for a period of 24 months commencing on date of final acceptance by Owner of each elevator unit, including unlimited 24-hour emergency callbacks. The maintenance shall include systematic examinations, adjustment, cleaning and lubrication of all equipment. The Contractor shall also repair or replace electrical and mechanical parts whenever required and shall use only genuine, standard parts produced by the Manufacturer of the equipment installed. Maintain elevator machine rooms, hoistways, and pits in clean condition.
2. All maintenance work shall be performed by competent personnel under the supervision and in the direct employment of the Contractor.
3. The Owner, at his option, may choose to delete this maintenance from the capital contracts and to pay this amount in equal installments directly to the Contractor during the period in which the work is being accomplished.
4. Consumable materials and spare parts for 24 months maintenance period shall be included in the bid price.
5. Preventive maintenance program indicating activities and their frequency shall be submitted with the bid.

B. Maintenance:

1. Quote the cost for a 5-year maintenance agreement to commence on completion of the 24-month period above. This quotation shall be submitted with the elevator tenders on standard maintenance form. Under this agreement, the equipment performance requirements, as specified, shall be provided at all times.
2. If this contract is accepted, the contractor price may be adjusted at the expiration of the new installation service period and, thereafter, as provided in the contract.

C. Interim Maintenance:

1. When one or more elevators have been installed and substantially completed and declared ready for service before the entire installation of all elevators has been completed and accepted, the Owner may accept the elevators for use and place them in regular service.

1.6 MATERIALS

The materials shall comply with following standards:

- A. Steel: Low carbon, cold rolled to stretcher leveled standard flatness as per ASTM A366 for sheet steel and ASTM A36 for structural steel.
- B. Stainless Steel: Type 302 or 304 with No. 4 or 8-polished directional finish on exposed surfaces as per ASTM A167, as specified. Finish is to be as per Architect/Engineers requirements.
- C. Aluminum: Extrusions per ASTM B221; sheet and plate per ASTM B209.
- D. Paint: All exposed metal work furnished under this section, except as otherwise noted, shall be cleaned of oil, grease, scale and other foreign matter and factory painted with two coats of Manufacturer's standard rust-resistant primer. After erection, provide two finish coats of industrial enamel paint. Galvanized metal exposed inside of the hoistway or in the machine room need not be painted (except as noted). Field paint and touch up any ferrous metal that is exposed or welded during construction or installation.
- E. Prime Finish: Clean all surfaces receiving a baked enamel finish of oil, grease, scale, etc. Apply one coat of rust-resistant mineral paint followed by a filler coat over uneven surfaces. Sand smooth and apply final coat of mineral paint.
- F. Baked Enamel: Prime per "E" above. Apply and bake three additional coats of enamel in the solid color and finish as selected by the Architect.

1.7 ELEVATOR CARS:

- A. General – All Elevators complete cars shall be delivered to the jobsite by the contractor.

Elevator Contractors shall provide cars as specified in the relevant section of these specifications. The cars are to include all interior finishes, the ceiling and interior lighting. The car platforms, steel shells, plenums,

emergency exits and contacts, front returns, transoms, and doors, sills, stiles, slings, safety plank, roller guides, headers, door operators, controls, toe guards, emergency exit and contacts are to be included in the bid.

B. Cars: The Elevator Contractor shall provide all drawings and materials included in this specification and install the cars. The Elevator Contractor shall also be responsible for the following:

1. Provide and install all electrical controls and signal fixtures and wire complete.
2. Provide and install conduit and wiring to lighting and ventilating fixtures.
3. Provide and install car door headers, tracks and threshold.
4. Provide and install car door hangers and gibs on car doors and hang doors.
5. Provide and install car operating panels and position indicator controls, sound-powered telephone jacks, car telephones, service panels, and faceplates.
6. Install life safety speakers and CCTV cameras in car canopy and security card readers in car front return; cameras and card readers and speakers provided by Building Contractor (Refer clause 1.1C 3&4).

C. Car Weights: For equipment design purposes, the Lift Contractor shall estimate the complete weight of the passenger lift interior car finish materials as per manufacturer's recommendations and comply with relevant codes.

1.8 KEYS

A. Five sets of keys to operate all keyed switches and locks shall be furnished upon completion. Keys shall be tagged properly. All keying shall be arranged with the Owner's representative.

1.9 HOISTING

This clause is related to attendance to be provided by the Elevator Contractor for the following items, which are to be performed during installaton:

- Unloading, distributing, hoisting craneage and lowering of materials, equipment machinery or the like.

- Scaffolding, including mobile platforms and provision of any specialist scaffolding.
- Provision of all specialist lifting, hoisting, craneage etc. for off loading, positioning and installation of services equipment.

PART 2 – TECHNICAL SPECIFICATIONS

2.1 ELEVATORS SCHEDULES

A. Passenger Elevators

(Opening In Line):

Machine Room less (MRL) Type

Number of Cars:	Thirteen (13 Nos.) Elevators at 03 Stations type (G)
Capacity:	630 Kg (08 persons)
Speed:	1.0 m/s
Roping:	1:1 or 2:1
Supervisory Control:	Microprocessor based Simplex Selective Collective system (latest version)
Encoder:	Machine-Room Mounted, Digitally pulsed type
Motor Control:	AC VVVF with automatic leveling and digital closed-loop motor feedback
Power Converter:	I.G.B.T. Converter/Inverter regenerative drives equipped with isolation transformers and EMI filter networks
Power Characteristics:	400 Volts, 3-Phase, 50 Hertz
Stops:	02 Stops and <u>openings in line</u>
Floors Served	G, 1
Travel:	6.6M±
Platform Size:	1190 Wide X 1600 Deep X 2400 (Car Height)

Car Inside:	1100 Wide X 1400 Deep X 2175 High (To Dropped Ceiling)
Entrance Size:	900 Wide X 2100 High
Entrance Type:	2-Panel, Center Opening
Door Operation:	High-Speed, Heavy-Duty, Closed-Loop Master ACV ³ F Door Operator (Minimum Opening Speed 0.75-0.90m/Sec)
Door Protection:	Infrared, pulsed matrix proximity detectors with variable timing feature and nudging Door edge Mechanical Protection.
Traction Media:	Traction Belt
Machine:	Overhead Gearless Traction (AC VVVF PMSM or Induction Type)
Safety:	Flexible Guide Clamp (Type "B" Only), Car and counterweight
Guide Rails:	Planed Steel Tees
Buffers:	Oil, spring return with access ladders, inspection platforms and blocking
Compensation:	Wire Rope and Pit Sheaves
Car Enclosure:	As specified in relevant sections of these specifications
Entrances:	As specified in relevant sections of these specifications
Signals –	
Registration Lights:	Car and hall touch buttons wall mounted
Position Indicators:	Car (Color LCD Digital Type) and Lobby
Hall Lanterns –	
(Prediction Type):	At all floors with adjustable-volume, electronic chimes (sound twice for down direction travel)
Communication System:	Intercoms and Distress Signal System
Car Video Camera:	CCTV Pinhole Color Camera Installation and providing Cat-6 Trail Cables

Life Safety: Sound Powered Telephone Jack, All Building
Paging Speaker Installation

Additional Features:-

Up fall and unintended car movement protection (individual, dual acting hoist machine emergency brakes, counterweight safeties or hoist machine rope brakes).

Car and Counterweight Roller Guides

Car Top Inspection Station

Access Panel in Car Ceiling

Automatic Emergency Landing Device, Battery Powered to lead car to nearest landing in event of power failure and doors to open automatically

Emergency Car Lighting with Battery Packs, Chargers and a Test Button

Zone 2B Seismic Designs and Operations

Full Height Car Operating Panel

Handicap COP

Hinged Car Front Return Panels

Hoistway Access Switches

Platform Isolation

Load-Weighing Device

False-Call Canceling

Firefighters' Control Panels (Color LCD Displays and Keyboards)

Conduits and Remote Wiring to Control Panels

Rail Backing (As Required)

Extruded or Milled Stainless Steel Car Sills (Narrow)

Hoistway Sill Support Angles

24-Month Maintenance with 24-Hour Callback Service

Full Interactive Elevator Monitoring, Control, and Security Integration with Remote Central Command and Control System.

Machine, Power Converter and Controller Sound Isolation

As-Built Wiring Diagrams, Operating Instructions, Maintenance Instructions, Parts Ordering Information, and a Lubrication Chart

B. Passenger Elevators

(Opening Through Type): Machine Room less (MRL) Type

Number of Cars:	Five (05 Nos.) Elevators at 03 Stations type (G)
Capacity:	630 Kg (08 persons)
Speed:	1.0 m/s
Roping:	1:1 or 2:1
Supervisory Control:	Microprocessor based Simplex Selective Collective system (latest version)
Encoder:	Machine-Room Mounted, Digitally pulsed type
Motor Control:	AC VVVF with automatic leveling and digital closed-loop motor feedback
Power Converter:	I.G.B.T. Converter/Inverter regenerative drives equipped with isolation transformers and EMI filter networks
Power Characteristics:	400 Volts, 3-Phase, 50 Hertz
Stops:	02 Stops and <u>openings Through</u>
Floors Served	G, 1
Travel:	6.6M±
Platform Size:	1190 Wide X 1600 Deep X 2400 (Car Height)
Car Inside:	1100 Wide X 1400 Deep X 2175 High (To Dropped Ceiling)
Entrance Size:	900 Wide X 2100 High

Entrance Type:	2-Panel, Center Opening
Door Operation:	High-Speed, Heavy-Duty, Closed-Loop Master ACV ³ F Door Operator (Minimum Opening Speed 0.75-0.90m/Sec)
Door Protection:	Infrared, pulsed matrix proximity detectors with variable timing feature and nudging Door edge Mechanical Protection.
Traction Media:	Traction Belt
Machine:	Overhead Gearless Traction (AC VVVF PMSM or Induction Type)
Safety:	Flexible Guide Clamp (Type "B" Only), Car and counterweight
Guide Rails:	Planed Steel Tees
Buffers:	Oil, spring return with access ladders, inspection platforms and blocking
Compensation:	Wire Rope and Pit Sheaves
Car Enclosure:	As specified in relevant sections of these specifications
Entrances:	As specified in relevant sections of these specifications
Signals –	
Registration Lights:	Car and hall touch buttons wall mounted
Position Indicators:	Car (Color LCD Digital Type) and Lobby
Hall Lanterns –	
(Prediction Type):	At all floors with adjustable-volume, electronic chimes (sound twice for down direction travel)
Communication System:	Intercoms and Distress Signal System
Car Video Camera:	CCTV Pinhole Color Camera Installation and providing Cat-6 Trail Cables
Life Safety:	Sound Powered Telephone Jack, All Building Paging Speaker Installation
Additional Features:-	

Up fall and unintended car movement protection (individual, dual acting hoist machine emergency brakes, counterweight safeties or hoist machine rope brakes).

Car and Counterweight Roller Guides

Car Top Inspection Station

Access Panel in Car Ceiling

Automatic Emergency Landing Device, Battery Powered to lead car to nearest landing in event of power failure and doors to open automatically

Emergency Car Lighting with Battery Packs, Chargers and a Test Button

Zone 2B Seismic Designs and Operations

Full Height Car Operating Panel

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Hinged Car Front Return Panels

Hoistway Access Switches

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Load-Weighing Device

False-Call Canceling

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Rail Backing (As Required)

Extruded or Milled Stainless Steel Car Sills (Narrow)

Hoistway Sill Support Angles

24-Month Maintenance with 24-Hour Callback Service

Full Interactive Elevator Monitoring, Control, and Security Integration with Remote Central Command and Control System.

Machine, Power Converter and Controller Sound Isolation

As-Built Wiring Diagrams, Operating Instructions, Maintenance Instructions, Parts Ordering Information, and a Lubrication Chart

2.2 PERFORMANCE

- A. Speed: $\pm 3\%$ under any loading condition or travel direction.
- B. Capacity: Safely lower, stop and hold up to **125%** of the rated load.
- C. Stopping Accuracy: 6 mm under any car loading condition.
- D. Door Times: The door **opening** time shall be measured from the instant the doors start to open until they are in the fully open position.

The door **closing** time shall not be less than that permitted by the ASME A17.1 Code, Rule 112.4.

The door opening times shall meet the indicated times and the door closing times shall be adjustable and approximate the following:

Doors		Elevators/Door Type	Door Opening Time (Adjustable) (Seconds)	Door Closing Time (Adjustable) (Seconds)
W	H			
900	2100	Passenger Elevators, CO	1.6	2.4

- E. Floor-to-Floor Time: Floor-to-floor time shall be measured from the instant the doors start to close at one floor until the car is level and stopped at the next floor. Doors shall not be more than 3/4 open before the car is level and stopped. These performance times shall be obtainable with dependable, consistent operation without undue wear or stress on the equipment and without excessive maintenance. The elevator shall provide a comfortable ride with smooth acceleration, retardation and a soft stop. The time for the elevators to travel from floor to floor under any loading condition shall not exceed the stipulated limits as per codes.

2.3 NOISE AND VIBRATION CONTROL

- A. All elevator equipment (including hoist machines, deflector sheaves, power conversion units and support equipment) shall be mechanically isolated from the structure and electrically isolated from the building power supply and each other to prevent noise and vibration being transmitted to occupied area of the building.
- B. Elevator equipment shall be designed, installed and adjusted to meet the performance requirements of Section 2.2 within the following parameters.
1. Horizontal acceleration (postwise and front to back) within cars during all riding and door operating conditions shall not exceed 15mg peak to peak.
 2. Acceleration and deceleration shall be constant and shall be at least 1.0m/sec^2 on the gearless elevators and not exceed 1.4m/sec^2 with an initial ramp between 0.5 and 0.75 second.
- C. Measured noise levels relating to elevator equipment and its operation shall not exceed 50-66 dBA in the elevator cars and lobbies and 75 dBA in

elevator machine space under any condition including door operation and car exhaust fan on highest speed.

2.4 CONTROL SYSTEM

A. Operational Control: The various systems specified hereafter shall be provided for each elevator as per the elevator schedules.

1. Microprocessor-Based, Simplex Selective Collective: Elevator shall operate without an attendant from buttons located at each floor entrance jamb and in the car. The registration of a hall call, when the car is idle, shall automatically start the elevator and dispatch it to the corresponding floor. If a call is registered at the floor where the car is idle, the doors shall automatically open.

Once the direction of travel has been established, the car will not reverse direction until all car calls have been answered or until all hall calls, ahead of the car and corresponding to the direction of car travel, have been answered.

The car shall slow down and stop automatically at floors corresponding to registered calls, in the order in which they are approached in each direction of travel. As slowdown is initiated for a hall call, that call shall be automatically canceled and the hall button for that direction of travel remain ineffective until the car leaves the floor. Car calls shall be similarly canceled.

The car shall only answer calls corresponding to the direction in which the car is traveling except that it may answer a call in the opposite direction if that call is the highest (or lowest) call registered.

Registration of a call shall cause the appropriate button to illuminate. When the call is answered, the light shall go out.

2. Additional Features:

- a. Stopping Accuracy: An automatic 2-way stopping and leveling device shall be provided, designed to govern the stopping accuracy of the car to within ± 6 mm above or below the landing sill. This operation shall be effective to avoid overtravel, as well as under travel, of the car and maintain the stopping accuracy regardless of the load in the car, direction of travel, rope slippage or stretch.

- b. Remote Monitoring and Diagnostics: Equip each car controller with standard ports, interface boards, and drivers to accept maintenance, data logging, and fault finding diagnostic computers, keyboards, modems, and programming tools. The system shall be capable of driving remote color LCD monitor(s) that continually scan and display the status of each car and call. Provide each BRT Station with a full, interactive Elevator Monitoring (EMS) System.
- B. Independent Service: Provide controls for operation of each elevator from car buttons only. Under this operation door closing shall be initiated by activating the desired destination floor button or the door close button.

Attendant Service Feature – Provide for elevators as specified in Elevator Schedule.
- C. Door Operation-Passenger Elevators: Doors shall open automatically when the car arrives at a floor to permit the transfer of passengers. In the event a passenger has entered the elevator, before it is assigned for dispatching, the doors shall reopen upon registration of a call on the car button or by pressing the door open button. Equip the car doors with preopening circuits so that the doors are about $\frac{3}{4}$ open when the elevator is level at the landing.
- D. Emergency Features:
 - 1. Firefighters' Service: Equip the elevators with control system to operate and recall the cars during a fire or other emergency condition per ASME A17.1-2005, Section 2.27. Provide terminals on the controller for connection of signal from sensors provided in other sections of the work. Operation shall be similar on all elevators and visual/audible signal shall operate until return is complete or automatic operation restored. Provide the designated level and alternate return level sequencing per the Local Fire Authority Requirements.
 - 2. Emergency Car Lighting and Emergency Alarm Unit: Car-mounted or machine room mounted battery unit including solid-state charger and testing means enclosed in common metal container. Battery to be rechargeable nickel cadmium, lead acid, or gel-cell type with a 10-year minimum life expectancy. Mount the emergency call bell on each car top. Locate emergency LED lamps above the car dropped ceiling so that the unit is not readily visible from the car interior but gives sufficient intensity to provide at least 50 lux measured at a height of 1 meter

above the car floor. Locate an emergency lighting test button in the car service panel. A main line power failure or pressing the test button shall illuminate the emergency LED lights.

3. Automatic Emergency Landing Device: In the event of normal power failure, an automatic battery powered landing device shall bring elevators to the nearest landing and doors shall open automatically.
 4. Standby Power Transfer: In the event of normal power failure, adequate standby power will be supplied through normal feeders to start and run Elevators designated full time at rated speed. Provide controls to automatically start and run the cars nonstop to the designated terminal, one car at a time. Under either mode of operation, only designated elevators shall be running on standby power at a time. Provide standby power to run the elevator E.M.S. system, the intercom system and all car lights, exhaust fan and emergency call bells.
- F. Car-to-Lobby Switches: Provide a switch or E.M.S. keyboard operations for each elevator in the command center control panel to return the car to the lobby floor. Activating the switch (control) shall cause the car to return to the lobby floor while bypassing hall calls but answering registered car calls en route.
- G. Sound-Powered Telephone Jack: Install a sound-powered telephone jack (provided by the Life Safety Contractor) and wiring in each elevator car. The system shall provide for 2-way communications between all of the stations with the wiring terminating at each machine room car controller's junction box.

2.5 MACHINE ROOM EQUIPMENT

- A. Arrange equipment in machine rooms. Provide identifying numbers on machine, power-conversion unit, controller, data concentrator and main line and auxiliary disconnect switch.
- B. Gearless Traction Machine:
1. ACV³F induction or P.M.S.M. gearless traction type motor with brake, drive sheave and deflector sheave mounted in proper alignment on a common, isolated bedplate. Machine shall have sealed ball or roller bearings and meet testing requirements without external cooling. Single-wrap, traction hoist machine drive sheaves with appropriate grooves shall be provided with friction reducing liners or be equipped

- with traction belt. Provide blocking to elevate secondary or deflector sheave above machine room floor.
2. Elevators shall be equipped with overhead gearless hoist machines equipped with steel traction belt. Synthetic hoist ropes suspension means are not acceptable for these units.
 3. Isolate the machine or bedplate and the deflector sheave from the building structure in order to minimize noise vibration transmission into occupied area of the building.
 4. Provide ACV³F induction motors with thermostatically operated cooling blowers, shrouds and mounting means.
 5. Provide a direct drive, digital, closed-loop velocity encoder on hoist machine.
 6. Provide dual, double independently operated disc or drum brakes to meet the “up-fall” elevator protection requirements.
 7. Hoist machine installations, which require blockouts through machine room, floor for other than hoist ropes shall be provided with a 14-gauge galvanized sheet metal smoke closures over entire blockout on underside of machine room floor slab.
- C. Power Conversion and Regulation Units: Provide solid-state, alternating current variable voltage, variable frequency (ACV³F) I.G.B.T. converter/inverter drives. The units shall be designed to limit current, suppress noise and prevent transient voltage feedback into the building power supply. Provide internal heat sink cooling fans for the power drive portion of the converter panels. Isolate unit from the building structure to minimize noise and vibration transmission. Provide each unit with isolation transformers, line filters, noise filter networks, and choke inductors, as required. The Elevator Contractor shall be responsible for all required corrections to suppress solid-state converter noises (audible and vibratory), radio frequency interference in unit, or eliminate regenerative voltage transients induced into main line feeders or the standby power generator. All gearless ACV³F drives shall be regenerative and utilize dynamic braking during an overhauling condition. Supplement direct-current power for the operation of the hoist machine brake, door operator, dispatch logic processors, and signal fixtures, etc., shall be supplied from separate, static power supplies.

- D. Encoder: Encoders shall be provided and mounted in the machine room. The encoders shall be the solid-state, optical, digital-count type, mechanically coupled to the car via a slotted tape with drive sheaves and a pit-tensioning sheave or driven from the car governor. Optical, inductive pulse, or mechanical cam-type tape encoders or rail "friction" encoders mounted in the hoistway shall not be used on the gearless elevators.
- E. Controller: Cabinet type controller shall be provided, with removable doors or drawers and adequate ventilation fans to dissipate heat complying with NEC Code Article 110-16(a) working clearances. Wire to identified terminal block studs. Identifying symbols or letters identical to those on wiring diagrams permanently marked adjacent to each component on the controller. Provide the proper ampere rating marked adjacent to all fuse holders. Each car controller, the group dispatch controller and data concentrator panels (if provided) shall be equipped with plug-compatible diagnostic ports, system monitoring ports, and remote LCD drivers and plugs. Provide the dispatch controller or data concentrator panel with a 56k modem and data card for the remote monitoring telephone line connections.
- F. Templates, Forms, Sleeves and Guards: All templates, forms and sleeves for providing necessary openings in the concrete slab over the hoistway shall be provided as part of this work. Sleeves for conduit and other small holes shall project 25mm above the concrete slab. Provide 25mm steel angle guards around hoist cables, governor ropes, encoder tapes, or duct slots that penetrate the machine room slab. Provide approved rope and smoke guards for sheaves and cable machine room slab penetrations.
- G. Machine Beams: Provide structural steel beams required for support of the elevator machine, secondary sheave, overhead sheaves, governors and dead-end hitches. Provide bearing plates, anchors, shelf angles, blocking, etc., to support beams and equipment. Elevator Contractors shall provide special slab support shelf angles welded into the webs of their machine beams, if required, to support the machine room slab and decking. Cope the machine beams and weld them to the building support steel, as required by the Structural Engineer for proper load transfer.
- H. Governor: Centrifugal type, for car and counterweight driven with pull-through jaws. Provide two bi-directional electrical shutdown switches and any overhead supports required which are additional to building structure.

2.6 HOISTWAY EQUIPMENT

- A. Guide Rails: Steel T-section suitable for travel, car and counterweight weights, seismic accelerations and support locations at structural floors. Provide rail backing, intermediate counterweight tie brackets, divider beams and hoistway inserts, if necessary, to meet ASME A17.1 Code requirements and the specified ride qualities. NOTE: Other Trades will provide only those supports indicated on the structural drawings. The Elevator Contractor shall be responsible for any additional divider beams, rail supports, brackets or attachments.
- B. Buffers: Oil type with any blocking, supports, and permanent inspection ladders and platforms (required where the car and/or counterweight buffer oil inspection port is located 2.0m or more above the pit floor). Provide reduced stroke buffers if required, to meet the minimum code overhead requirements.
- C. Sheaves: Machined grooves with ball or roller bearings. Provide mounting means to machine beams, machine bedplate, car and counterweight structural members, etc. Provide drip pans under 2:1, overhead, and deflector sheaves, rope guards on drive, compensation, 2:1 and all secondary sheaves. Provide car top and counterweight 2:1 sheaves with removable top metal dust covers and guards. Provide lock down compensation pit embedment items and support channels, if required.
- D. Governor and Encoder Pit-Tensioning Sheaves: The sheaves shall be mounted to pit support members or the rails and provided with guides or pivot points to enable free vertical movement.
- E. Compensation: Gearless Elevators: Rope type with pit-tensioning sheaves. Provide electrical contacts on tension sheave to stop elevator on sheave over or under travel.
- F. Counterweight: Channel construction, steel channel frame with cast iron filler weights, and two subweight retainer rods that pass through all subweights and the counterweight crosshead, guided by four sets of roller guide shoes. Each roller guide shall have three rollers of a diameter sufficient to limit the rotational speed to less than 1000 r.p.m.
 - 1. Provide seismic counterweight retainer plates on the top and bottom of each counterweight frame on elevators.

- G. Counterweight Safety: Per Code. Provide on all elevators with “occupied” spaces below their pits and as indicated in Elevator Schedules.
- H. Counterweight Guard: Metal guard around counterweight in pit, per code.
- I. Hoist and Governor Belt/Ropes:
1. Coated Steel Reinforced traction belt; minimum twelve steel ropes encased with Polyurethane coating comprising a flat traction belt for hoisting.
 2. Governor rope with adjustable wedge type shackles.
 3. Fasten hoist ropes or belts with adjustable, wedge type shackles.
 4. 2:1 roping dead-end hitches shall be provided with dampening springs.
- J. Normal and Final Terminal Stopping Devices: As per Code. Provide emergency terminal slowdown devices, if required, to meet the minimum Code overhead and pit depth requirements.
- K. Electrical Wiring:
1. Conductors: Stranded copper throughout with individual wires coded and all connections on identified studs or terminal blocks. Use no splices or similar connections in wiring except at terminal blocks, control cabinets, junction boxes. Provide 10% spare conductors throughout. Flexible conduit shall not be used on flat portions of the car top.
 2. Conduit, Etc.: Galvanized steel conduit and duct. Conduit size shall be 20mm minimum. Flexible conduit exceeding 45cm in length or mounted on flat portions of the car top shall not be used. Flexible heavy-duty service cord may be used between fixed car wiring and car door protection light matrix junction boxes.
 3. Traveling Cables: Flame and moisture-resistant outer cover. Include six sets of shielded communication wires and car lighting circuits from machine room to car connection points. Prevent traveling cables from rubbing or chafing against hoistway or car items. Traveling cables exceeding 30m in length shall be supported with steel internal messenger wires. Provide a continuous vertical strip of wire cloth between the cables and hoistway items. Provide each set of traveling

cables with 10% spare conductors and 4 spare sets of shielded pairs and a coaxial or dedicated CCTV monitor cable(s).

L. Entrance Equipment:

1. Door Hangers: 2-point suspension with upthrust adjustment. Hanger rollers shall be equipped with polyurethane insert tires; no metal-to-metal contact permitted.
2. Door Tracks: Bar or formed, cold-drawn steel with smooth hanger contact surface. Tracks shall be removable for replacement.
3. Interlocks: Type operable without retiring cam. Provide fire-resistant wiring, NEC, Type SF-2 or equivalent.
4. Closers: Spring, spirator, or weighted type attached to the entrance struts.
5. Relating Cables: Provide between door panels, include stainless steel aircraft cord, swaged fasteners, sheaves and adjustment clips.
6. Provide the emergency “blind” hoistway access doors located in the express run portions of the hoistway(s), if required, with electrical contacts and closers per ASME A17.1, Rule 2.11.1.2.

M. Pit Stop Switch: As Per Code.

N. Floor Numbers: Provide painted 10cm high fire floor numbers within the hoistway as per ASME A17.1 Code, Rule 2.29.2.

2.7 HOISTWAY ENTRANCES

- A. Summary: Provide complete entrances with the clear dimensions and finishes indicated.
- B. Frames: No. 14 U.S. gauge steel welded and mitered construction.
- C. Door Panels: No. 16 U.S. gauge steel with 2 removable, fire type gibs located .3m on center per panel. Doors with heights greater than 2.10m shall be constructed with interlocking stiffening ribs. Providing all door panels with top and bottom fire safety retainer clips that mesh with the entrance jambs when in the closed position per ASME A17.1 Code Rule 2.11.11.8.

- D. Sight Guards: Same material and finish as door panels.
- E. Transoms: Provide fire rated flush transoms and offset, sheet type transoms at indicated openings.
- F. Sills: Passenger elevators extruded or formed stainless steel at the ground entrance. Provide extruded aluminum sills at all other floors. Provide and install “groutless” steel angle sill supports for all entrance sills.
- G. Fascia, Toe Guards, Dust and Hanger Covers: No. 14 U.S. gauge furniture steel with Manufacturer’s standard dark color enamel finish.
- H. Struts and Headers: Provide for necessary support of entrances and related material. Provide door open rubber bumpers on each entrance support strut.

2.8 CAR EQUIPMENT

- A. Car Frame: Welded or bolted steel channel construction.
- B. Car Safety Device: Type B, flexible guide clamp type.
- C. Platform: Isolated type constructed entirely of steel; Class “A” freight loading.
- D. Guide Shoes: Roller type with three or more sound-deadening rollers per shoe. Maximum rotation speed, 350rpm up to speeds of 5.0mps.
- E. Floor Covering: Inset Stone or granite as approved by the Architect/Engineer set with thin set mortar in passenger elevators.
- F. Car Sill: Narrow type, extruded or formed stainless steel, set at a height to be flush with the finished car flooring.
- G. Toe Guard: As Per Code.
- H. Car Door Hangers and Tracks: Conform to specification on hoistway entrance hangers and tracks. Equip doors with polyurethane-tired hanger rollers.
- I. Header: Constructed of 5mm thick steel shaped to provide stiffening flanges, securely mounted and braced to the car top.
- J. Car Door Clutches: Provide heavy-duty clutches, vanes, linkage arms, drive blocks and pickup rollers or cams to provide positive, smooth, quiet door

operations and up to 75-150mm of predoor opening. The clutches shall be designed with movable vanes to permit the car doors to be closed while the hoistway doors remain open at the floor for maintenance purposes. Provide car doors with restrictors per ASME A17.1 Code Rule 2.12.5.

- K. Car Door Electrical Contact: Electrical contact to operate in conjunction with the car doors so that elevator cannot operate unless doors are closed or within tolerance allowed by Code.
- L. Door Operator: High-speed, heavy-duty, ACV³F closed loop, door operator capable of opening doors at no less than .75 to .9mps and accomplishing reversal in no more than 6.5 cm of door movement. Arrange operator so the car doors can be opened by hand from inside the car in case of power failure, if it is within the hoistway door-unlocking zone.

M. Door Reopening and Control Devices:

- 1. Car Door Reversal Device: A solid-state electronically operated infrared door reversal, proximity device shall be installed on the car doors. The device shall contain specially designed electronic components enclosed in an insulated chassis. The device will create a criss-cross matrix of invisible, infrared, light beams, minimum 32 beams, which shall scan the car doorway and shall detect, through the breaking of any light beam, any opaque object that may be placed in its path.

After a car stop is made, the door shall remain open for a predetermined interval before closing. If, while the door is closing, a passenger or an object interrupts the matrix of invisible light beams entering or leaving the car, the door shall stop and reopen, after which the door shall again start to close.

- 2. Variable Timing Feature Passenger Elevators: Provide separately adjustable timers, to enable varying the time that the hoistway doors remain open after stopping in response to a car call or a landing call. The dwell time for a car call stop shall be adjustable between one and four seconds and the timing for a landing call stop shall be adjustable between three and eight seconds. If a stop is made in response to both a landing call and a car call, the timing of the landing call shall predominate. In the event that the light beam is interrupted while the doors are opening or after the doors are fully open, the time that the doors remain open after the light beam has been reestablished shall be reduced to an adjustable time between two and one second,

depending upon whether a landing call or a car call predominated. This time shall also be a minimum time that the doors remain open if the door protection beams are interrupted and reestablished before the door is fully open.

3. Nudging Action: In the event, a door protection light beam is continually obstructed, or the door hold open button is continually activated, for a predetermined time interval (20 seconds) after automatic door closing has been initiated, a buzzer shall sound and the doors shall be closed at a gentle, reduced speed. Timers shall be individually adjustable.

N. Car Control Stations:

1. A Car Control stations with stainless-steel flush mounted faceplate containing the operating fixtures, and a lockable service panel shall be mounted in the car front return panel on the passenger elevators. A Handicap Car Operating station with a stainless-steel faceplate, flush mounted with tamperproof screw shall be provided in addition.
2. The front return panels or faceplates shall be engraved and filled with the identifying number of each elevator and its capacity in KG and number of permitted persons. Permanently applied, tactile symbols and markers shall suitably identify the floor call buttons, alarm button, door open button, and emergency stop switch. All automatic operating controls shall be located no higher than 135 cm above the car floor (90 cm for stop switch and alarm button). Engrave and fill CERTIFICATE OF INSPECTION ON FILE IN THE BUILDING OFFICE and NO SMOKING at the top of the return panels or faceplates in each car. The operating panel shall contain the following controls and buttons:
 - a. Car floor buttons with 13 mm numbers corresponding to the floors served for registration of car calls. Call registered lights, located within or behind the buttons, shall illuminate the floor number corresponding to the call registered.
 - b. An illuminating alarm button shall be provided at the bottom of each car station to ring a bell located in the hoistway near the main lobby and on top of the car.
 - c. Provide an illuminating intercom call button. Actuating the intercom call button shall activate the control center panel intercom distress

signal. The call button light shall flash for 10-20 seconds once the intercom call is answered.

- d. A red emergency stop switch shall be provided at the bottom of each car station to interrupt the power supply independently of the regular operating devices. The switch shall be so arranged that when operated, it will sound the alarm bell as described above and activate the control center panel intercom distress signal. The actuation of this switch shall not cancel registered calls. Alternately, the stop switch may be installed in the car service panel.
- e. A door open button, which shall stop the closing motion of the doors and return them automatically to their fully open position. This button shall be effective while the car is at a landing and until the car starts into motion, regardless of any special operational features.
- f. One Firefighters' service key switch, door close button, light jewel, buzzer, and call cancel button.
- h. One sound-powered telephone jack.
- i. One security card reader in specified elevators (provided by others).
- j. A service panel with a heavy-duty, vandal-resistant, hinged, lockable, door matching the front return panel finishes or faceplates shall be mounted below the main car operating station.

The service panel shall contain the following controls with each control and its operating positions identified by engraved and black filled letters:

- 1) A door protection light ray cutout switch to disconnect the light rays from the door closing circuit.
- 2) An inspection (hand) service switch for disconnecting all automatic operation, limiting the car speed, and making the appropriate hoistway access switch operable, when the car is at the top or bottom terminal, conforming to the ASME A17.1 Code.
- 3) Car lighting ON and OFF Switch.
- 4) An emergency lighting "test" button to activate the car emergency lights.

- 5) A 4-position (off, low, medium, high speeds) car exhaust fan switch.
- 6) CCTV security camera on/off switch.
- 7) An independent service selection switch to permit the selection of independent or automatic operation.
- 8) Attendant service operating lights, chimes and “up”, “down”, and “pass” and “door control” buttons for elevators.
- 9) A start button for closing the doors and starting the elevator when operating on independent service. Alternately, the car floor pushbuttons may be used for this function.
- 10) A 220 volt, 1 phase, 50-hertz 13A duplex power outlet.

O. Car Top Control Station: Provide stations as per Code.

P. Emergency Exits: Provide car top emergency access exits and contacts as per Code.

Q. Work Light and Duplex Plug Receptacle: Provide on the top and the bottom of the elevator car lights with an on/off switch and wire lamp guards.

2.9 CAR ENCLOSURES

A. Passenger Elevators: Elevator car enclosure shall be manufactured as per code. The interior side and rear wall finishes, the car ceiling, the car handrails and lighting, and car flooring finished materials and features are to be as below:

1. Wall Finish: Stainless Steel panels in finish as per Architects choice.
2. Floor Finish: Granite as per Architects choice.
3. Car Doors: Stainless steel finish as per Architects choice.
4. Ceiling: Stainless Steel in decoration finish with concealed LED lighting as approved by Architect.
5. Mirror: Mirror on rear wall full width, half height.
6. Handrail: Rear side with Handicap COP.

7. Front Return Panels and Integral Entrance Columns: Provide patterned and mirrored polished stainless steel finish as approved by Architect. The entire units are to swing on concealed hinges or pivots for access to integral car station wiring and fixtures. Secure in closed position with concealed 3-point latch. Provide cabinets with flush doors for service controls and cutouts for pushbuttons, etc.
8. Transom: Stainless steel with finish as approved by Architect
9. Shell: Reinforced U.S. 14 gauge furniture steel side and rear walls with baked enamel interior finish, top and side exits (if required). Shell base is to contain concealed ventilation cutouts on the side and rear walls. Apply sound-deadening mastic to exterior.
8. Top: Reinforced U.S. 12 gauge furniture steel with hinged, lockable exit and baked enamel finish.
9. Ventilation: 3-speed, exhaust fan with a diffuser and exhaust and intake port screens. The fan shall exhaust the car air into the hoistway.
10. CCTV Security Cameras: Install color CCTV security cameras provided by the building contractor concealed in the elevator dropped ceilings and positioned to view the complete elevator car interiors and the car position indicator. Provide shielded wire pairs or coaxial cables from each CCTV camera run to the lift machine room junction boxes.

2.10 CONTROL AND SIGNAL FIXTURES

- A. Pushbuttons: Provide the Passenger elevators with touch button controls as specified in Elevator Schedules, flush mounted. Provide standard, finished stainless steel fixtures mounted with vandal-resistant screws at all typical floors. Each fixture shall include touch buttons for each direction of travel, which illuminate to indicate call registration.
- B. Hoistway Access Switches: Mount without faceplates in entrance frame side jamb at all top floors and bottom floors where walk-in pits are not provided.
- C. Firefighters' Switch and Box: Mount on ground floor and identify purposes with permanent engraving. Provide flush-mounted box with lockable-hinged cover as directed by the local Fire Department to contain keys and instructions for emergency use of elevators. Box faceplate material to be

similar to fire command console faceplate and contain engraved legend, EMERGENCY ONLY in 13 mm high letters.

- D. Interactive Elevator Monitoring System: Provide a microprocessor-based, interactive elevator monitoring and control system E.M.S. that will permit elevator data acquisition and control. Provide consoles, containing 40 cm color S.V.G.A. or LCD monitors (1 per group), interactive keyboards, central processing computers, 12-giga byte hard disk storage device, an 8.8 cm floppy disk, 1.44 M byte C.D. disk drive, graphic cards, serial communication data links, laser printers, power supplies, driver cards and complete wiring. The consoles shall be located in the Fire/Security command center control panel and shall be provided with a synchronous communications to each elevator performance, elevator status, tabular display, security features, elevator on-off functions, elevator control functions, elevator parameter functions, performance monitoring, fault diagnostics, traffic analysis and report generation. The interactive elevator parameter functions shall include the capability to change the lobby loading sign floor selections, elevator acceleration/deceleration values and jerk rates, the elevator door dwell times, the hall lantern pre and post-call activation times, elevator energy conservation, security car and hall call lock offs, up peak, down peak, bypass, attendant service selections, standby power applications, etc., from the console keyboards.
- E. Car Position Indicators: Color, 250mm, LCD or LED display screens mounted in car swing front return panel. The position indicators shall display the travel direction and floor position of the elevator in the hoistway at all times.
- F. Hall Lanterns: Provide direction signals illuminating white for up and red for down, located adjacent to each hoistway entrance at indicated landings. Provide hall lanterns as approved by Architect from Manufacturer's different options, equipped with polished stainless steel (passenger elevators) or brushed stainless steel faceplates mounted with tamperproof screws at typical levels. Lantern shall illuminate indicating the direction of travel and chime sound (once for up direction, twice for down direction) approximately 4 seconds before the arriving car's doors open.

2.11 COMMUNICATION SYSTEMS

- A. General: Provide Audio Intercom system for all Elevators including all equipment. Provide all wiring and conduits between elevator hoistways and the intercom stations. The system shall contain the following stations:

Station Location	Station Type	Selection Buttons To Call
All Elevator Control Panels	Master	Elevator Cars, Command Center Panel
Command Center Panel	Master	All Elevator Control Panels, All Elevator Cars
All Elevator Cars	Slave	Command Center Panel, Elevator Control Panels

1. Basic Equipment: The system shall contain the following equipment:
 - a. A solid-state amplifier including preamplifier of appropriate rating shall provide voice transmission with adequate volume and a minimum of distortion at each station in the system.
 - b. Master stations shall contain the following:
 - 1) Speaker, microphone and a handset for 2-way communication.
 - 2) Selection buttons to enable communication with the master and slave stations as listed above. When a selected button is depressed, continual reception from that station shall be maintained.
 - 3) A two-position talk-receive button: Press to talk, release to receive.
 - 4) "In use" light to be illuminated when any master station is being used.
 - 5) Reset button shall reset the station selection buttons and switch off the "in use" light, making the system available for use by any master station.
 - 6) A volume control knob for adjustment of incoming volume.
 - 7) A button to establish communications with all other stations in the elevator system simultaneously, (Command center panel).
 - 8) A distress light consisting of a separate light fixture for each elevator, shall be illuminated when the alarm button or emergency stop switch in the elevator car is actuated. This light shall be provided in the master station in the Command center panel. A buzzer shall sound whenever a distress light is illuminated.

9) Both the distress light and buzzer shall remain energized until the intercom selection button for that car has been depressed at the command center to indicate communication.

10) A slave station in each elevator car, shall consist of a microphone and speaker or transceiver-speaker combination located above the car dropped ceiling. The car remote speakers shall be mounted in the car canopy and be equipped with a protective grille.

Provide an illuminating intercom call button in each car.

2. Station Housings:

- a. The master station in the Control Panel shall be housed in cabinet of baked enamel finish attached to the group elevator supervisory control panel or wall mounted. Provide a handset with 7.5m long cord.
- b. The Command center master intercom shall be provided with stainless steel faceplates with engraved and filled operating instructions. Coordinate faceplates and installation of units with the Console Manufacturer. Provide each master station with a handset, equipped with a 3m long cord.

2.12 ELEVATOR SEISMIC DESIGNS AND EMERGENCY OPERATIONS

Seismic Designs: The Elevator Contractor shall prepare and submit all required equipment seismic design calculations, reactions, and supporting information on the shop drawing as per ASME A17.1-2005. Provide all required seismic designs, restraints, guards, tie downs and operations for Zone 2B.

Calculations shall indicate the vertical and horizontal seismic design loads, for all operating and control equipment and the rail loads. Calculations shall bear the stamp of a licensed Structural Engineer.

PART 3 – EXECUTION

3.1 SITE CONDITIONS AND INSPECTION

A. Prior to beginning the installation of equipment, contractor to examine the hoistway and machine room areas and verify that no irregularities exist that would affect quality of execution of work as specified. Particularly, note:

1. Hoistway size and plumbness.
2. Sill supports and pockets.

- 3. Support areas for brackets, beams, etc.
- 4. Building and divider beams.
- B. Notify the Main Contractor if any discrepancies exist in the building work that will prevent the installation of the elevator equipment.
- C. Separator beams in hoist way shall be provided by Main Contractor as per requirement.

3.2 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Deliver materials in Manufacturer's original, unopened protective packaging.
- B. Store materials in original protective packaging. Prevent soiling, physical damage or wetting.
- C. Protect equipment and exposed finishes during transportation, erection and construction period against damage and stains.

3.3 INSTALLATION

- A. Install each equipment item in accordance with accepted Manufacturer's direction, referenced codes and specifications.
- B. Install machine room equipment with clearances complying with referenced codes and specifications.
- C. Install items so that they may be removed by portable hoists or other means for maintenance and/or repair.
- D. Install items so that access for maintenance is safe and readily available.
- E. Install equipment to afford maximum safety and continuity of operation after a seismic acceleration.
- F. Add equipment identification numerals.

3.4 FIELD QUALITY CONTROL

- A. Work at the jobsite will be checked during the course of installation. Full cooperation with these Consultant and Owner representatives is mandatory. Any corrective work they require shall be accomplished prior to performing further installation dependent upon or related to the required correction.

- B. Have Code Authority acceptance inspection performed. Verification that such tests have been completed, all corrective work accomplished and installation approved for issuance of a permit to operate shall be required before acceptance of any unit.

3.5 ADJUSTMENTS

- A. Align guide rails vertically within a tolerance of 1.6mm in 30 m. Secure joints without gaps and file any irregularities to a smooth surface.
- B. Balance cars after the final car installations to equalize pressure of roller guide shoes on rails.
- C. Lubricate all equipment in accordance with Manufacturer's instructions.
- D. Adjust motors, power converters, brakes, and controllers, leveling switches, limit switches, stopping switches, door operators, interlocks and safety devices to achieve required performance levels.
- E. Fabricate and assemble the various parts in the shop insofar as practical to minimize field assembly. Parts, which cannot be shop, assembled or require close field fit shall be trial assembled in the shop and marked for field erection.

3.6 CLEANUP AND TOUCHUP

- A. Keep work areas orderly and free from debris during progress of project.
- B. Remove all loose materials and filings resulting from this work from hoistway surfaces.
- C. Clean machine room equipment and floor of dirt, oil and grease.
- D. Clean hoistway, car, car enclosures, entrances, operating and signal fixtures, and trim of dirt, oil, grease and finger marks.
- E. Touchup all minor scratches, dings or imperfections in finished materials and painted surfaces that are exposed to public view.

3.7 ACCEPTANCE INSPECTIONS AND TEST

- A. General: Final acceptance of the installation shall be made only after all field quality control inspections and tests are complete, all submittals and certificates have been received and the Owner's Representative satisfied that the following have been satisfactorily completed:

1. Workmanship and equipment comply with specification.
2. Contract speed, capacity and floor-to-floor performance comply with specification.
3. Performance of following is satisfactory:
 - a. Starting, accelerating, running.
 - b. Decelerating, leveling, stopping.
 - c. Door operation and closing force.
- B. Personnel, Equipment and Instruments: Furnish personnel, equipment and instruments to perform required tests. The following instruments are necessary to complete the tests and shall be provided by the Contractor:
 1. Test weights.
 2. Multi meter.
 3. 500-volt Megger.
 4. Alternating-current voltmeter and ammeter.
 5. Stop watch.
 6. Celsius-calibrated thermometers (4 minimum on traction elevator test).
 7. Precision tachometer.
 8. Spring scale for door-force test.
 9. Decibel meter for noise test.
 10. 3-axis recording accelerometer for vibration, car sway and car ride test.
- C. Traction Elevators Tests:
 1. Insulation-Resistance Test: Test safety circuit, door lock circuit, loop circuit, and motor and generator field circuits at 500 volts. Minimum resistance to ground shall be one megohm.
 2. Running Test: With equipment within 5°C of ambient machine room temperature, the following shall be accomplished:

- a. Insert thermometers in hoist motor field coil windings. (Shield with cotton waste).
- b. Check floor-to-floor performance time, speed, stopping accuracy and general ride of elevator with no load, balanced load and full load in car.
- c. Run fully loaded car continuously for a period of one hour with a minimum of 150 starts, stopping at each floor in both directions for a period of 10 seconds.
- d. At the end of the test, again check floor-to-floor performance time, stopping accuracy and general ride with full load, balanced load and no load in car.

3 Test Results:

- a. In all test conditions speed and performance times specified should be met, stopping accuracy shall be maintained without releveling and general riding quality shall be acceptable to the Consultant and Owner's Representatives.
 - b. Temperature rise in windings shall not exceed 50° Celsius above ambient.
- D. Performance Guarantee: Should these tests develop any defects or poor workmanship, any variance or noncompliance with the requirements of the specified codes and/or ordinances or any variance or noncompliance with the requirements of these specifications, the following work and/or repairs shall be completed at no expense to the Owner.
1. Replace all equipment that does not meet Code or specification requirements.
 2. Perform all work and furnish all materials and equipment necessary to complete the specified operation and/or performance.
 3. Perform all retesting required by the governing Code Authority and the Consultant/Owner to verify the specified operation and/or performance.

3.8 OWNER'S INFORMATION

- A. Submittals: Provide written information and equipment necessary for proper maintenance and adjustment of the equipment prior to final acceptance, as follows:
1. Single-line wiring diagram of as-installed elevator circuits with index of location and function of all components. Mount installation diagrams on Masonite panels or hang bound sets in racks and leave on the job. Provide three final corrected sets, one copy, CD (compact disc) within 30 days after job acceptance for the Owner's file.
 2. Lubrication instructions, including recommended grade of lubricants.
 3. Parts catalogs for all replaceable parts including ordering forms and instructions.
 4. Complete operating and maintenance instructions for all controls and switches provided.
 5. Five sets of keys to operate each type of key switch provided.
 6. Any special maintenance or trouble shooting tools or devices required for maintenance on all elevators.

3.9 OWNER'S PERSONNEL TRAINING

- A. Assist the designated Owner's elevator operating, safety and security personnel in understanding and training to operate the elevator intercoms, card readers, E.M.S. Systems, security keyboards, elevator operations, emergency systems and car operating panel controls.
- B. Provide all required training information, videos, CD ROMs, manuals, training classes, and training personnel to the provide Owner's personnel with training knowledge, and information on how to operate all of the elevator interface functions and controls.

3.10 WARRANTY INSPECTION

- A. At least 30 days prior to warranty expiration, schedule final inspection and retest with Owner's Representative. Requirements shall include close examination of all equipment.
- B. Replace, repair or adjust any equipment found defective and covered by warranty prior to expiration of warranty period.

END OF SPECIFICATION

SPECIFICATION PLUMBING WORKS

(Sect. 10520) -	FIRE EXTINGUISHERS
(Sect. 15140) -	DOMESTIC WATER PIPING
(Sect. 15145) -	DOMESTIC WATER PIPING SPECIALTIES
(Sect. 15150) -	SANITARY WASTE, VENT AND STORM PIPING
(Sect. 15155) -	DRAINAGE PIPING SPECIALTIES
(Sect. 15410) -	PLUMBING FIXTURES
(Sect. 15441) -	BOOSTER WATER PUMPS
(Sect. 15471) -	WATER CONDITIONING EQUIPMENT

(Sect. 10520) – FIRE EXTINGUISHERS**PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions apply to this Section.

1.02 SUMMARY

- A. This Section includes the following:
 - 1. Portable fire extinguishers.
 - 2. Wheeled fire extinguishers.

1.03 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of portable fire extinguishers that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Failure of hydrostatic test according to NFPA 10.
 - b. Faulty operation of valves or release levers.
 - 2. Warranty Period: Three years from date of Substantial Completion.

PART 2 - PRODUCTS**2.01 PORTABLE FIRE EXTINGUISHERS**

- A. Manufacturers:
 - 1. Ansul Incorporated.
 - 2. Badger Fire Protection.
 - 3. Kidde Fyrnetics.
 - 4. NAFFCO
 - 5. Bristol
 - 6. SRI
 - 7. Angus

- B. Regular Dry-Chemical Type: BS EN3 + CE approved and ISO 9001 Certified, ABC type 5 kg nominal capacity, with sodium bicarbonate-based dry chemical in manufacturer's standard enameled container.
- C. Carbon Dioxide Type: BS EN3 + CE approved and ISO 9001 Certified 6kg nominal capacity, with carbon dioxide in enameled-steel container.

BS EN3 Powder Type Fire Extinguisher



BS EN3 CO2 Type Fire Extinguisher



END OF SECTION 10520

Sect.15140 - DOMESTIC WATER PIPING**PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions apply to this Section.

1.02 SUMMARY

- A. This Section includes domestic water piping inside the building.

1.03 DEFINITIONS

- A. CPVC: Chlorinated polyvinyl chloride plastic.
- B. PEX: Crosslinked polyethylene plastic.
- C. PVC: Polyvinyl chloride plastic.
- D. PPR: Poly propylene Random

1.04 PERFORMANCE REQUIREMENTS

- A. Provide components and installation capable of producing domestic water piping systems with 125 psig (860 kPa) unless otherwise indicated.

1.05 SUBMITTALS

- A. Product Data: For pipe, tube, fittings, and couplings.
- B. Water Samples:
- C. Field quality-control test reports.

1.06 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with NSF 14, "Plastics Piping System Components and Related Materials," for plastic, potable domestic water piping and components

- C. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9," for potable domestic water piping and components.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Manufacturers: Refer Approved List of Manufacturers.

2.02 PIPING MATERIALS

- A. The pipe materials shall as stated below.

2.03 DOMESTIC COLD WATER BELOW AND ABOVE GRADE

- 1. Polypropylene pipes and pipe fitting PN20 to DIN 8077 for pipe size upto 110mm dia.
- 2. uPVC pipes to BS 3505 with Class E with solvent welded fittings to BS 4346 for pipe sizes above 110mm dia.

2.04 DOMESTIC HOT WATER PIPING

- 1. Polypropylene pipes and pipe fitting PN20 to DIN 8077 for pipe size upto 110mm dia.
- 2. cPVC Sch 80 pipes with solvent welded fittings for pipe sizes above 110mm dia.

2.05 IRRIGATION PIPES

- 1. uPVC pipes to BS 3505 with Class E with solvent welded fittings to BS 4346 for all pipe sizes.

2.06 VALVES

- A. 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.
- B. All valves 65 mm and larger shall be Cast iron type and shall be flanged (or grooved for grooved coupling joints).
- C. For PPR piping use PPR Coated valves of the same piping material and manufacturer.

- D. 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
 - 1. Manufacturer's Name.
 - 2. Catalogue or Figure No.
 - 3. Size and Pressure Class.
- E. Arrows to indicate direction of flow on check, globe, angle, non-return, and eccentric plug valves.

2.07 GATE VALVES

- A. [Size 50 mm and Smaller]. Furnish bronze valves with screwed-in bonnet, non-rising stem, solid wedge disc, and threaded ends. Pressure rating PN20.
- B. [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 rings.

2.08 GLOBE VALVES.

- A. [Size 50mm and Smaller]. Furnish valves designed for minimum PN20 working pressures.
- B. [Size 65 mm and Larger]. Furnish valves designed for minimum PN16 working pressure.

2.09 CHECK VALVES

- A. [50 mm and smaller]. Furnish swing valves designed for minimum PN20 non-shock working pressures. Valves shall have renewable discs and side plugs, integral seats.
- B. [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.

2.010 RELIEF VALVES.

Domestic Water Temperature and Pressure Relief Valve.

- A. 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 - 140 degrees C. Relief valve pipe to discharge to floor drain.

2.011 BALL VALVES.

- A. [Size 50 mm and Smaller]. Valves shall be standard port, 2-piece construction with screwed ends. Valves shall be designed for minimum PN25. Valves shall have bronze or brass body, stainless steel ball, steel handle with vinyl grip.
- B. [Size 65 mm and Larger]. Valves shall be standard port, BS 5159 with flanged ends. Valves shall be designed for minimum PN16 working pressure. Valves shall have steel body, chrome or nickel plated steel or stainless steel ball.

2.012 Float Valves

- A. 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. Bronze equilibrium float valves 80 and above shall be flanged end, flat faced and drilled to suit BS4504 PN16.
- B. Bronze equilibrium float valves upto 50 shall be screwed end BS2779 parallel and shall be provided complete with back nut.
- C. Floats for valve sizes 80mm and above shall be of copper.

2.013 Solenoid Valves

- A. Electrically operated solenoid valves shall be single phase 220V and shall be rated for the system pressure

2.014 Bib Taps

- A. Bib-cocks shall be in accordance with BS 1010: 1973. They shall be provided with hose union nosepiece and hand wheel operated.

2.015 Automatic Air Valves

- A. Automatic air valves shall have a bronze body with bolted cover and a 9mm top outlet.

2.016 Strainers

- A. 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.
- B. Strainers above DN50 shall be manufactured from cast iron and shall be of the 'Y' type with bolted cap, PN16 temperature/pressure rating and shall be complete with drilled and tapped caps complete with drain cocks.

- C. 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.

PART 3 - EXECUTION

3.01 EXCAVATION

- A. Excavating, trenching, and backfilling are specified in Section "Earthwork."

3.02 PIPE AND FITTING APPLICATIONS

- A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below, unless otherwise indicated.
- B. Flanges may be used on aboveground piping, unless otherwise indicated.
- C. Grooved joints may be used on aboveground grooved-end piping.

3.03 VALVE APPLICATIONS

- A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
 - 1. Shutoff Duty: Use bronze ball or gate valves for piping NPS 2 (DN 50) and smaller. Use cast-iron butterfly or gate valves with flanged ends for piping NPS 2-1/2 (DN 65) and larger.
 - 2. Hot-Water-Piping, Balancing Duty: Calibrated balancing valves.
 - 3. Drain Duty: Hose-end drain valves.
- B. PPR Coated PN-25 rated ball, butterfly, and check valves may be used in matching piping materials.

3.04 PIPING INSTALLATION

- A. Install domestic water piping level without pitch and plumb.
- B. Rough-in domestic water piping for water-meter installation according to utility company's requirements.

3.05 HANGER AND SUPPORT INSTALLATION

- A. Install supports according to Division 15 Section "Hangers and Supports."
- B. Support vertical piping and tubing at base and at each floor.

- C. Rod diameter may be reduced 1 size for double-rod hangers, to a minimum of 3/8 inch (10 mm).
- D. Install hangers for PVC/cPVC/PPR and PE piping with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 2 (DN 50) and Smaller: 48 inches (1200 mm) with 3/8-inch (10-mm) rod.
 - 2. NPS 2-1/2 to NPS 3-1/2 (DN 65 to DN 90): 48 inches (1200 mm) with 1/2-inch (13-mm) rod.
 - 3. NPS 4 and NPS 5 (DN 100 and DN 125): 48 inches (1200 mm) with 5/8-inch (16-mm) rod.
 - 4. NPS 6 (DN 150): 48 inches (1200 mm) with 3/4-inch (19-mm) rod.
 - 5. NPS 8 (DN 200): 48 inches (1200 mm) with 7/8-inch (22-mm) rod.
- E. Install supports for vertical PVC/cPVC/PPR piping every 48 inches (1200 mm).

3.06 FIELD QUALITY CONTROL

- A. Inspect domestic water piping as follows:
 - 1. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
 - 2. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:
 - a. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
 - b. Final Inspection: Arrange final inspection for authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
 - 3. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
- B. Test domestic water piping as follows:
 - 1. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
 - 2. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
 - 3. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
 - 4. Cap and subject piping to water pressure of 150 psi or 50 psi above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
 - 5. Repair leaks and defects with new materials and retest piping or portion thereof until satisfactory results are obtained.

6. Prepare reports for tests and required corrective action.

END OF SECTION 15140

Sect.15145 - DOMESTIC WATER PIPING SPECIALTIES**PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions Specification Sections, apply to this Section.

1.02 SUMMARY

- A. This Section includes the following domestic water piping specialties:

1. Balancing valves.
2. Strainers.
3. Outlet boxes.
4. Hose stations.
5. Hose bibs.
6. Drain valves.
7. Water hammer arresters.
8. Air vents.
9. Flexible connectors
10. Flow Sensing Devices
11. Puddle flanges

1.03 PERFORMANCE REQUIREMENTS

- A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig (860 kPa), unless otherwise indicated.

1.04 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings:
- C. Field quality-control test reports.
- D. Operation and Maintenance Data: For domestic water piping specialties to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS**2.01 BALANCING VALVES**

- A. Refer Section 15140

2.02 STRAINERS FOR DOMESTIC WATER PIPING

A. Y-Pattern Strainers :

1. Pressure Rating: 125 psig (860 kPa) minimum, unless otherwise indicated.
2. Body: Bronze for NPS 2 (DN 50) and smaller; cast iron with interior lining complying with AWWA C550 or FDA-approved, epoxy coating and for NPS 2-1/2 (DN 65) and larger.
3. End Connections: Threaded for NPS 2 (DN 50) and smaller; flanged for NPS 2-1/2 (DN 65) and larger.
4. Screen: Stainless steel with round perforations, unless otherwise indicated.
5. Perforation Size:
 - a. Strainers NPS 2 (DN 50) and Smaller: 0.020 inch (0.51 mm) .
 - b. Strainers NPS 2-1/2 to NPS 4 (DN 65 to DN 100): 0.045 inch (1.14 mm)
6. Drain: Factory-installed, hose-end drain valve.

2.03 HOSE BIBBS

A. Hose Bibbs :

1. Standard: ASME A112.18.1 for sediment faucets.
2. Body Material: Bronze.
3. Seat: Bronze, replaceable.
4. Supply Connections: NPS 1/2 or NPS 3/4 (DN 15 or DN 20) threaded or solder-joint inlet.
5. Outlet Connection: Garden-hose thread complying with ASME B1.20.7.
6. Pressure Rating: 125 psig (860 kPa).
7. Finish for Equipment Rooms: Rough bronze, or chrome or nickel plated.
8. Finish for Service Areas: Rough bronze, or chrome or nickel plated.
9. Finish for Finished Rooms: Chrome or nickel plated.
10. Operation for Equipment Rooms: Wheel handle or operating key.
11. Include operating key with each operating-key hose bibb.

2.04 DRAIN VALVES

A. Ball-Valve-Type, Hose-End Drain Valves:

1. Standard: MSS SP-110 for standard-port, two-piece ball valves.
2. Pressure Rating: 400-psig (2760-kPa) minimum CWP.
3. Size: NPS 3/4 (DN 20).
4. Body: Copper alloy.
5. Ball: Chrome-plated brass.
6. Seats and Seals: Replaceable.
7. Handle: Vinyl-covered steel.
8. Inlet: Threaded or solder joint.
9. Outlet: Threaded, short nipple with garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

B. Gate-Valve-Type, Hose-End Drain Valves

1. Standard: MSS SP-80 for gate valves.

2. Pressure Rating: Class 125.
3. Size: NPS 3/4 (DN 20).
4. Body: ASTM B 62 bronze.
5. Inlet: NPS 3/4 (DN 20) threaded or solder joint.
6. Outlet: Garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

C. Stop-and-Waste Drain Valves :

1. Standard: MSS SP-110 for ball valves or MSS SP-80 for gate valves.
2. Pressure Rating: 200-psig (1380-kPa) minimum CWP or Class 125.
3. Size: NPS 3/4 (DN 20).
4. Body: Copper alloy or ASTM B 62 bronze.
5. Drain: NPS 1/8 (DN 6) side outlet with cap.

2.05 WATER HAMMER ARRESTERS

A. Water Hammer Arresters :

1. Standard: ASSE 1010 or PDI-WH 201.
2. Type: Metal bellows / Copper tube with piston.
3. Size: ASSE 1010, Sizes AA and A through F or PDI-WH 201, Sizes A through F.

2.06 AIR VENTS

A. Bolted-Construction Automatic Air Vents :

1. Body: Bronze.
2. Pressure Rating: 125-psig (860-kPa) minimum pressure rating at 140 deg F (60 deg C).
3. Float: Replaceable, corrosion-resistant metal.
4. Mechanism and Seat: Stainless steel.
5. Size: NPS 1/2 (DN 15) minimum inlet.
6. Air vents shall be installed on all coils and all other high points required for efficient operation and venting of system.
7. Air vents shall be provided at all high points in the pipework, whether indicated on the drawings or not.
8. Large diameter automatic air vents shall be provided at all primary venting positions, such as plant rooms and at the head of vertical risers.
9. Air bottles shall be provided at all venting points.
10. The Sub CONTRACTOR shall be responsible for the design and positioning of all air vents.

2.07 PUDDLE FLANGES

- A. Where pipework passes through the external walls of the buildings or trenches below ground level, the CONTRACTOR shall supply and cast or built puddle flanges into the structure.
- B. Puddle flanges are to be manufactured from the same material as the pipework of which they form a part.

- C. Each puddle flange shall comprise a length of pipe, flanged or screwed at end according to diameter with an undrilled slip on flange welded on the outside at a point where it will be located mid way in the thickness of the wall. The puddle flange is to be painted externally with two coats of bituminous paint before being built into the structure.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install water regulators with inlet and outlet shutoff valves. Install pressure gages on inlet and outlet.
- B. Install balancing valves in locations where they can easily be adjusted.
- C. Install Y-pattern strainers for water on supply side of each pump.
- D. Install water hammer arresters in water piping according to PDI-WH 201.
- E. Install air vents at high points of water piping. [Install drain piping and discharge onto floor drain.]

END OF SECTION 15145

Sect.15150 - SANITARY WASTE, VENT AND STORM PIPING**PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions apply to this Section.

1.02 SUMMARY

- A. This Section includes the following for soil, waste, and vent piping inside the building:
 - 1. Pipe, tube, and fittings.

1.03 DEFINITIONS

- A. ABS: Acrylonitrile-butadiene-styrene plastic.
- B. EPDM: Ethylene-propylene-diene terpolymer rubber.
- C. LLDPE: Linear, low-density polyethylene plastic.
- D. NBR: Acrylonitrile-butadiene rubber.
- E. PE: Polyethylene plastic.
- F. PVC: Polyvinyl chloride plastic.
- G. TPE: Thermoplastic elastomer.

1.04 PERFORMANCE REQUIREMENTS

- A. Components and installation shall be capable of withstanding the following minimum working pressure, unless otherwise indicated:
 - 1. Soil, Waste, and Vent Piping: 10-foot head of water (30 kPa) .
 - 2. Sanitary Sewer, Force-Main Piping: 150 psig (1035 kPa).
- B. Seismic Performance: Soil, waste, and vent piping and support and installation shall be capable of withstanding the effects of seismic events.

1.05 SUBMITTALS

- A. Product Data: For pipe, tube, fittings, and couplings.

B. Shop Drawings:

1. Design Calculations: Signed and sealed by a qualified professional engineer for selecting seismic restraints.
2. Drainage System: Include plans, elevations, sections, and details.

C. Field quality-control inspection and test reports.

1.06 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

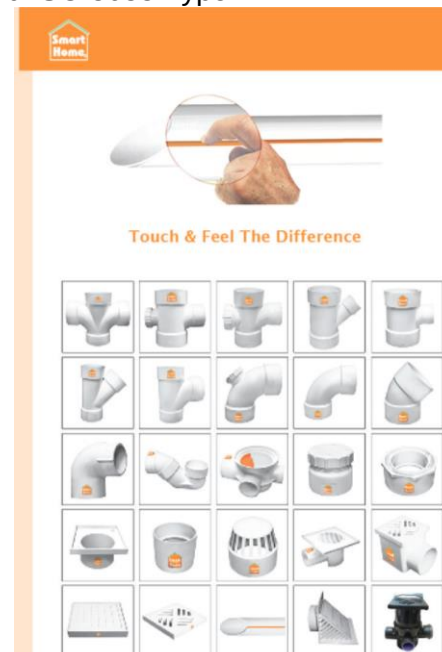
PART 2 - PRODUCTS

2.01 PIPING MATERIALS

- A. Piping materials shall be as under.

2.02 ABOVE GROUND SOIL, WASTE AND VENT PIPE

- A. Plastic pipes shall be extruded un-plasticized PVC (UPVC) conforming to the following British Standards:
 1. Pipes 32mm to 40mm diameter: uPVC pipe with solvent joints (as approved by consultant) as per DIN 8061/8062 and ISO 3633 Type B.
 2. Pipes 82mm to 160mm diameter: uPVC pipe with solvent joints (as approved by consultant) as per DIN 8061/8062 and ISO 3633 Type B.



2.03 BELOW GROUND SOIL AND WASTE PIPE

- A. uPVC conforming to the following British Standards:
 - 1. Pipes 110mm and 300mm diameter: uPVC pipe with solvent weld fitting as per BS 4660 (BS EN 1401)
 - 2. Pipes larger than 300mm diameter: to BS 3506.

2.04 STORM WATER PIPE

- A. Plastic pipes shall be extruded un-plasticized PVC (UPVC) conforming to the following British Standards:
 - 1. uPVC pipe with solvent joints (as approved by consultant) as per DIN 8061/8062 and ISO 3633 Type B

2.05 CONTENSATE DRAIN PIPING (ABOVE AND BELOW GRADE)

- A. uPVC conforming to the following British Standards:
 - 1. Pipes 20mm and 300mm diameter: Upvc class 'E' pipe with solvent weld fitting as per BS 3505 (EN 1401).

2.06 PRESSURE PIPING FROM PUMPS (ABOVE AND BELOW GRADE)

- A. uPVC conforming to the following British Standards:
 - 1. Pipes 20mm and 300mm diameter: Upvc class 'E' pipe with solvent weld fitting as per BS 3505 (EN 1401).
- B. Alternatively (Kite Mark) pipes are acceptable only if approved by consultant.

2.07 SPECIAL PIPE FITTINGS

2.08 ENCASEMENT FOR UNDERGROUND PIPING CROSSING DRIVEWAYS

- A. All Drainage pipes crossing driveways and subjected to heavy traffic shall be provided in concrete encasement.

PART 3 - EXECUTION

3.01 EXCAVATION

- A. Refer to "Earthwork" for excavating, trenching, and backfilling.

3.02 PIPING INSTALLATION

- A. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers.
- B. Install cleanout fitting with closure plug inside the building in sanitary force-main piping.
- C. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8-bend fittings if 2 fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.
- D. Lay buried building drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream.
- E. Install soil and waste drainage and vent piping at the following minimum slopes, unless otherwise indicated:
 - 1. Building Sanitary Drain: 2 percent downward in direction of flow for piping NPS 2 DN 50 and smaller; 1 percent downward in direction of flow for piping NPS 3 (DN 75) and larger.
 - 2. Horizontal Sanitary Drainage Piping: 1 percent downward in direction of flow.
 - 3. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.
- F. Install PVC soil and waste drainage and vent piping according to ASTM D 2665.
- G. Install underground PVC soil and waste drainage piping according to ASTM D 2321.
- H. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction or Consultant.

3.03 HANGER AND SUPPORT INSTALLATION

- A. Pipe hangers and supports are specified in Division 15 Section "Hangers and Supports." Install the following:
- B. Install hangers for PVC piping with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): 48 inches (1200 mm) with 3/8-inch (10-mm) rod.
 - 2. NPS 3 (DN 80): 48 inches (1200 mm) with 1/2-inch (13-mm) rod.
 - 3. NPS 4 and 5 (DN 100 and 125): 48 inches (1200 mm) with 5/8-inch (16-mm) rod.

4. NPS 6 (DN 150): 48 inches (1200 mm) with 3/4-inch (19-mm) rod.
 5. NPS 8 to NPS 12 (DN 200 to DN 300): 48 inches (1200 mm) with 7/8-inch (22-mm) rod.
- C. Install supports for vertical PVC piping every 48 inches (1200 mm).

3.04 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.
- C. Connect drainage and vent piping to the following:
1. Plumbing Fixtures: Connect drainage piping in sizes indicated, but not smaller than required by plumbing code.
 2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
 3. Plumbing Specialties: Connect drainage and vent piping in sizes indicated, but not smaller than required by plumbing code.
 4. Equipment: Connect drainage piping as indicated.

3.05 FIELD QUALITY CONTROL

- A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
 2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
- B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
- C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
- D. Test sanitary drainage and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
 2. Leave uncovered and unconcealed new, altered, extended, or replaced drainage and vent piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.

3. Roughing-in Plumbing Test Procedure: Test drainage and vent piping, except outside leaders, on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water (30 kPa). From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.
4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch wg (250 Pa). Use U-tube or manometer inserted in trap of water closet to measure this pressure. Air pressure must remain constant without introducing additional air throughout period of inspection. Inspect plumbing fixture connections for gas and water leaks.
5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
6. Prepare reports for tests and required corrective action.

3.06 PROTECTION

- A. Exposed PVC Piping: Protect plumbing vents exposed to sunlight with two coats of water-based latex paint.

END OF SECTION 15150

Sect.15155 - DRAINAGE PIPING SPECIALTIES**PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions apply to this Section.

1.02 SUMMARY

- A. This Section includes the following drainage piping specialties:
 - 1. Cleanouts.
 - 2. Floor drains.
 - 3. Trench drains.
 - 4. Channel drainage systems.
 - 5. Roof drains.
 - 6. Manhole Covers
 - 7. Miscellaneous drainage piping specialties.

1.03 DEFINITIONS

- A. ABS: Acrylonitrile-butadiene-styrene plastic.
- B. FOG: Fats, oils, and greases.
- C. FRP: Fiberglass-reinforced plastic.
- D. HDPE: High-density polyethylene plastic.
- E. PE: Polyethylene plastic.
- F. PP: Polypropylene plastic.
- G. PUR: Polyurethane plastic.
- H. PVC: Polyvinyl chloride plastic.

1.04 SUBMITTALS

- A. Product Data: For each type of product indicated above.
- B. Shop Drawings: Show fabrication and installation details for frost-resistant vent terminals.
- C. Field quality-control test reports.
- D. Operation and Maintenance Data: For drainage piping specialties to include in emergency, operation, and maintenance manuals.

1.05 QUALITY ASSURANCE

- A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

1.06 COORDINATION

- A. Coordinate size and location of concrete bases.
- B. Coordinate size and location of roof penetrations.

PART 2 - PRODUCTS

2.01 CLEANOUTS

- A. Plastic Floor Cleanouts:
 - 1. Size: Same as connected branch.
 - 2. Body: PVC.
 - 3. Closure Plug: PVC.
 - 4. Riser: Drainage pipe fitting and riser to clean out of same material as drainage piping.
 - 5. Finish: Stainless steel cap

2.02 FLOOR DRAINS

- A. Plastic Floor Drains:
 - 1. Standard: ASME A112.6.3.
 - 2. Material: PVC.
 - 3. Outlet: Side
 - 4. Sediment Bucket: Not required.
 - 5. Top or Strainer Material: Stainless steel <Refer Architect finishes schedule>.
 - 6. Top of Body and Strainer Finish: Stainless steel.
 - 7. Top Shape: Square. <Refer Architect finishes schedule>.
 - 8. Trap Material: Plastic drainage piping.
 - 9. Trap Pattern: Standard Multi Floor Trap with Multiple inlets and one outlet.
- B. Funnel floor drain where specified on drawings shall include a nickel bronze funnel secured to the grating

2.03 TRENCH DRAINS

- A. Trench Drains :
 - 1. Standard: ASME A112.6.3 for trench drains.
 - 2. Outlet: Side.
 - 3. Grate Material: Cast Iron/PVC. <Refer Architect finishes schedule>.
 - 4. Grate Finish: Epoxy coated for cast iron <Refer Architect finishes schedule>.
 - 5. Dimensions of Frame and Grate: Refer drawings
 - 6. Top Loading Classification: As mentioned on MEP drawings and BOQ.

2.04 ROOF DRAINS

A. Plastic Roof Drains:

1. Standard: ASME A112.21.2M.
2. Pattern: Balcony/ Roof drain.
3. Body Material: PVC.
4. Dimensions of Body: Refer Drawings
5. Outlet: Bottom.
6. Dome Material: PVC/Stainless Steel <<Refer Architect finishes schedule>.

2.05 MISCELLANEOUS DRAINAGE PIPING SPECIALTIES

A. Vent Caps:

1. Description: PVC of same brand as of piping.
2. Size: Same as connected stack vent or vent stack.

B. Expansion Joints:

1. Standard: ASME A112.21.2M.
2. Body: Cast iron with bronze sleeve, packing, and gland.
3. End Connections: Matching connected piping.
4. Size: Same as connected soil, waste, or vent piping.

C. Manholes/gully traps covers

1. All covers shall be Cast Iron with black bitumen coating. Manhole covers shall have clear opening of 600 x 600 mm.
2. All manholes and gully traps shall be vented as per drainage department requirements.
3. Gully trap covers shall have clear opening of 300 x 300 mm.
4. All manhole covers and frames shall comply with BS 497:1976 (BS EN 124:1994)
5. Covers in paved areas shall be medium duty type having weight as per Table 1
6. Covers in plinth protection shall be light duty having weight as per Table-1
7. Covers in Driveways shall be Heavy duty having weight as per Table-1

CAST IRON MULTI DUTY MANHOLE COVER & FRAME

Features :

Single Seal
Closed Key Holes
Coating Cold Applied

Option :

Ductile Iron
Epoxy Coated
Lockable

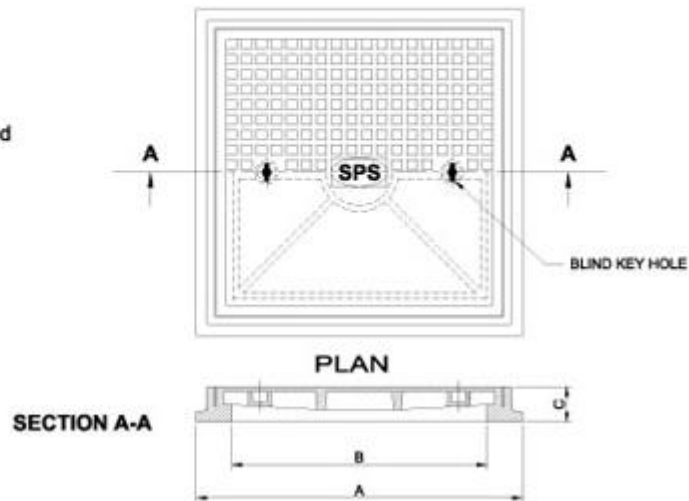


Table 1-1 (Manhole Covers Weights)

S.no	Cover material	Clean Opening	Type	Weight	Standard	Remarks
1	Cast Iron	600 x 600	Light duty	45 Kg	BS EN 124:1994	
2	Cast Iron	600 x 600	Medium duty	67 Kg	BS EN 124:1994	
3	Cast Iron	600 x 600	Heavy duty	90 Kg	BS EN 124:1994	

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:
1. Size same as drainage piping up to NPS 4 (DN 100). Use NPS 4 (DN 100) for larger drainage piping unless larger cleanout is indicated.
 2. Locate at each change in direction of piping greater than 45 degrees.
 3. Locate at minimum intervals of 50 feet (15 m) for piping NPS 4 (DN 100) and smaller and 100 feet (30 m) for larger piping.

4. Locate at base of each vertical soil and waste stack.
- B. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.
- C. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.
- D. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.
 1. Position floor drains for easy access and maintenance.
 2. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.
 3. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.
- E. Install trench drains at low points of surface areas to be drained. Set grates of drains flush with finished surface, unless otherwise indicated.
- F. Assemble and install ASME A112.3.1, stainless-steel channel drainage systems according to ASME A112.3.1. Install on support devices so that top will be flush with surface.
- G. Install fixture air-admittance valves on fixture drain piping.
- H. Install stack air-admittance valves at top of stack vent and vent stack piping.
- I. Install air-admittance-valve wall boxes recessed in wall.
- J. Install flashing fittings on sanitary stack vents and vent stacks that extend through roof.
- K. Install through-penetration firestop assemblies in plastic stacks at floor penetrations.
- L. Install floor-drain, trap-seal primer fittings on inlet to floor drains that require trap-seal primer connection.
 1. Exception: Fitting may be omitted if trap has trap-seal primer connection.
 2. Size: Same as floor drain inlet.
- M. Install vent caps on each vent pipe passing through roof.
- N. Install frost-resistant vent terminals on each vent pipe passing through roof. Maintain **1-inch (25-mm)** clearance between vent pipe and roof substrate.
- O. Install expansion joints on vertical stacks and conductors. Position expansion joints for easy access and maintenance.
- P. Install grease interceptors, including trapping, venting, and flow-control fitting, according to authorities having jurisdiction and with clear space for servicing.
 1. Above-Floor Installation: Set unit with bottom resting on floor, unless otherwise indicated.

2. Flush with Floor Installation: Set unit and extension, if required, with cover flush with finished floor.
 3. Recessed Floor Installation: Set unit in receiver housing having bottom or cradle supports, with receiver housing cover flush with finished floor.
 4. Install cleanout immediately downstream from interceptors not having integral cleanout on outlet.
- Q. Install grease removal devices on floor. Install trap, vent, and flow-control fitting according to authorities having jurisdiction. Install control panel adjacent to unit, unless otherwise indicated.
- R. Install oil interceptors, including trapping, venting, and flow-control fitting, according to authorities having jurisdiction and with clear space for servicing.
- S. Install solids interceptors with cleanout immediately downstream from interceptors that do not have integral cleanout on outlet. Install trap on interceptors that do not have integral trap and are connected to sanitary drainage and vent systems.
- T. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.
- 3.02 CONNECTIONS
- A. Install piping adjacent to equipment to allow service and maintenance.
- B. Grease Interceptors: Connect inlet and outlet to unit, and connect flow-control fitting and vent to unit inlet piping. Install valve on outlet of automatic drawoff-type unit.
- C. Oil Interceptors: Connect inlet, outlet, vent, and gravity drawoff piping to unit; flow-control fitting and vent to unit inlet piping; and gravity drawoff and suction piping to oil storage tank.
- 3.03 LABELING AND IDENTIFYING
- A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:
1. Grease interceptors.
 2. Oil interceptors.
 3. Solids interceptors.
- B. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit.
- 3.04 FIELD QUALITY CONTROL
- A. Perform tests and inspections and prepare test reports.
1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled FOG disposal systems and grease removal devices and their installation, including piping and electrical connections, and to assist in testing.

B. Tests and Inspections:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.05 PROTECTION

- A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.
- B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

3.06 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain FOG disposal systems and grease removal devices.

END OF SECTION 15155

Sect.15410 - PLUMBING FIXTURES**1.01 QUALITY ASSURANCE**

- A. Quality Standard: NSF 61 for fixture materials in contact with potable water.

1.02 WARRANTY

- A. Materials and Workmanship:
 - 1. Commercial Applications: One year.

1.03 FAUCETS

- A. Lavatory Faucets, <Refer Architecture fixture selection and Specifications>:
 - 1. Two-handle mixing non-pressure type valve.
 - a. Body Material: Commercial, solid brass (with non-metallic coatings or Chrome finish as required by the architect).
 - b. Finish: Polished chrome plate.
 - c. Maximum Flow Rate: Maximum [2.5 gpm (9.46 L/min.)],
 - d. Mounting: [Deck, exposed] [Deck, concealed] [Back/wall, exposed] [Back/wall, concealed].
 - e. Spout: [Rigid, gooseneck] type.
 - f. Spout Outlet: Aerator/ Spray
- B. Sink Faucets, <Refer Architecture fixture selection and Specifications>:
 - 1. [Kitchen faucet with spray, three-hole fixture].
 - a. Body Material: [Commercial, solid brass] (with non-metallic coatings or Chrome finish as required by the architect).
 - b. Finish: Polished chrome plate]
 - c. Maximum Flow Rate: 2.5 gpm (9.46 L/min.), unless otherwise indicated.
 - d. Mixing Valve: Two-lever handle.
 - e. Backflow Protection Device for Hose Outlet: Not required.
 - f. Mounting: Deck, Back/wall as recommended by the architect.
 - g. Spout Outlet: Aerator/ Spray
 - h. Drain: Stopper with chain.

1.04 TOILET SEATS

- A. Toilet Seats :
 - 1. Toilet seat for water-closet-type fixture.

- a. Material: Molded, solid plastic.
- b. Configuration: front with cover.
- c. Size: Regular.
- d. Class: Standard commercial.

1.05 FIXTURE SUPPORTS

A. Water-Closet Supports :

- 1. Combination carrier designed for standard mounting height of wall-mounting, water-closet-type fixture.

B. Lavatory Supports:

- 1. Type [lavatory carrier with exposed arms and tie rods] or [lavatory carrier with concealed arms and tie rod] for wall-mounting, lavatory-type fixture.

C. Sink Supports:

- 1. Type [sink carrier with exposed arms and tie rods] or [II, sink carrier with hanger plate, bearing studs, and tie rod] for sink-type fixture.

1.06 WATER CLOSETS (WASTREN)

A. Water Closets, <Refer Architecture fixture selection and Specifications> :

- 1. Floor-mounting, floor-outlet, vitreous-china fixture designed for [gravity-type tank] operation.
 - a. Style: [Close coupled] [One piece].
 - 1) Bowl Type: Round front design. Include bolt caps matching fixture.
 - 2) Height: Standard.
 - 3) Design Consumption: Dual Flush Design with Major (6.0 L/flush) Minor (4 L/flush)].
 - 4) Tank: Gravity type. Include cover.
 - b. Supply: [NPS 3/8 (DN 10)] [NPS 1/2 (DN 15)] chrome-plated brass or copper with wheel-handle stop.
 - c. Toilet Seat: Included

1.07 WATER CLOSETS (EASTREN)

A. Squatting WC, <Refer Architecture fixture selection and Specifications> :

- 1. Flat Bowl, vitreous-china fixture designed for [gravity-type tank] operation.
 - 1) Type: Flat and Shallow design
 - 2) Flush Tank : Yes (check drawings for installation height)

- 3) Design Consumption: Single Flush Design with Major (6.0 L/flush).
- 4) Tank: Gravity type.
- 5) Color (Refer Architecture fixture selection and Specifications)
- b. Supply: [NPS 1/2 (DN 15)] chrome-plated brass or copper with wheel-handle stop.
- c. DN50 supply pipe from Flush tank to WC. Pipe shall be concealed.

END OF SECTION

PLUMBING PUMPS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions apply to this Section.

1.02 SUBMITTALS

- A. Product Data: For each type and size of domestic water pump specified. Include certified performance curves with operating points plotted on curves; and rated capacities of selected models, furnished specialties, and accessories.
- B. Shop Drawings: Diagram power, signal, and control wiring.
- C. Operation and Maintenance Data: For domestic water pumps to include in emergency, operation, and maintenance manuals.

1.03 QUALITY ASSURANCE

- A. Product Options: Drawings indicate size, profiles, and dimensional requirements of domestic water pumps and are based on the specific system indicated.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. UL Compliance: Comply with UL 778 for motor-operated water pumps.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Retain shipping flange protective covers and protective coatings during storage.
- B. Protect bearings and couplings against damage.
- C. Comply with pump manufacturer's written rigging instructions for handling.

1.05 COORDINATION

- A. Coordinate size and location of concrete bases.

PART 2 - PRODUCTS

2.01 BOOSTER AND TRANSFER PUMPS

A. Manufacturers:

1. Armstrong Pumps Inc.
2. Grundfos Pumps Corp.
3. Wilo Pumps
4. Refer Approved list of manufacturers

B. Description: Factory-assembled and -tested, Multistage stage

1. Supply and install transfer and Booster water Set designed for a total system capacity as shown on Pump Schedule. The systems shall be tested and calibrated, and shipped to the job site as an integral unit ready to receive suction and discharge piping and incoming power supply.
2. The unit shall be a packaged factory assembled and tested unit complete with duty/stand by pump, interconnecting pipework in copper, bronze, valves, safety devices and prewired control panel.
3. Pumps shall be constant speed:
4. Pump shall be bronze fitted centrifugal, single stage, end suction type
5. Pump shall be rated for a minimum of 175 PSIG working pressure.
6. Casings shall be cast iron with gauge ports, vent and drain ports at top and bottom of casing.
7. Shaft impeller shall be stainless steel 316.
8. The pumps shall be complete with temperature control, gate valves, check valves, pressure gauges, thermal bleed circuits, wiring, conduit and interconnecting pipe work, mounted on anti-vibration mountings and neatly arranged and firmly supported by the framework of the unit. Suction connection shall be horizontal, as close to the base as possible to connect to inlet pipe from the water storage tank.
9. Mechanical seals shall be with carbon rotating ring, stainless steel spring, ceramic seat and flexible bellows and gaskets. Grease lubricated ball type bearings shall be provided.
10. Pump and Motor Assembly: Hermetically sealed, replaceable type unit with motor and impeller on common shaft and designed for installation with pump and motor shaft mounted horizontally.

C. Capacities and Characteristics:

1. Capacity: Refer Equipment Schedule
2. Total Dynamic Head: Refer Equipment Schedule
3. Maximum Continuous Operating Temperature: 220 deg F (104 deg C).
4. Impeller Size: As per Manufacturer Recommendation
5. Inlet and Outlet Size: As per Manufacturer Recommendation
6. Speed: As per Manufacturer Recommendation
7. Motor Horsepower: Refer Schedule
8. Brand used for design selection : Grundfos

2.02 CONTROLS

1. The pump set control panel shall be in a NEMA I enclosure which includes motor starters, time delays, protected control circuit, transformer, current relays, hand-off-automatic switches for each pump, minimum run timers, and low suction pressure cut out etc.
2. Transfer pump shall be controlled by float switch.

2.03 SUMP PUMPS

1. Pump casing shall be Stainless steel.
2. Impeller shall be stainless steel wear resistant, semi shrouded, multi vane with adjustable diffusers.
3. Shaft shall be Stainless Steel 316SS.
4. Pumps shall be fitted with two mechanical seals with silicon carbide rotating & seat stainless steel spring, flexible bellows and gaskets. The chamber between the shaft seal to be oil filled.
5. Shaft shall be mounted on pre-greased rolling element bearings.
6. Pumps shall be selected to match the duties indicated on drawings.
7. Pumps shall be supplied with control as per Specifications below
8. Pumps shall be provided with Chain for lighting arrangement.
9. Motor shall be of the synchronous squirrel cage type, IP68 rating, hermetically enclosed within the stator housing. Stator shall be wound with double lacquered wire and subsequently triple dipped to provide insulation in accordance with IEC 85 temperature Class F (155 Deg. C). Stator winding over temperature shall be prevented by bimetallic thermal switches or thermistors embedded in each of the stator phase windings. Motor shall be designed for a maximum of 10 starts/hour. Motor casing shall be with integral ribs for maximum heat dissipation. Motor casing shall be S.Steel 304.

10. Cable entry glands shall be suitably designed to effectively seal the junction box from the surrounding liquid at depths upto 20 metres and to mechanically restrain the cable to avoid distortion of the gland rubbers and to prevent kinking of the cable adjacent to the cable entry.
11. Motor shaft shall be of stainless steel and mounted on robust pregreased rolling element bearings rated for L10 duty life of at least 100,000 hours at the rated capacity. The shaft seal assembly shall comprise of two independent mechanical face seals mounted in tandem with an interposing oil chamber to cool the seals and to act as an additional leakage barrier. Seal combination shall be high wear resistant tungsten carbide/tungsten carbide.
12. Pump casing shall be constructed of stainless steel.
13. Pump casing shall be smooth profiled volute geometry for clog free operation fitted with replaceable inlet wear rings, fabricated from heat treated stainless steel.
14. Fabricate impeller of Stainless Steel or better. Impeller shall be dynamically balanced single/multi-channel type depending on the pump selection and duty specified.
15. The control panel shall be prewired, with IP65 enclosure and include the following:
 - a) Panel mounted, door interlocked disconnect switch.
 - b) Circuit breaker and earth leakage breaker for each pump.
 - c) Magnetic starters with 3 leg overload protection.
 - d) Selector switch Hand Off Auto (HOA) for each pump.
 - e) 24 Volt control transformer.
 - f) Float switch for high level alarm and pump operating.
 - g) Pilot lights for power on, pump failure, high water level.
16. Volt free contacts to interface with Building Management System for Power ON, HOA switches in auto position, Common fault, pump run/trip, high level and Hours run meter (One per pump).
17. Pump operation shall be automatic controlled through mercury type float switches installed in the collection pit.
18. Pumps shall be supplied with all accessories including foot bends, stainless steel guide rails, stainless steel lifting chains, float switches, gate and check valves on each pump discharge.
19. All fasteners on the submersible pump and motor casing shall be type 316 stainless steel.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine roughing-in of domestic-water-piping system to verify actual locations of connections before pump installation.

3.02 CONCRETE BASES

- A. Install concrete bases of dimensions indicated for pumps and controllers.
 - 1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on **18-inch (450-mm)** centers around full perimeter of base.
 - 2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
 - 3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 4. Install anchor bolts to elevations required for proper attachment to supported equipment.

3.03 PUMP INSTALLATION

- A. Install pumps with access for periodic maintenance including removal of motors, impellers, couplings, and accessories.
- B. Independently support pumps and piping so weight of piping is not supported by pumps and weight of pumps is not supported by piping.

3.04 CONNECTIONS

- A. Install piping adjacent to pumps to allow service and maintenance.
- B. Connect domestic water piping to pumps. Install suction and discharge piping equal to or greater than size of pump nozzles.
 - 1. Install flexible connectors adjacent to pumps in suction and discharge piping of pumps:
 - 2. Install shutoff valve and strainer on suction side of pumps, and check valve and throttling valve on discharge side of pumps
 - 3. Install pressure gages at suction and discharge of pumps.

3.05 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Check piping connections for tightness.
3. Clean strainers on suction piping.
4. Perform the following startup checks for each pump before starting:
 - a. Verify bearing lubrication.
 - b. Verify that pump is free to rotate by hand and that pump for handling hot liquid is free to rotate with pump hot and cold. If pump is bound or drags, do not operate until cause of trouble is determined and corrected.
 - c. Verify that pump is rotating in the correct direction.
5. Prime pump by opening suction valves and closing drains, and prepare pump for operation.
6. Start motor.
7. Open discharge valve slowly.
8. Adjust timer settings.

3.06 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain controls and pumps.

END OF SECTION

Sect.15471 - WATER FILTRATION AND CONDITIONING EQUIPMENT**PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions apply to this Section.

1.02 SUMMARY

- A. This Section includes the following types of water filtration equipment for water systems in buildings:
 - 1. Multimedia sand filters.

1.03 DEFINITIONS

- A. ABS: Acrylonitrile-butadiene-styrene plastic.
- B. FRP: Fiberglass-reinforced plastic.
- C. NBR: Acrylonitrile-butadiene rubber.
- D. PE: Polyethylene plastic.
- E. PP: Polypropylene plastic.
- F. Ppm: Parts per million.
- G. PVC: Polyvinyl chloride plastic.

1.04 SUBMITTALS

- A. Shop Drawings: Detail water filtration equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
- B. Certificates of Shop Inspections and Data Reports: For products required to have ASME label, signed by product manufacturer.
- C. Operation and Maintenance Data: For water filtration equipment to include in emergency, operation, and maintenance manuals.

1.05 QUALITY ASSURANCE

- A. Source Limitations: Obtain each type of water filtration equipment through one source from a single manufacturer.
- B. Product Options: Drawings indicate size, profiles, and dimensional requirements of water filtration equipment and are based on the specific system indicated.

1.06 PROJECT CONDITIONS

- A. Contractor to perform test and Reports to ensure the quality of Bore Water from the Well: The below mentioned information to be provided by the Contractor

- 1. Alkalinity: (mg/L).>
- 2. Arsenic: (mg/L).>
- 3. Calcium: (mg/L).>
- 4. Chlorine: (mg/L).>
- 5. Hydrogen-Ion Concentration:
- 6. Hardness: ppm (mg/L).>
- 7. Hydrogen Sulfide: ppm (mg/L).>
- 8. Iron: ppm (mg/L).>
- 9. Lead: ppm (mg/L).>
- 10. Magnesium: ppm (mg/L).>
- 11. Manganese: ppm (mg/L).>
- 12. Potassium: ppm (mg/L).>
- 13. Sand: ppm (mg/L).>
- 14. Silt: ppm (mg/L).>
- 15. Sodium: ppm (mg/L).>
- 16. Total Dissolved Solids: ppm (mg/L).>
- 17. Turbidity: ppm (mg/L).>

1.07 COORDINATION

- A. Coordinate size and location of concrete bases with Architectural and Structural Drawings.

PART 2 - PRODUCTS

A. 3- STAGE UV FILTERS

- 1. Description: three stage cartridge Filter by So-Safe/Mulligan comprising of the following.
 - a. 5.0 Microns first stage Cartridge filter.
 - b. 1.0 Microns second stage Cartridge filter.
 - c. UV filter
- 2. SEDIMENT FILTER 01 MICRON

- | | | |
|----|--------------------------|---------------------|
| a. | Make | Taiwan |
| b. | Flow Rate | 0.8 GPM |
| c. | Maximum pressure | 90 psi |
| d. | Type of Cartridge | Polypropylene fiber |
| e. | Filtration Micron Rating | 05 & 01 Micron |

3. ULTRAVIOLET FILTER

- | | | |
|----|-----------------------|------------------------------------|
| a. | Flow Rate | 0.8 GPM |
| b. | Lamp life | 10, 000 running hours |
| c. | Power consumption | As per Manufacturer recommendation |
| d. | Ultraviolet output | As per Manufacturer recommendation |
| e. | Design pressure | 125 psi |
| f. | Operating temperature | 35 – 100 C |
| g. | Ultraviolet dosage | 30, 000 MW sec/cm2 |
| h. | Inlet / Outlet | 1" |

Model PWDWUFKC3

Kwik-Change™ Ultra Filtration Membrane Water Filtration System

Features

- Includes Designer Faucet in Brushed Nickel finish
- Kwik-Change™ cartridges are the fastest changeable cartridges on the market (30 second filter changeout process)
- ¼-turn pivot filter head makes for ease of accessibility and filter change, reduces the amount of tube connections for greater reliability and reduces leak potential
- Cartridges connect to and disconnect from the unit by simple ¼-turn
- Space saving design installs under sink or in limited space
- Double Seal O-ring cartridges ensure system integrity
- No storage tank needed
- Requires only normal line pressure to operate
- Dispenses a continuous supply of water
- Requires minimal maintenance and will provide clean, safe, great-tasting water

Reliability and Performance

- Advanced design uses unique technology and high-quality components to ensure years of continuous operation with trouble-free performance
- The Kwik-Change™ System water quality output exceeds the purity of other filtration and faucet mount devices

Performance

Tested	% of Reduction
Cysts	99.95
Cryptosporidium	99.95
Entamoeba	99.95
Giardia	99.95
Toxoplasma	99.95
Chlorine	98.00

Dimensions

10" W x 15" H x 4" D

Specifications

Stage 1: Sediment Filter removes particulates down to 5 microns

Stage 2: Carbon Block Filter removes objectionable taste, chlorine taste, and odors

Stage 3: UF Membrane consists of a capillary bundle of ultrafiltration membranes providing a physical barrier to particles, large dissolved molecules, suspended solids, turbidity, most colloids, and impurities as small as 0.25 microns



PWDWUFKC3
Ordering Code: 7100106

- Adapt-A-Valve™ easily connects to water source
- Automatic shutoff valves in the manifold eliminate the need to shut off the incoming water supply when changing out the filters
- Proprietary sanitary filter cartridges eliminate water spills during cartridge replacement



NSF/ANSI STD 372 & 53

Replacement Filter Packs

MODEL NO.		FREQUENCY	DESCRIPTION
PWFPK2KC4	7100116	6 Months	Includes sediment and carbon pre-filters only
PWFPKKCUF	7100118	Annual	Includes all filters and UF membrane

Note: Water conditions may require more frequent cartridge replacement

For additional information, access online literature [ES-WQ-PWDWUFKC3](#).

*The wetted surface of this product contacted by consumable water contains less than 0.25% of lead by weight.



WARNING Do not use with water that is microbiologically unsafe or of unknown quality without adequate disinfection before or after the system. Systems certified for cyst reduction may be used on disinfected waters that may contain filterable cysts.

Water Systems

1 pure water

2.2 Water Coolers

2.2.1 Construction Material: Stainless Steel Electric water cooler with three taps,

2.2.2 R-22 Refrigeration system

2.2.3 S.Steel Tank safety tested at 10kg/cm² (142 p.s.i.) with recommended maximum working pressure of 3kg/cm² (42 p.s.i.) including all accessories like Valves, interconnecting piping, drain tray and drain connection.

Capacity Chart

Power	20000 BTU/hr
Rated Capacity	100-119 USG/hr
Capacity with room temp 32.2°C and inlet water 26.6°C	405 Litres/hr
Capacity with room temp 37.7°C and inlet water 26.6°C	243 Litres/hr
Compressor Rating	1738 watts

Dimensions and Weight

Width	76 cm (30")
Depth	56 cm (22")
Height	125 cm (50")
Net Weight	93 kg
Gross Weight	96 kg
Packed Size	79 x 69 x 126cm



PART 3 - EXECUTION**3.01 EXAMINATION**

- A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of filters.
- B. Examine roughing-in for piping systems to verify actual locations of piping connections before equipment installation.
- C. Examine walls and floors for suitable conditions where filters will be installed.

3.02 CONNECTIONS

- A. Install piping adjacent to equipment to allow service and maintenance.
- B. Make piping connections between water filtration equipment and dissimilar-metal water piping with dielectric fittings.
- C. Install shutoff valves on feedwater-inlet and filtrate-outlet piping of each water filtration equipment filter and on inlet and outlet headers.
- D. Install valve bypass water piping around each water filtration equipment filter.
 - 1. Exception: Bag-type water filtration equipment.
 - 2. Exception: Cartridge water filtration equipment.
- E. Install drains as indirect wastes to spill into open drains or over floor drains.

3.03 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.
- B. Remove and replace water filtration equipment that does not pass tests and inspections and retest as specified above.

3.04 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service for Water Coolers.

END OF SECTION 15471

SPECIFICATION HVAC

TECHNICAL SPECIFICATIONS – AIR CONDITIONING WORKS

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3.	ELECTRICAL WORKS	8
4.	LIST OF APPROVED MANUFACTURERS	9

TECHNICAL SPECIFICATIONS – Air Conditioning Works

1.0 GENERAL:

The contract drawings indicate the extent and general arrangement of the Air Conditioning System. Equipment and piping shall fit into the space allotted and shall allow adequate and acceptable clearance for entry, servicing and maintenance. Where component parts of equipment or system cannot be serviced without distributing adjacent work resulting from original installation of other work, corrective action satisfactory to the Client / Project Managers / Consultant shall be taken, without any additional cost to the Owner.

- (a) Capacities of equipment and materials shall not be less than those indicated.
- (b) Conformance with Agency requirements: Where materials or equipment are specified to conform to requirements of Underwriter's laboratory, Inc., Air-conditioning and Refrigeration Institute of Heating, Refrigeration and Air-conditioning Engineers, etc., the Contractor shall submit proof of conformance. The label or listing of the specified agency will be acceptable evidence.
- (c) Nameplates: Each major item of equipment shall have the manufacturer's name, address serial and model numbers on a plate securely attached to the item.
- (d) Protective and Access requirements: Belts, pulleys, chains, gears, coupling, projecting set-screws, keys and other rotating parts are so located that any person in close proximity shall be fully enclosed or properly guarded. High temperature equipment and piping so located as to endanger personnel or create a fire hazard shall be properly guarded or covered with insulation of a type as specified by the manufacturer. Items such as catwalk ladders and quadrails shall be provided where indicated for safe operation and maintenance of equipment.
- (e) Verification of dimensions: The Contractor shall visit the premises to thoroughly familiarize himself with all details of the work and working conditions and verify all dimensions in the field, and shall advise the Client / Project Managers / Consultant of any discrepancy before performing any work. The Contractor shall be specifically responsible for the co-ordination and proper relation of his work to the building structure and to the work of all trades.
- (f) Cost of wooden frame: The cost of termite treated deodar wood frame equal to size of opening shall be deemed to have been

included in the relevant items.

- (g) Pipes crossing fire rated wall, the gap between wall and pipes shall be filled with soft packing like mineral wool, the ends shall be closed with approved sealant shall be deemed to have been included in the relevant items.

1.1 Equipment and Material:

(a) General:

These shall conform to the respective publications and other requirements specified herein, and as shown on the drawings and shall be the products of the manufacturers regularly engaged in the manufacture of such products. Items of equipment shall essentially be duplicate of equipment that has been in satisfactory use at least 10 years prior to bid opening and shall be supported by a service organization that is, in the opinion of the Client / Project Managers / Consultant, reasonably convenient to the site. It shall be solely the Contractor's responsibility to ensure that the equipment / material supplied by him shall fit into the space allotted for the purpose. If at any stage it is detected that the equipment supplied by him cannot fit into the space provided for the equipment, then the Contractor shall be responsible for supplying other equipment of suitable size, without incurring any additional cost to the Owner.

(b) Approval of Equipment and Material:

Before starting installation of any material or equipment, the Contractor shall submit for approval, working drawings of all areas and lists of materials and equipments to be incorporated in the work. The layout drawings shall include a plan and elevations of the proposed work, piping and equipment to establish that the equipment will fit in the allotted space with clearances for installation and maintenance. The drawings shall show proposed details for attachment anchoring, and hanging to structural framing of the building; vibration isolation units; foundation and support; location and size of sleeves and prepared openings for passage of pipes. If departures from the contract drawings are deemed necessary by the Contractor, details of such departures including changes in related portions of the project and the reasons thereof shall be submitted with the drawings. Approved departures shall be made at no additional cost to the Owner. A complete electrical connection diagram, for each electrically controlled component having automatic or manual control device, shall be submitted for approval. Wiring diagrams shall identify each component and one diagram shall show all interconnected or interlocked components. The lists of materials

and equipment shall be supported by sufficient descriptive material, such as catalogs, diagrams, performance curves, charts,

layout drawings and other data published by the manufacturer, to demonstrate conformance to the specifications requirements; model numbers alone will not be acceptable. The data shall also include the name and address of the nearest service and maintenance organization that regularly stock repair parts. Listings of items that function as parts of an integrated system shall be furnished at one time. One copy of the layout drawings, wiring diagrams and lists will be returned, marked to indicate approval.

All material / equipment shall be submitted for approval and only approved material / equipment shall be supplied to the site.

1.2 Equipment and Material:

The contract shall provide at his cost, samples of material, equipment for approval by the Engineer before order is placed for the same. Engineer may waive this requirement, if detailed published catalogues submitted by the contractor provide sufficient information for approval. These samples shall include but not limited to:

- (a) Pipe Insulation and Covering
- (b) Adhesive and Tapes
- (c) Electrical Items (Power and Control Cables, Conduit, Circuit Breakers)
- (d) Hangers and supports
- (e) Copper Piping and fittings
- (f) Condensate Drain Piping and fittings

2.0 WALL MOUNTED DX SPLIT AIR CONDITIONING UNITS:

2.1 General:

Dx Split system air-conditioning Units, cool only type. Units to be in two parts indoor & outdoor units, including filters, evaporator coils, compressors, condenser coils, and fan section, connection of power, refrigerant piping, remote sensors, control wiring, complete in all respect.

Provide units pre-piped, pre-wired, pre-charged refrigerant gas (Ozone Friendly Green Gas), factory assembled and factory tested, with all controls pretested prior to shipping. Provide a terminal strip with each electrical component individually and separately wired to strip. Provide a separate fuse, internally mounted, for each electrical component. A single fuse for multiple compressors or fan motors will not be accepted.

2.2 Indoor Unit:

2.2.1 Cabinet, Casing and Frame:

Unit framework to be formed of structural steel members of 12 to 14 gauge mild steel. After assembly paint the framework for maximum protection against rust. Exterior panels to be fabricated of 18 gauge galvanized steel finished with a baked acrylic enamel over an epoxy primer. Provide neoprene gasketing between panels and frame members; panels to be attached to the frame with quick release latches (no sheet metal screws). Insulate sections including compressor compartment with 1" thick, 3-lb./cu. ft. density fiberglass having an R value of 4.16.

Arrange units for full front, side and rear service access to all mechanical, electrical and refrigeration controls, check out of electrical control panel, without disrupting or interfering with air flow.

2.2.2 Supply Fan and Motor:

Provide single width, forward curved Class I & II supply fans secured to a machined, ground and polished solid steel shaft. Coat shaft with a rust inhibitor and support by two outboard bearings selected for a minimum 200,000 hours average life.

Provide three-phase NEMA design 'B', 40qC continuously rated fan motor with energy-saving design, .85 power factor, NEMA 'T' frame, open drip-proof, operating at 1750 rpm and supplied with grease-lubricated ball bearings.

2.2.3 Direct Expansion Coil:

Provide direct expansion coil with ½" OD seamless copper tubes

expanded into copper fins, not less than 3 rows deep or more than 12 fins per inch. Provide evaporator coil with a distributor with side port for hot gas bypass and thermostatic expansion valve with adjustable superheat and external equalizer. Test coil at 300 PSIG air pressure under water, completely dehydrate and pressure test with refrigerant. Provide coils with heavy gauge, insulated, galvanized steel drain pans complete with mastic coating for corrosion protection.

2.2.4 Filters:

Provide filters having a 40% ASHRAE dust spot efficiency, U.L. Class I pleated media type 2-inch deep.

2.2.5 Evaporator Defrost Thermostat:

Provide defrost thermostat package with enclosure, wiring and hardware for field installation.

2.3 Condensing Unit:

2.3.1 General:

Provide units pre-piped and pre-wired, pre-charged refrigerant gas, factory assembled and factory tested, with all controls pre-tested prior to shipping. Design units for use with Ozone Friendly Green Gas Refrigerant.

Assemble all condenser components on a common base in a weatherproof housing. Provide condenser coil, condenser fans and motors, refrigerant reservoir, charging valve, all controls and holding charge of Refrigerant.

2.3.2 Condenser Coil:

Construct condenser coil of copper plate fins, mechanically bonded to seamless copper tubes. Circuit coil for sub-cooling. Test coils to 425 psi.

2.3.3 Condenser Fans and Motors:

Furnish direct driven, propeller type belt driven, centrifugal fans arranged for vertical horizontal discharge. Provide condenser fan motors of the permanently lubricated type, resiliently mounted. Provide a safety guard for each fan. Include controls for cycling fans for intermediate season operation and low ambient control. Balance each fan statically and dynamically.

2.3.4 Controls:

Locate factory wired controls in a separate enclosure. Provide high and low pressure switches and compressor overload devices. Incorporate a positive acting timer to prevent short cycling of compressor if power is interrupted. Timer to prevent compressor from restarting for approximately 5 minutes after shutdown.

2.3.5 Refrigerant Circuits:

Each refrigerant circuit is to be an independent circuit completely piped, tested, dehydrated and fully charged with oil and Ozone Friendly Green Gas Refrigerant. The Refrigerant circuits are to include compressor, condenser coil with integral liquid sub-cooler, liquid line service and charging valve, filter drier, and sight glass. Compressor units to include suction and discharge line braided-wire isolators.

2.3.6 Casing:

Make unit casing fully weatherproof for outdoor installation. Construct casing of galvaneal steel, zinc phosphatized and finished with baked enamel. Provide openings for power and refrigerant connections. Make panels removable for servicing. Provide heavy duty coil guards, unit mounting rails and drain holes.

2.4 Execution:

Provide refrigerant piping and accessories to connect condensing units condensers to indoor air conditioning units according to manufacturer's instructions.

Copper pipes shall be insulated with 1-1/4" (32 mm) thick closed cells synthetic elastomeric foam insulation and wrapped with self-adhesive waterproofing tape. Condensate drain shall be insulated with 3/8" (10mm) thick closed cell synthetic elastomeric foam insulation. Contractor to provide minimum 25 mm dia Condensate Drain and terminate to nearest drain point.

No insulation shall be applied to any system of piping until all pipe work has been tested, cleaned out and made tight. All insulation shall be applied in a manner consistent with good practice and methods. All longitudinal joints of pipe shall be at the top and bottom. Insulation shall be continuous through walls, floors, ceiling and partitions etc.

All insulated refrigerant pipes exposed to atmosphere shall be provided with a cladding of 26 guage (0.55 mm) thick G.I. or aluminium sheet metal with proper support system for cladding works. Cladding works shall be painted with one coat of primer and two coats of finish paint, as approved by the Engineer and as direct by Engineer incharge.

2.4.1 Startup and Testing:

- a. Manufacturer's service technician to check alignment of bearings, drives and motors after installation to ensure that no misalignment exists, or make any necessary alignment adjustments prior to startup.
- b. The manufacturer shall furnish a start up check list to the Owner at least two months prior to start up. The list must be explicit as to the various items to be checked prior to start up.
- c. Before units are started up, manufacturer to pump new grease into bearing housings to force out old grease and provide adequate lubrication.
- d. Before acceptance of the equipment by the Owner, conduct all tests as required to demonstrate that the equipment operates mechanically, electrically and acoustically as specified.
- e. Conduct a satisfactory performance test in the presence of the Owner / Engineer incharge. Any units found to vibrate beyond acceptable levels must be rebalanced in the field at the Contractor's expense.

2.5 Spare Compressors and Parts:

Minimum 10% spare shall be supplied as per Manufacturer's recommendations for two years continues operation.

3.0 ELECTRICAL WORKS:

3.1 General:

The Contractor shall be responsible for the complete power and control electric wiring required for Air Conditioning System. The Owner shall provide electric supply at point (Contractor to verify this point). Wiring onwards from this supply point to all motors, equipments and controls, etc., shall be the responsibility of the Air Conditioning Contractor. The electrification work shall be carried out by a licensed workman, authorized to undertake such a work under the provision of Pakistan Electricity Act and Rules and the latest edition of I.E.E. Wiring Regulations. Any special requirements of the local Electric Supply Company shall be complied with.

3.2 Cables and Conduit:

All the cables listed, except otherwise specified in Electrical Drawings, are four cores PVC insulated PVC sheathed cables 600/1000 volts grade as per British Standard B.S. 6004:1969. The conductors shall be of high conductivity annealed copper wires of 99.97% purity heavily insulate with PVC compound and sheathed overall with PVC compound. The insulation color identification will be as red, yellow, blue and black for neutral. In general all the cables, except otherwise specified in the cable schedule will be non-armored types. All cables shall be selected at 45 °C.

All conduits shall be of heavy gauge 16 SWG G.I, manufactured and tested in accordance with latest relevant standards. The minimum size of conduit shall be 20 mm.

The conduit shall be protected by two base coats of red oxide anti-rust paint and finished in first quality black enamel paint. The coating shall be of heavy enamel, which shall not flake or crack during installation and handling. Each conduit length shall be furnished with threaded ends and a threaded coupling at one end. Soft metal bushes shall be provided at conduit termination to prevent damage to cable during pulling operation. Flexible steel conduits shall be installed at all points locations where flexible connection is required, as directed by the Engineer in charge. The flexible conduits when used, shall be protected by external PVC sheath, resistant to oil damages. All conduits shall be cut square and reamed at the end. All conduit ends and the inside of conduits shall be clean and free from burrs.

The Contractor shall coordinate with Electrical Drawings for detailing.

4.0 LIST OF APPROVED MANUFACTURERS:

S.NO.	EQUIPMENT / MATERIAL	APPROVED MANUFACTURERS
1	WALL MOUNTED DX SPLIT AIR CONDITIONING UNITS	a) GREE b) HAIER c) MITSUBUSHI
2	COPPER PIPING	a) MUELLER b) YORKSHIRE c) CRANE ENFIELD d) NIBCO
3	UPVC PIPING	a) DADEX b) JEDDAH POLYMER c) PAK ARAB
4	HANGERS & SUPPORTS	a) HILTI b) FISHER c) SIKLA d) MUNGO
5	ELECTRICAL CABLES	a) PAKISTAN CABLES b) FAST CABLES c) NEWAGE CABLES
6	GI CONDUIT FOR ELECTRICAL WORKS	a) HILAL, PAKISTAN b) PREMIER, PAKISTAN

SPECIFICATION DCC WORKS

**CONDUIT LAYING WORKS FOR
SECURITY AND DATA NETWORKS
TECHNICAL SPECIFICATIONS BY DCC
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	LIST OF APPROVED MANUFACTURE'S BRANDS	10

D-1- TECHNICAL PROVISION

D.1.1 General

The general instructions are given to the tenders elsewhere in this contract documents. The additional instruction in the following paragraphs are given in order to invite the tenderer's attention towards some major points pertaining to electrical work only and to assist them in preparing tenders. These instructions shall be deemed as Technical Provision of the Contract.

D.1.2 Scope of work

The work consists of furnishing all tools, plants, labor material and equipment and performing the internal and external electrical works comprising of:

- a) Conduit laying for security camera
- b) Conduit laying for data network
- c) Floor Outlet Box with Flanged Frame
- d) Any other system / item given in the drawings but not mentioned above

The work shall be carried out in strict accordance with the conditions of Contract, special Conditions, Drawings, Technical Specification and as per items of Bill of Quantities and including the responsibility of all related work necessary for their proper functioning, testing, commissioning and satisfactory operation and performance including maintenance for the period specified elsewhere. The contractor shall provide for all required technical and non – technical personal, skilled and non- skilled labor, construction equipment, transportation etc. as required for the completion of work is strict according with the Technical Specification laid herein- after.

D.1.3 Prequalification

The Electrification work shall be carried out only by a licensed Contractor authorized to undertake such work under the provision of Electricity Act.1910 and the Electricity Rules, 1973 as adopted and modified by the Government of Pakistan.

D.1.4 Qualification

A licensed Electrical Contractor should have the following qualifications:

- a) Must have in his employment a competent graduate Electrical Engineer registered with Pakistan Engineer Council.
- b) Must possess a valid Electrical Contractor's License issued by the Electric Inspector of the region where the site is situate
- c) Must have in its employment an Electrical Supervisor having certificate of competency who will exclusively supervise this work.
- d) Must have necessary tools, plant and instruments.
- e) Must have adequate experience of similar works.

If a contractor does not have the above qualifications he shall be allowed to sublet the Work to a competent Sub-Contractor provided an application for his pre-qualification is made to the Engineer for his approval. Decision of the Engineer in this case shall be binding on the Contractor.

D.1.5 Rules and Regulations

The installation in general shall be carried out in conformity with the Electricity Rules, 1937, and the latest edition of the Regulations for the electrical Equipment of Buildings issued by the institution of Electrical Engineers London (I.D.E). However, in case of conflict between these specifications and the I.D.E Regulations, these Specifications shall be followed.

D.1.6. Standards

The latest relevant British specifications and Codes, Pakistan Standard Specifications, VDE, I.D.C and I.D.E recommendations shall be applicable and be followed for the equipment specified herein.

D.1.7 Climatic Conditions

All equipment supplied shall withstand, without developing any defect, the following climatic conditions:-

Maximum Ambient Temperature	=	113 ⁰ F or 45 ⁰ C
Minimum ambient Temperature	=	28 ⁰ F or (-) 2.2 ⁰ C
Maximum Humidity	=	90%

D.1.8 Specifications

The Contractor shall furnish all material and equipment at site, conforming fully to the specifications given herein and to the accepted standards as laid down by British Standards,

the Institution of Electrical Engineers, London, and the Pakistan Standard institution. It is not the intent of these specifications to include all details of design and construction of various material and equipment to be supplied under this contract. The contractor shall supply and install all material and equipment specified herein and also all installation and small material such as nuts, bolts, washers, shims angles, leveling material, insulation, tape, solders, etc and all such other material whether specified herein or otherwise required for complete installation as intended by the Specifications.

All material and equipment supplied by the Contractor shall be new and in all respects conformed to the high standard of engineering design and workmanship, perform and function as herein specified and fully meet the quality level and ruggedness requirement of the Specifications. All material and equipment which have to be supplied and installed by the Contractor shall be passed / approved by the Engineer, even if the same is exactly in accordance with the Bill of Quantities and drawings.

D.1.9 Submittal

The Contractor after the award of works shall submit for approval of the Engineer all samples / catalogues of equipment, appliances, fixtures and accessories that are to be furnished under the contract. After final approval a sufficient number of copies of drawings / catalogues as desired shall be furnished for distribution. Samples, catalogues and drawings shall be clearly marked to indicate, the item furnished. Samples of all fixtures, and not a few, shall be submitted.

D.1.10 Approval of Drawings and Data

The contractor shall provide detailed drawings if any changing will require, for the Engineer's review and approval. Three sets of equipment drawings shall be provided for obtaining approval.

The manufacture of equipment shall be started only after the above mentioned drawings and data are approved.

The time required for review and approval shall be considered included in the total time of completion of job.

D.1.11 Drawings & Data

Three sets of drawings and data for each equipment shall be furnished to the Contractor for the Engineer's approval before commencement of fabrication and manufacture. The drawings to be supplied to the Contractor shall be as follows:-

Electrical Drawings showing:-

- One-Line diagram
- All interconnections
- Cameras locations and diagrams
- Other electrical devices including meters instruments and their wiring diagram
- Signal, turnstiles and sliding doors diagrams

D.1.12 Shop Drawings

The design drawings show conduit routes and depict only the position of various fixtures and outlets. All the planning for the conduit routes shall be carried out, well in advance of the actual execution of work, by the Contractor to the satisfaction of the Engineer.

D.1.13 Setting out of work

The Contractor shall set out the Work himself and if any discrepancy is found, he shall report the matter to the Engineer and shall act as directed. If any defective or modified setting out is carried out by the Contractor on his own, he shall rectify or make it good at his own cost.

D.1.14 Programming

The Contractor shall keep pace with the Work of the Civil Contractor and any other Specialist contractor. The Engineer shall be kept informed about the program and the progress of Work so that there is no hindrance in the execution of Work at site.

D.1.15 Protection

The Contractor shall take care not to damage the structure, material, equipment and property belonging to and / or installed by other Contractor during execution of work and shall repair and make good all losses at his own cost, if found guilty in the opinion of the Engineer.

D.1.16 Change of Specifications

No change in Specification of the equipment/ material will be allowed at any stage, except with the approval of the Engineer and if mentioned in the tender submitted.

D.1.17 Purchase of Equipment / Material

All the equipment and material e.g. conduits, bends, joints and floor outlet box will be purchased direct from the manufacturer / authorized dealer to ensure the use of genuine material will be, produced as and when desired.

D.1.18 Manufactures and brands

Where brands and names of Sub-station equipment or any other system are specified by name, alternative can be offered provided these are equal in quality to those satisfaction. Satisfaction of the Engineer in this respect shall be essential and prior approved for such deviation shall have to be obtained by giving details in the tender submitted. However all equipment for any one substation or system shall be from one manufacturer only.

D.1.19 Spare Parts List

A list of spare parts required for one year's operation of each equipment where deemed necessary together with unit price of each part, shall be supplied by the Contractor.

D.1.20 Guarantee

The Contractor shall furnish written guarantee in triplicate of the manufacturer for successful performance of each equipment. Such guarantee shall be for replacement which may be found defective in material or workmanship. The guarantee shall cover a minimum period of 1-2 months effective from the date of completion certificate.

D.1.21 As- Built Drawings

The Contractor shall, during the progress of work, keep a careful record of all changes and revisions where the actual installation differs from that shown on shop drawings. These changes and revisions shall be accurately carried out or, the shop drawings and submitted to the Engineer for approval. After approval these drawings shall become the property of the Owner. These updated and approved shop drawings depicting clearly all changes and revisions at site shall be called As-Built Drawings. Reproducible tracings with two sets of prints of all these. As-Built Drawings shall be handed over to the

Engineer. Final payment will be withheld until the receipt of the approved As-Built Drawings.

D-2 - TECHNICAL SPECIFICATIONS

SECTION 2.1 - CONDUITS "& CONDUIT ACCESSORIES

D. 2.1.1 Conduit Pipe

The conduit for wiring shall be made of PVC manufactured by as approved manufacturer conforming to BSS 6099.

The conduit shall have following wall thickness and standard weights :-

Pipe Size:	Wt/100M.	Wall thickness
25mm dia	4.5 g..	1.15mm to.1.29
150mm dia	20.0 g..	2.2mm to.3mm

D.2.1.2 Conduit Accessories

D.2.1.2.1 The use of factory made PVC junction boxes is prohibited. Only cast steel Box for floor outlet (L259mm x W203mm x H84mm); conforming to BSS. 31/latest having nipples to receive PVC. pipe with force fit shall be used for ceiling outlets. Each junction box shall be provided with one piece Flanged Frame Covers shall be in brass and stainless steel material providing a perfect look to match virtually any decor style. which shall be fitted on the box with chromium plated screws, and a temporary construction cover shell be used for time or construction.

D2.1.2.2 Conduit shall be installing concealed in wall for CCTV Cameras must be 3 meters height on wall ends of conduit shall be solidly plugged till such time as final and proper terminations are made.

D.2.1.2.3 Conduit accessories steel Box for floor outlet shall be made of 16 SWG sheet steel having dust tight covers. All boxes shall have required number of conduit entry holes and earth terminals for connecting 1 .C.C. All the rectangular or square shaped boxes shall have nipples to receive PVC conduit with three fit. All these boxes shall be painted inside and outside with Powder Coating. Shapes and sizes of these boxes shall be determined on each application.

D.2.1.2.4 Manufacture smooth bends shall be used where conduit changes direction. Bending of conduit by heating or otherwise shall be allowed only at special situations with the permission of the Engineer. Use of sharp 90 degree bends and tees is prohibited. Bends shall have enlarged ends to receive the conduit without any reduction in the internal diameter of the PVC pipe

D.2.1.2.5 All accessories e.g. boxes, couplings, bends, bushes, reducers, check nuts etc. Shall be equal in quality to the specified conduit.

D.2.1.2.6 The use of looping in box -shall be allowed in places where floor slab thickness permits 90 degree bends in conduit.

D.2.1.3. Installation Instructions

The Contractor shall furnish all labor and material for the installation of conduit as required.

D.2.1.3.1 Conduit shall be installed concealed in RCC slabs, columns, walls and Floors etc. Recessed conduit shall be laid over the first tier of reinforcement and under ne second tier of reinforcement before pouring of concrete. All conduit outlet boxes to be concealed shall be laid finally flush with the soffit of the slab or beam. The conduit should be tied to the reinforcement firmly so that the alignment is not disturbed by vibrators. All the outlet boxes installed shall be stuffed and their-cover plates fixed so as prevent concrete entering the outlet boxes.

Under no circumstances shall chassis be made for recessing conduit in the RCC structure after it has been cast without the permission of the Engineer. Where conduits must be concealed in Cement concrete or brick masonry, chassis shall be made with appropriate tools not deeper than required. The conduit shall then be fixed in the chassis before covering it up with at least 20r11in thick plaster_ conduit ends pointing upward shall be properly plugged to avoid entry of foreign material.

D.2.1.3.2 The drawings show conduit routes and all the planning for arranging conduit routes shall be carried out to the Contractor the satisfaction of the Engineer.

D.2.1.3.4 The entire conduit system shall be essentially completed before the wire pulling is taken in hand. Each conduit run shall be tested for continuity and obstructions. Al obstructions shall be cleared in an approved manner. Water and moisture that has entered any section of the conduit installation must be dried with suitable swabs to the satisfaction of the Engineer.

D.2.1.3.5 Adequate expansion joints shall be provided in all conduit runs passing across the expansion joints in file concrete slabs of the buildings. A typical arrangement is shown on drawing.

D.2.1.3.6 Pull boxes or Floor box shall be installed in conduit runs at intervals Mentioned below to facilitate die pulling length or wires:-

i) Straight runs

- 20 meters

- | | |
|---|--------------|
| ii) Runs with one 90 degree Bends | -15 riveters |
| iii) Runs with two 90 degree Bends | - 10 meters |

The minimum length of inspection/pull boxes should be four times the cable manufacturer's recommended bending radius of the cable.

- D.2.1.3.7** The conduit shall be terminated at pull boxes, distribution boards and switchboards in an approved manner to the satisfaction of the Engineer without any additional cost to the Owner.
- D.2.1.3.8** Conduit runs between two outlets shall not contain more than two quarter bends or one 90 degree bend.
- D.2.1.3.9** All the free ends of conduit shall be solidly plugged till such time as final and proper terminations are made.
- D.2.1.3.10** All conduits of a system shall be run at least 6" away from the other systems and services where conduit one of system crosses the other it shall do so at right angle i.e- 90 degree.
- D.2.1.3.11** All multiple runs of conduit shall be arranged symmetrically.-
- D.2.1.3.12** Exposed runs of conduit where required shall be firmly fixed by clamps and brackets etc. to the surfaces of walls, columns and ceiling. Rawal plugs or Phil plugs may be used for fixing saddles, clamps and d b rackets etc.
The spacing between two saddles may not be more than 30". They straight runs on walls may be-18" to 24" below the ceiling and in the event of any obstruction one to beams the reins may be routed around them. The conduit shall have a minimum clearance of 6 mm from the surface supporting it. Purpose made special clips and brackets may be required at some situations to support the conduit.
- D.2.1.3.13** No conduit less than 20 mm die shall be used for single point and 25mm dia for dual point. The size of conduit shall however be determined from the number of wires required in the conduit ruts according to number of wires allowed as per IEE Regulations.

HDPE PIPE Laying and Specifications

Following guidelines must be followed when laying the HOPE pipe for the optical fiber cable.

1. Suitable mechanical protection by using one I RCC I GI pipes to be provided for cable at places where depth is less than 1.2M due to presence of nullah or any other reason.
2. The route of the pipes should be kept as straight as possible. Whenever curves or deviations are encountered it should be a very smooth curve, the radius of curvature should be more than 50 cm at least.
3. After the trench is ready, bed of trench should be prepared by even & soft layer of 5.0 cm sieved earth and properly leveled.
4. The ends of the pipe in each hand-hole/ man-hole should be closed with caps.
5. A 4mm polypropylene rope should be drawn through the pipes and safely tied to the caps at either end with hooks. These 4mm ropes are, to be provided throughout the route which could, serve to pull the 12mm rope which is ultimately required to pull the cable.
6. Backfill the trench with six inches of select fill, e.g., sand, crushed stone dust, or sandy soil.
7. Locating wire and/or plastic warning tape should be installed about 12 inches above the cable during the backfilling process
8. Tamp i.e. pack down the trench line to prevent settlement. Best results may be obtained by tamping the backfill in two or more passes; however, do not compact the trench until at least 12 inches of backfill has been placed over the pipe.

D.2.1.4 Measurement

- D.2.1.4.1** All conduit work including all accessories shall be measured on the basis of actual numbers of floor outlet points installed as shown on the drawings.
- D.2.1.4.2** for other systems the conduit work shall be on actual measurement basis on the running length installed in feet or meters as the case may be.

LIST OF APPROVED MANUFACTURER'S BRANDS

S. No.	Description	Page No.
1.	PVC Conduit & Accessories	BETA /GALCO/SHAVYUDEX
4.	Back Boxes for floor outlet, cover and other accessories	Hussain & Company I PPI/ITC



**GOVERNMENT OF SINDH
SINDH MASS TRANSIT AUTHORITY
TRANSPORT & MASS TRANSIT DEPARTMENT**



**Sindh
Mass Transit
Authority**

MAINTENANCE OF BRTS GREEN AND ORANGE LINES

**“MISCELLANEOUS REPAIR/REPLACEMENT/MAINTENANCE
WORKS OF ROAD, BUILDINGS, ELECTRICAL, HVAC AND MEP
WORKS AT BRT GREEN & ORANGE LINE CORRIDORS”**

BID DOCUMENTS VOLUME- III

PRICE BID

(SINGLE STAGE TWO ENVELOPE)

September 2026

FORM OF PRICE BID

Bid Reference No. _____
(Name of Contract/Work)

To:

1. Having examined the bidding documents including Instructions to Bidders, Bidding Data, and Conditions of Contract, Specifications, Drawings and Bill of Quantities and Addenda Nos. _____ for the execution of the above-named work, we/I, the undersigned, offer to execute and complete the work and remedy any defects therein in conformity with the Conditions of Contract, Specifications, Drawings, Bill of Quantities and Addenda for the sum of _____ Rs.
_____ (Rupees _____) or such other sum as may be ascertained in accordance with the said conditions.
2. We/I understand that all the Appendices attached hereto form part of this bid.
3. As security for due performance of the undertakings and obligations of this bid, we/I submit herewith a bid security in the amount of Rupees _____ (Rs. _____) drawn in your favour or made payable to procuring agency and valid for a period of _____ days beginning from the date, bid is opened.
4. We/I undertake, if our bid is accepted, to commence the works and to complete the whole of the works comprised in the contract within the time stated in Appendix-A to Bid.
5. We/I agree to abide by this bid for the period of _____ days from the date fixed for opening 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 do hereby declare that the bid is made without any collusion, comparison of figures or arrangement with any other bidder for the works.
8. We understand that you are not bound to accept the lowest or any bid you may receive.
9. We undertake, if our/my bid is accepted, to execute the Performance Security referred to in Clause 10 of Conditions of Contract for the due performance of the Contract.
10. We confirm, if our bid is accepted, that all partners of the joint venture shall be liable jointly and severally for the execution of the Contract and the composition or the constitution of the joint venture shall not be altered without the prior consent of the procuring agency. (Please delete this in case of Bid form a single bidder)

in the capacity of _____ duly authorized to sign Bids for and on behalf of
_____ Dated this _____ day
of _____ 2022 _____

Signature: _____

(Name of Bidder in Block Capitals)
(Seal)

Address: _____

Witness:

Signature: _____

Name: _____

Address: _____

Occupation: _____

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PREAMBLE TO BILL OF QUANTITIES

A Preamble

1. The Bill of Quantities shall be read in conjunction with the Conditions of Contract, Specifications and Drawings.
2. The basis of payment will be the actual quantities of work executed and measured by the Contractor and verified by the Engineer and valued at the rates and prices entered in the priced Bill of Quantities, where applicable, and otherwise at such rates and prices as the Engineer may fix as per the Contract (in case of item not mentioned in Bill of Quantities).
3. The rates and prices entered in the priced Bill of Quantities shall, except insofar as it is otherwise provided under the contract include all costs of Contractor's plant, labour, supervision, materials, execution, insurance, profit, taxes, GST and duties, together with all general risks, liabilities and obligations set out or implied in the contract. Furthermore all duties, taxes and other levies payable by the Contractor under the contract, or for any other cause, as on the date 28 days prior to deadline for submission of Bids shall be included in the rates and prices and the total bid price submitted by the bidder.
4. Percentage (%) of Premium/Rebate shall be entered against each bill in the priced Bill of Quantities. The premium/rebate in the bills against which the Contractor will have failed to enter a Premium/Rebate shall be considered zero percent (0%).
5. The whole cost of complying with the provisions of the Contract shall be included in the items provided in the priced Bill of Quantities, and where no items are provided, the cost shall be deemed to be distributed among the premium/rebate entered for the related bill.
6. General directions and description of work and materials are not necessarily repeated nor summarised in the Bill of Quantities. References to the relevant sections of the bidding documents shall be made before entering premium/rebate against each Bill in the priced Bill of Quantities.
7. Provisional sums included and so designated in the Bill of Quantities shall be expended in whole or in part at the direction and discretion of the Engineer in accordance with Clause 58 of the Conditions of Contract.
8. The following abbreviations for the units or units of measurement have been used in the bidding documents including BOQ.

B) Preamble to Pricing and Method of Measurements

Generally

The Bill of Quantities herein, including all notes and instructions, forms an integral part of the Bid/Contract Documents. However, the descriptions contained in the Bill of Quantities for each item are not necessarily complete. The Contractor is referred to the Conditions of the Contract and other Documents, Specifications and Drawings as well as relevant Standards and Codes of Practice for further information as no claim or variation will be considered on account of the Contractor's failure to do so.

The Contractor is cautioned to familiarize himself with the full content of other Contract Documents including the Instructions to Bidders, Bid Form, General Conditions, Particular Conditions, Bid / Contract Drawings and Specifications or any other information that can be easily inferred from any of them and all obligations contained in the documents shall be included in the item rates and / or contract price.

Drawings, Specifications and Bill of Quantities and all other documents are complementary and if description of any item is included in any of them, it shall be deemed included in all.

The Contractor's bid for the entire work shall provide for supervision of any or all trades that are intended to be performed with his own forces, his domestic sub-Contractors and nominated sub-Contractors. No extra compensation for services as a General Contractor will be paid.

The Contractor shall not use these Bills of Quantities as the basis for the purposes of ordering materials or arranging sub-contracts. The references for these activities shall be the drawings, specifications and instructions issued by the Engineer.

This is a Measurable type of Contract.

Items in the Preamble Section of these Bills of Quantities are deemed to qualify and to form part of description of measured work to which they refer including composite description.

All measurements are net, and the rates shall include for all laps, waste, working space, etc. and trade or traditional allowances.

Amendments shall not be made to these Bills of Quantities without the authority, in writing of the Engineer.

Method of Measurement

These preambles are to be read in conjunction with the item description in the Bill of Quantities.

“As described” means as directed in the Specifications and / or Drawings.

Unless otherwise described or measured separately, prices for all items shall include for all necessary straight, raking or circular cutting.

The Conditions of Contract applicable to this Contract is as specified in Volume 1 – Tender & Contract Conditions of the Tender and Contract Document.

Pricing

The premium/rebate shall be comprehensive and must include for complying in all respects with the instructions to Bidder, Conditions of Contract, Specifications, and Drawings and for all matters and things necessary for the proper construction and completion of the whole of the Works. No claim for additional payment will be allowed for any error or misunderstanding by the Contractor of the work involved.

The rates and sums inserted in the Bills of Quantities are deemed to include for the following:

- (i) Labor and all costs in connection therewith.
- (ii) Materials, goods and all costs in connection therewith (e.g. carriage, freight, delivery, unloading, storing, returning packing handling, Letters of Credit, Bank Guarantees, Bank charges and the like, Customs duties, port dues, import duties,

taxes including sales tax, charges, Insurances and other dues levied by any authority or imposed by the Government, hoisting or lowering, replacing work, goods or materials damaged, broken, lost or stolen until the issue of a Certificate of Completion.

- (iii) Fittings and fixing materials or goods in position.
- (iv) Plant.
- (v) Waste, bulking, shrinkage and overlaps.
- (vi) Land required for tips and stockpiles including all costs for obtaining any necessary licenses and approvals.
- (vii) Allowance for phasing requirements of works, effect on programming of the works of all traffic diversions and construction activity associated with diversion or installation of services.
- (viii) For taking measures for the support and full protection of pipes, cables and other apparatus required during the progress of the Works as required by Service Authority or the Engineer.
- (ix) For working alongside and liaising with other Contractors working on the same site.
- (x) Preparation and submission of shop drawings.
- (xi) Overhead charges and profit.
- (xii) Guarantees and warranties where necessary.
- (xiii) Temporary works, if any.

Lump sums shall not be given where unit rates are applicable.

Where the word “allow” is used, the cost of the item shall be the responsibility of the Contractor.

The amounts set against any items of overhead shall include for all costs in connection with letters of credit, bank charges, interest charges and insurance after the materials come under the control of the Contractor.

The rates inserted will be used to determine the amount of the Contractor’s Interim Payments.

Where “fix only” items are specified, the rate shall be deemed to include for taking delivery, storing and installation of goods or materials in works where appropriate.

General Requirements

Standards

Where no reference is made to a code, standard or Specifications of the CONTRACT Documents, the Standard Specifications of the American Society of Testing Materials, (ASTM), British Standard Codes of Practice (BSCP) or any other relevant standard as approved by the Engineer shall govern.

Drawings

The WORK shall agree in all particulars with the Drawings or any approved modifications of them or such other drawings as may be issued during the CONTRACT.

CONTRACTOR'S (Drawings & Documents)

The CONTRACTOR shall submit three prints/copies of all drawings, documents and schedules to be prepared by him. These will be of a standard size and format acceptable to the Engineer. All such submission by the CONTRACTOR shall be accompanied by a letter of submittal.

Record Drawings

The CONTRACTOR shall prepare during the progress of the CONTRACT, drawings showing the WORK "as built" including the positions of all services, plant and equipment. The drawings shall be prepared to a form & detail to the satisfaction of the Engineer and prints shall be submitted to the Engineer's Representative for his approval as the WORK proceeds. At the completion of the CONTRACT the CONTRACTOR shall supply to the Engineer reproducible of each drawing.

Supply of Water and Electricity

The CONTRACTOR shall make his own arrangements for the provision of water & electricity whether for use in the execution and construction of the WORK or otherwise. In the event of the source of water being from any existing piped supply the CONTRACTOR shall comply with any regulations laid down by the Water Authority and shall pay for such supply, stand-pipe connections, meter rents and all other charges as required all at his own expense. Similarly, he will be responsible for all costs in providing electricity. Where electricity is not available for 24 hours, diesel/petrol driven electricity generators in good and reliable condition and of sufficient capacity to meet the requirements of construction equipment and lighting and other facilities at Site will be used by the CONTRACTOR.

Disposal of Wastes

The CONTRACTOR shall make adequate arrangements to the satisfaction of the EMPLOYER'S REPRESENTATIVE for disposal of all sewage, rubbish and all other waste material arising from or connected with the execution of the WORK.

Other Services

The CONTRACTOR shall make his own arrangements for and shall provide any service (including telephone) which may require in addition to the foregoing.

Bench Marks and Control Points

All levels, lines, grades and measurements shown on the Drawings shall be measured from a Bench Mark and points to be established by the Engineer within the Points Site of the WORK. The CONTRACTOR shall be responsible for ensuring the levels of all parts of the work are accurately related to this Bench Mark which shall be notified to the CONTRACTOR by the Engineer immediately after commencement of the WORK.

Survey

The CONTRACTOR shall furnish and maintain at his own expense survey instruments stakes and other such materials and give such assistance, including qualified staff as may be required by the EMPLOYER who will establish Bench Marks base lines, grades and other principal control points. The CONTRACTOR shall, however, call the Engineer's attention to any inaccuracies and discrepancies of such controlling points etc., before proceeding with the work. The CONTRACTOR shall at his own expense, establish working or construction lines and grades as required, which shall be frequently checked by the Engineer's Representative, but the CONTRACTOR shall be solely responsible for the accuracy thereof.

Safeguarding Bench Marks & Control Points

The CONTRACTOR shall safeguard all points, stakes, grade marks and bench marks made or established on the work. If disturbed he shall bear the cost of re-establishing them and also the entire Points expense of rectifying the work rendered defective due to such disturbance.

Progress Photograph

The CONTRACTOR shall, throughout the construction of the WORK use digital camera for photography and provide the progress photographs in color to the Engineer. He will also submit three prints each of size 5"x7" along with the recorded data at two week intervals. All such photographs will be taken under the direction of the Engineer.

Materials and Workmanship

As soon as possible after the CONTRACT has been awarded, the CONTRACTOR shall submit to Engineer list of suppliers from whom he proposes to purchase the materials necessary for the execution of the WORK. The information regarding the names of suppliers may be submitted at different times, as may be convenient, but no approved source of supply shall be changed without the prior permission of the Engineer.

Preference shall be given to the use of materials and fittings manufactured in Pakistan which comply with the CONTRACT and are competitive in price.

All materials incorporated in the WORK shall be new and of the best quality and description of their respective kinds and shall comply with all relevant specifications. Similarly the workmanship in every case shall be of the best character, and the whole shall be subject to the approval of the Engineer.

Materials whose quality and construction are not covered by the Technical Specifications shall be of equal or better quality than the relevant sample accepted by the Engineer.

Samples

In addition to any special provisions herein for the sampling and testing of materials, the CONTRACTOR shall submit to the Engineer as he may require samples of all materials and goods which he proposes to use or employ in or for the WORK. Such samples, if approved, will be retained by the Engineer, and no materials or goods of which samples have been submitted shall be used on the WORK unless and until such samples have been approved in writing by the Engineer.

The Engineer may reject any materials and goods which in his opinion are inferior to the samples thereof previously approved and the CONTRACTOR shall promptly remove such materials and goods from the Site.

The cost of supplying all such samples and of conveying same to such place of inspection or testing as the Engineer may designate within the country of origin shall be deemed to be included in the tendered premium/rebate.

Samples will be retained by the Engineer and when directed by the Engineer the CONTRACTOR shall dispose of the samples. Except for those which may be incorporated into the WORK after approval, such as plumbing and electric fixtures.

Tests Generally, Access to Premises

The Engineer may examine and may require to be tested any materials or goods required.

In or for the WORK such as he may decide from time to time and shall have unrestricted access to the CONTRACTOR'S and supplier's premises for such purpose at all times and the CONTRACTOR shall specify this requirement when placing all orders.

The Engineer will notify the CONTRACTOR whether materials and goods will be inspected at the manufacturer's or supplier's premises or at the Site. No materials or goods shall be dispatched from such premises until such notification is given and, if appropriate, inspection is complete, and a release certificate is given to this effect. In both cases the CONTRACTOR is to notify the EMPLOYER when materials and good will be ready for inspection and shall do so adequately in advance for him to make the necessary arrangement for inspection

The CONTRACTOR shall afford the Engineer's all facilities, assistance, labor and appliances necessary for the convenient examination, testing weighing or analysis of all such materials or goods. The CONTRACTOR shall provide and prepare such test pieces of any such materials or goods as the Engineer may require.

Notwithstanding any tests which may have been carried out off the Site the Engineer shall be empowered to order further tests of any materials or goods to be made on the Site and to reject such materials or goods should they fail to pass such test on the Site.

The full cost of providing all facilities, labor, consumable stores and appliances required in connection with all testing on the Site shall be deemed to be included in the tendered rates and prices.

Test Certificates

Should the Engineer not inspect any materials or goods at the place of manufacture, the CONTRACTOR shall, if required, obtain certificates of test from the suppliers of such materials or goods and shall send such certificates to the Engineer. Such certificates shall certify that the materials or goods concerned have been tested in accordance with the requirements of the Technical Specifications and shall show the results of all the tests carried out. The CONTRACTOR shall provide adequate means of identifying the materials & goods delivered to the Site with the corresponding certificates

Testing at an independent Laboratory

Where tests are specified or directed by the Engineer to be carried out in an independent testing laboratory, the CONTRACTOR shall supply and deliver the samples and shall arrange for the relevant tests to be carried out. The independent testing laboratory shall be nominated by the CONTRACTOR and acceptable to the Engineer.

Unless otherwise specified the CONTRACTOR shall arrange for one copy each of the independent testing laboratory's test certificates to be delivered to the Engineer not less than 3 working days before the materials covered by the relevant test certificates are to be incorporated in the WORK. Each test certificate shall be relatable to the materials from which the sample was taken.

Site Testing

The CONTRACTOR shall carry out such laboratory and field test (including tests to check the accuracy of testing equipment and methods but excluding tests specified to be carried out in an independent testing laboratory) as specified or as can reasonably be inferred from herein, as may be necessary to ensure and satisfy the Engineer that the requirements of the Technical Specifications are met. The type and frequency of testing shall be in accordance with the relevant standards except as otherwise specified herein or directed by the Engineer.

Unless otherwise agreed or directed by the Engineer methods of sampling and test procedures shall be in accordance with the relevant Standard Methods of ASTM, British Standard Codes of Practice or any other relevant standard approved by the Engineer. Sample will be selected by the Engineer.

Shop Drawings, Working Drawings, Operations and Maintenance Instructions.

The Contractor is to allow in his premium/rebate for the production of all shop drawings, working drawings, operations and maintenance instructions called for in the Specifications.

These shall include but not to be limited to the following:

- (i) The surveyed location of all existing services.
- (ii) A Combined Services Drawing including all surveyed existing and proposed services showing manholes, draw pits, joint boxes, inspection chambers, lighting column bases traffic signal bars, concrete surrounds, pipe diameters, etc. to scale, plus any other possible obstructions.
- (iii) Combined Services Working drawings original and new.
- (iv) Separate sets of working drawings for each individual service showing proposed locations for submission to the service authorities.
- (v) Existing ground levels.
- (vi) Earthworks cross sections.
- (vii) Temporary traffic sign design and fixing details.
- (viii) Proposed traffic sign design and fixing details.
- (ix) Mechanical, electrical and other services drawings, diagrams and instructions as required in the contract and directed by the Engineer.
- (x) Temporary work drawing where requested by the Engineer.

The premium/rebate in the appropriate section shall include for design of the civil works as specified in the Contract and for providing working drawings, shop drawings, schedules, specifications, calculations, etc. and for obtaining the Engineer's approval.

Rates for various items throughout the Bills of Quantities shall include, unless otherwise stated or measured, for cutting of every description and the consequent waste, for work in girths, widths or heights of less than 300mm and for all short lengths.

Rates for all work shall include for protection, provision of samples and testing.

The pricing of materials shall take account of the following:

- (i) Pricing Preambles and Specifications shall apply reciprocally between sections of the works unless otherwise described.
- (ii) Materials shall be of the quantity specified unless otherwise directed by the Engineer.
- (iii) All materials shall be transported, handled, stored and fixed in accordance with the printed instructions or recommendations of their manufacturer's or suppliers.
- (iv) Protection of completed work, all casings and temporary coverings and making good, cleaning and polishing and clearing away upon completion.

Rates for Plumbing and HVAC Work

Rates for all pipe work shall include for assembling and joining, pipe supports, pipe sleeves and cover plates and the like.

Rates for pipework shall include for all fittings to small pipes (i.e. pipes into an internal dia. of 60mm or less) fittings (except joint in running lengths) to large pipes (i.e. pipes with internal dia exceeding 60mm) and to gutters shall be enumerated, grouped together for each size of pipe and gutter and described as fittings.

Rates for duct work are to be included all fittings, brackets, hangers and other support.

Rates for insulation are to be included for cutting, waste, joining lap and working around and our ancillaries, fittings, flanges and other obstructions.

Electrical Installations

The rates and prices for plant, equipment and installations are to be all inclusive of supply, installation, testing, commissioning and all associated builders work required for the full operation of such plant, equipment and installations, to comply in all respects with the Specification, Bills of Quantities, Drawings and to the complete satisfaction of the Local Regulatory Body and the Engineer.

The rates in general shall include for the following:

- (i) All cutting, short lengths and small quantities.
- (ii) All joints in the running length and all connections.
- (iii) All considerations arising from the specification.
- (iv) Fixing conduits / cable trays, etc., by approved methods.
- (v) Pipe sleeves through walls.
- (vi) Assembling component parts.
- (vii) Cleaning off all protective wrappers and leaving ready for use.
- (viii) Leaving all equipment etc., clean and in full working order.
- (ix) Draw wires in empty conduits.

- (x) Rates for cable and duct trench excavation shall include for all excavation, bedding, backfill and disposal as required by the Statutory Authority standard specification.
- (xi) Backfilling to trenches with approved excavated material. If the excavated material is not suitable imported fill shall be used.

The Contractor shall include for the supply of manufacturers recommended spares as required by the Specification for all electrical engineering installations and shall submit details of spares to be provided by him on the Schedule of Recommended Spares, including other relevant details.

The cable lengths / routes are measured from point to point on the drawing (horizontal plan distance on the drawing, any cable required for connections, loops, etc., at equipments, appliances, control gear or the like will be deemed to be included.

Multiple Ducts and Cables

The quantity stated in the Bills of Quantities for multiple ducts and cables is the length of a single duct or cable in the particular group of ducts or cables. The Contractor will allow the cost of number of ducts or cables in the rate as appropriate. eg., a qty of 50m against a 3 way 200mm dia duct means that a total quantity of $50 \times 3 = 150\text{m}$ of 200mm duct is to be priced for, ditto for cables.

External Services

The rates for all manholes and the like are to be all inclusive of all costs for the complete construction, in accordance with the specifications, drawings and local authority requirements.

External Works

Where external works are analogous to other sections of the work e.g. excavation concrete etc., the clauses elsewhere shall apply equally to this section of the work.

Kerbing – Rates shall include for construction of concrete bed and lacking, supply and laying of precast concrete kerbs either straight or curved, finishing, curing and protecting building in gratings and frame.

Paved areas (footpaths and roadways) – Rates shall include bedding material, supply and laying of paving slabs including all cutting to fit around manhole covers and the like. Allow for forming patterns and designs in the paving stones all as detailed.

ABBREVIATIONS

In the Specification and Bill of Quantities the following abbreviations have the meanings hereby assigned to them:

British Standards Institution (B.S.I.)	B.S.
Code of practice issued by the B.S.I.	C.P.
American State Highways & Transportation Officials	AASHTO.
American Society for Testing & Materials	ASTM
International Standards Organization	ISO
Local Regulatory Body	L.R.B. or LRB
Asbestos Cement	AC

Diameter	Dia or dia
Drawings	Drg or drg
Extra Over	E.O. or EO
Fiber Cement	F.C. or FC
Glass Fiber Reinforced Plastics	GRP
High Density Polyethylene	HDPE
Medium Density Polyethylene	MDPE
Polyethylene	PE
Polyvinyl Chloride	PVC
Unplasticised Polyvinyl Chloride	upVC or UPVC
Rectangular Hollow Section	RHS
Specifications	Spec.
Provisional Quantity	P.Q.
Quantity	Qty.
Maximum Dry Density	MDD
Ordinary Portland cement	OPC or O.P.C.
Sulphate Resisting Cement	S.R.C. or SR Cement
Prime Cost Rate	P.C. Rate
MANHOLE	MH
Minimum	Min
Maximum	Max
Lump Sum	LS or L.S.
Provisional Sum	PS or P.S.
Horse Power	HP
Kilowatt per hour	Kw/hr
Kilogram	kg or Kg
Kilometer	km or Km
Meter or Linear Meter	M or m or lm or RM or LM
Millimeter	MM or mm
Square Meter	Sq.m. or sq.m or SM or sm or m ² or M ²
Cubic Meter	Cu.m. or cu.m or CM or cm or Cum or cum or m ³ or M ³
Micron	Misc
Number	No. or Each or each

Job	Job
Tonne	t or ton or M.Ton or Ton
Greater than	>
Less Than	<
Equal to or Less than	≤
Equal to or Greater than	≥
Equal to	=

GREEN & ORANGE LINES BRTS, KARACHI
MISCELLANEOUS REPAIR/REPLACEMENT/MAINTENANCE WORKS OF ROAD,
BUILDINGS, ELECTRICAL, HVAC AND MEP WORKS

Contract Package # SMTA/GL&OL/MAINTENANCE/CP-01

SUMMARY OF BILLS

BILL No.	DESCRIPTION	Estimate Cost
1	ROAD WORKS	
2	ANCILLARY WORKS	
3	WATER AND SEWERAGE WORKS	
4	BUILDING WORKS	
5	ELECTRICAL WORKS	
6	PLUMBING AND HVAC	
7	MISCELLENOUS WORKS	
Total Budgeted Cost		300 Million
TOTAL CONSTRUCTION COST		300 Million
PROVISIONAL SUM AMOUNT		
TOTAL COST OF PROJECT		300 Million

Note: The estimated percentage of different bills is

Road Works	5%
Ancillary Works	5%
Water and Sewerage works	5%
Building Works	25%
Electrical Works	30%
Plumbing and HVAC	20%
Miscellaneous Works	10%
	100%

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Item No.	Description	Unit	Unit Rate (Rs.)
	BILL NO. 01; ROAD WORKS		
106c i	Excavate unsuitable or surplus material in all type of Strata	Cum	
108c	Formation of Embankment From Borrow Excavation in Common Material (Sand A3 material)	Cum	
209a	Breaking and Existing Road Pavement structure	Cum	
209b	Scarification of Existing Road Pavement Structure	Sqm	
302a	Bituminous Prime Coat (cut- Back)	Sqm	
303b	Bituminous Tack coat (Emulsified)	Sqm	
305b	Asphaltic concrete for Wearing course (Class B)	Cum	
309b	Cold Milling, 0 - 50mm	Sqm	
510	Dismantling of structure & Obstruction	Cum	
401ali	Concrete Class AI (Underground)	Cum	
401alii	Concrete Class AI (On Ground)	Cum	
401aliiii	Concrete Class AI (Elevated)	Cum	
401a3i	Concrete Class A3 (Underground)	Cum	
401a3ii	Concrete Class A3 (On Ground)	Cum	
401a3iiiii	Concrete Class A3 (Elevated)	Cum	
401b	Concrete Class B	Cum	
401 f	Lean Concrete	Cum	
401gi	Precast Concrete, Class A1	Cum	
401gii	Precast Concrete, Class A3	Cum	

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BILL OF QUANTITIES

Item No.	Description	Unit	Unit Rate (Rs).
404h	Reinforcement As per AASHTO M. 31 Grade 60	Ton	
412 a	Stone Masonry dressed coursed with mortar	Cum	
502 a	Granular Material in bed to Concrete Pipe culvert	Cum	
601 aiii	RCC NEW JERSEY Barriers (in-Situ) for median double face including Reinforcement)	RM	
601 diii	RCC NEW JERSEY Barriers (Precast) for median double face (including Reinforcement)	RM	
RA	PRECAST Kerbs in Concrete Class A-1 of size 300mm x150mmx 300mm inc. BEDDING &I-HAUNCHING	RM	
RA	PRECAST Kerbs in Concrete Class A-1 of size 300mm x150mm x 450mm inc. BEDDING &I-HAUNCHING	RM	
107d	Granular Backfill (Pure Sand only)	Cum	
RA	Paver Blocks 60mm i/c Sand filling, 30mm Thick Bedding and 10mm Lean Concrete complete	Sqm	
RA	Colored Paver Blocks 60mm i/c Sand filling, 30mm Thick Bedding and 10mm Lean Concrete complete	Sqm	

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BILL OF QUANTITIES

Item No.	Description	Unit	Unit Rate (Rs).
	BILL NO. 02 ANCILLARY WORKS		
611b	Iron Grill / Fencing (As per BRTS Standard) as per Drawing complete in all respect.	RM	
02-01	Providing, Fabricating, welding and fixing in position MS Fence comprising 50mm x 75mm x 4mm thick main tube frame with 25mm x 75mm x 3mm thick vertical bars as shown on drawing including all required hardware and epoxy paint of approved color and shades as per manufacturers specification etc. complete in all respect as per drawing, standard, specifications and direction of the Engineer.	RM	

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BILL OF QUANTITIES

Item No.	Description	Unit	Unit Rate (Rs).
	BILL NO. 03; WATER & SEWERAGE WORK		
(Vol-III, Part-III, Chap-III A, Pg-62, Sr. 5)	Excavation for pipe line in trenches, and pits in all kind of soils of murum i/c trimming and dressing sides to true alignment and shape leveling of beds of trenches to correct level and grade, cutting joint holes and disposal of surplus earth within a one chain as directed by Engineer Incharge. Providing fence guards, lights, flags and temporary crossings for non-vehicular traffic where ever required lift upto 5 ft.(1.52m) and lead upto one chain (30.5m)		
i	Lift 0' - 5'	Cum	
ii	Lift 5' - 8'	Cum	
iii	Lift 8' - 11'	Cum	
iv	Lift 11' - 14'	Cum	
	BACKFILL		
Item 24/ Pg.77 Vol-III, Part-III, chap-II	Refilling the excavated material in trenches in 150mm thick layer including watering, ramming to full compaction etc. complete in all respect as per drawing ,specification and as directed by the Engineer/Representative.	Cum	
	DEWATERING		
Item 18(ii)/Pg.75 Vol-III, Part-III, chap-II	Bailing or pumping out sub soil water/or any water accumulated in trenches during excavation, concreting, cast in situ concrete or masonry work in foundation etc. For pipeline, trench volume under water to be measured first time for excavation, second time for cast in situ concrete (Bedding in pipeline) and third time for pipe laying.	Per Day	
	PLAIN CEMENT CONCRETE		
Item 5(f) /Pg.16 Chp 4 Vol-III, Part-II	Cement Concrete Plain including placing compacting finishing and curing complete in all respect as per drawing and approval of the Engineer/Representative.		
a	Lean (1:4:8)	Cum	
b	Concrete Pipe Encasement (Ratio 1:2:4)	Cum	
c	Thrust Blocks (Ratio 1:2:4)	Cum	
d	Pump Pad Cement Concrete (Ratio 1:2:4)	Cum	
(Vol-III, Part-II, Chap-4, Pg-18, Sr. 19-b, ii)	Erection and removal of centering for R.C.C or plain cement concrete works of Partal wood		
(i)	Vertical	Sqm	
	REINFORCED CEMENT CONCRETE		
(Vol-III, Part-II, Chap-4, Pg-16, Sr. 6a)	Reinforced Cement concrete including all labor and material except the cost of steel reinforcement and its labor for bending and binding which will be paid separately. this rate also includes all kind of forms molds, lifting shuttering curing rendering and finishing the exposed surface (including screening and washing of shingle)		
	Ratio 1:2:4 (For A1 Concrete)	Cum	
a	Precast reinforced cement concrete		
(i)	Ratio 1:2:4 (For Precast concrete class A1)	Cum	

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BILL OF QUANTITIES

Item No.	Description	Unit	Unit Rate (Rs).
	CARRIAGE OF MATERIAL		
(Vol-I, Part-I, Chap-1, Pg-1, Sr. 1)	Cartage of excavated material earth work wet silt building material rubbish murrum earth including loading and unloading lead upto 7 miles		
	1st Mile	Cum	
	2nd Mile	Cum	
	3rd Mile	Cum	
	4th Mile	Cum	
	5th Mile	Cum	
	6th Mile	Cum	
	After 7th Mile and every Sub-sequent Miles	Cum	
	DISMANTLING OF CEMENT CONCRETE		
Vol-III, Part-II, Chap-II, Pg-10, Sr. 19c (General)	Dismantling of cement concrete plain (Ratio 1:2:4)	Cum	
	BITUMEN COATING		
Item 9/ Pg.71, Chap-11, CSR2012	Bitumen coating to plastered or cement concrete surface, complete in all respect, as per specifications & relevant drawings and all works to the entire satisfaction of the Engineer/Representative.	Sqm	
	WATER STOPPER		
Item-2 /Pg.56, Vol-III, Part-III, CSR2012	Providing and fixing expansion /construction joint in concrete work of 9" or 225mm wide corrugated PVC water stop (with bulb) i/c soldering and cost of the material and labor etc. complete in all respects as per standard specification, drawing and entire satisfaction of the Engineer.	RM	
	PLASTER WORKS		
Item-11(c,d) /Pg.52, chptr-09 CSR2012	Cement Plaster (1:4) for Internal R.c.c Wall , R.c.c Bed Slab and R.c.c Top Slab (3/4"thick)	Sqm	
	Cement Plaster (1:4) for Pump Room Block Masonry	Sqm	
	BLOCK MASONARY		
Item 9/ Pg.17, Chap-4, CSR2012	Precast concrete solid or face Block including cost of temples. complete in all respect as per drawing and as directed by the Engineer/Representative.	Cum	
	IRON WORK		
Item 24/ Pg.92, chptr17-CSR2012	Making and fixing steel grated door and windows with 1/16" thick sheeting including angle iron frame 2" x 2" x 3/8" and 3/4" square bars 4" center to center with locking arrangement.	Sqm	
	CAST IRON COVER		
	C.I cover (Hinged) with frame size (600mm x 600mm) ,65kg etc.	Each	

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BILL OF QUANTITIES

Item No.	Description	Unit	Unit Rate (Rs).
	PIPES (M.S)		
Item H/ Pg., chptr2- CSR2012	Manufacturing, Supplying & fixing black steel M.S pipe made out of M.S sheet confirming to API 5L grade X-42 spirally welded & externally asphalt coated with fiber Glass 5mm thick (3 Layers) & Internally C.C lining 8mm thick (AWWA specification) i/c laying jointing with helical welding in trenches I/C cost of bends of any degree & testing with water specified pressure (Spirally welded), complete in all respect as per drawing and as directed by the Engineer/Representative.		
II	6.4mm thick		
a)	12"	R.M	
b)	16"	R.M	
d)	18"	R.M	
e)	24"	R.M	
III	7.1mm thick		
	24"	R.M	
IV	7.9mm thick		
a)	26"	R.M	
V	8.74mm thick		
a)	30"	R.M	
b)	32"	R.M	
VI	9.50mm thick		
a)	36"	R.M	
VIII	10.31mm thick		
a)	48"	R.M	
	PIPES (H.D.P.E)		
Item F/ Pg., chptr2- CSR2012	Providing, Laying & Fixing in trench i/c fitting, jointing & testing etc. complete in all respect the high Density Polyethylene PE pipe (HDPE-100) for W/S confirming ISO 4427/DIN8074/8075 B.S 3580 & PSI 3051, complete in all respect as per drawing and as directed by the Engineer/Representative.		
	PN-10		
a)	25 mm	R.M	
b)	32 mm	R.M	
c)	40 mm	R.M	
d)	50 mm	R.M	
e)	63 mm	R.M	
f)	75 mm	R.M	
g)	90 mm	R.M	
h)	110 mm	R.M	
i)	125 mm	R.M	
j)	140 mm	R.M	
k)	160 mm	R.M	
l)	180 mm	R.M	
m)	200 mm	R.M	
n)	225 mm	R.M	
o)	250 mm	R.M	
p)	280 mm	R.M	
q)	315 mm	R.M	
r)	355 mm	R.M	
s)	400 mm	R.M	
t)	450 mm	R.M	

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Item No.	Description	Unit	Unit Rate (Rs).
u)	500 mm	R.M	
v)	560 mm	R.M	
w)	630 mm	R.M	
x)	710 mm	R.M	
y)	800 mm	R.M	
z)	900 mm	R.M	
aa)	1000 mm	R.M	
ab)	1200 mm	R.M	
ac)	PN-8		
ad)	160mm	R.M	
af)	200mm	R.M	
ag)	250mm	R.M	
	PIPES (U.P.V.C)		
Item F/ Pg., chptr2- CSR2012	Providing PVC Pipes of Class "B" (equivalent make) fixing in trench i/c cutting fitting and jointing with "Z" joint with one rubber ring i/e testing with water to head of 61 meter or 200 ft, complete in all respect as per drawing and as directed by the Engineer/Representative.		
a)	80mm 3"dia)	R.M	
b)	100mm 4"dia)	R.M	
c)	125mm 5"dia)	R.M	
d)	150mm 6" dia)	R.M	
e)	200mm 8" dia)	R.M	
f)	250mm 10" dia)	R.M	
g)	300mm 12"dia)	R.M	
i)	350mm 14" dia)	R.M	
j)	400mm 16" dia)	R.M	
k)	450mm 18" dia)	R.M	
l)	500mm 20" dia)	R.M	
m)	600mm 24" dia	R.M	
2	Providing, Laying UPVC Pressure Pipes of Class "C" (equivalent make) fixing in trench i/c cutting fitting and jointing with "Z" joint with one rubber ring i/e testing with water to head of 91.5 meter or 300 ft., complete in all respect as per drawing and as directed by the Engineer/Representative.		
a)	50mm 2" dia	R.M	
b)	80mm 3"dia)	R.M	
c)	100mm 4"dia)	R.M	
d)	125mm 5"dia)	R.M	
e)	150mm 6" dia)	R.M	
f)	200mm 8" dia)	R.M	
g)	250mm 10" dia)	R.M	
h)	300mm 12"dia)	R.M	
i)	350mm 14" dia)	R.M	
j)	400mm 16" dia)	R.M	
k)	450mm 18" dia)	R.M	
l)	500mm 20" dia)	R.M	
m)	600mm 24" dia	R.M	

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3	Providing, Laying UPVC Pressure Pipes of Class "D" (equivalent make) fixing in trench i/c cutting fitting and jointing with "Z" joint with one rubber ring i/e testing with water to head of 122 meter or 400 ft., complete in all respect as per drawing and as directed by the Engineer/Representative.		
a)	25m 1" dia	R.M	
b)	31mm 1¼" dia	R.M	
c)	38mm 1½" dia	R.M	
d)	50mm 2" dia	R.M	
e)	80mm 3" dia)	R.M	
f)	100mm 4" dia)	R.M	
g)	125mm 5" dia)	R.M	
h)	150mm 6" dia)	R.M	
i)	200mm 8" dia)	R.M	
j)	250mm 10" dia)	R.M	
k)	300mm 12" dia)	R.M	
l)	350mm 14" dia)	R.M	
m)	400mm 16" dia)	R.M	
4	Providing Laying and jointing RCC pipes (Rubber Gasket		
	Providing, Laying RCC pipes of A.S.T.M. C-76-62. T/C-76-70. class II wall B and fixing in trench. i/c cutting, fitting, and jointing with rubber ring i/c testing water to specified pressure.		
a)	200 mm (8" dia)	R.M	
b)	300mm 12" dia)	R.M	
c)	375mm 15" dia)	R.M	
d)	450mm 18" dia)	R.M	
e)	525mm (21" dia)	R.M	
f)	600mm 24" dia)	R.M	
g)	750mm 30" dia)	R.M	
h)	825mm 33" dia)	R.M	
i)	900mm 36" dia)	R.M	
j)	1050mm 42" dia)	R.M	
k)	1200mm 48" dia)	R.M	
l)	1350mm 54" dia)	R.M	
m)	1500mm 66" dia)	R.M	
5	RCC VALVE CHAMBERS		
	Construction of RCC Valve Chambers of dimensions as shown below and as mentioned in drawings including cost of RCC Works with Steel Reinforcement & Shuttering, Internal Plaster, External Bitumen Coating, cast iron cover with frame also including cost of labor and all work should be as per drawings & Specifications and to the entire satisfaction of the Engineer/Incharge.		
a)	2.4 m x 2.4 m x 2.5m	Nos	
b)	1.6 m x 1.6 m x 2.5m	Nos	

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6	STONE SOLING		
	Providing and laying stone soling from approved quarry including handpacking & filling voids with stone metals, consolidating & compacting with powerroller,etc ,complete in all respect, as per specifications ,relevant drawings, all works to be carried out to the entire satisfaction of the Engineer/Incharge.	Sqm	
7	M.S PIPE		
a)	1219.20 mm (48") I.D	RM	
b)	406.40 mm (16") I.D	RM	
c)	323.85 mm (12.75") I.D	RM	
d)	152.4 mm (6") I.D	RM	
7.1	M.S PIPE SLEEVES		
	Manufacturing, supplying and laying/fixing black steel M.S Pipe made out of M.S sheet conforming to DIN 30670/ or equivalent standard and externally 3 layers of poly ethylene tap coating and internally C.C lining as per AWWA (American Water Works Association) Specification i/c laying, jointing with shield metal Arc welding (SMAW) in trenches and testing with water specified pressure for different dia of pipes as below, complete in all respect as per drawing and as directed by the Engineer/Representative.		
a)	273.05 mm (10.75") I.D X 5.6 mm WT	RM	
7.2	M.S FITTINGS		
	Manufacturing, supplying and fixing M.S fittings made out of M.S sheet conforming to DIN 30670 /or equivalent standard and externally 3 layers of poly ethylene tap coating and internally C.C lining, including jointing fabrication of bends/tees will be through shield metal Arc welding (SMAW) process, testing and inspection as per AWWA (American Water Works Association) standards, complete in all respect as per drawing and as directed by the Engineer/Representative.		
7.2.1	TEES (Equal)		
a)	1219.20 mm (48") I.D (Header)	Nos	
b)	914.4 mm (36") I.D (Header)	Nos	
c)	406.40 mm (16") I.D (Header)	Nos	
d)	323.85 mm (12.75") I.D (Header)	Nos	
e)	MS Tee 4" x 4" x 4"	Nos	
7.2.2	TEES (Unequal)		
a)	1219.20 mm (48") I.D (Header)	Nos	
b)	323.85mm (12.75") I.D (Header)	Nos	
7.2.3	BENDS		
a)	1219.20 mm (48") I.D (45° bend)	Nos	
b)	406.40 mm (16") I.D (45° bend)	Nos	
c)	323.85 mm (12.75") I.D (45° bend)	Nos	
7.2.4	EXTRA BENDS		
a)	HDPE 12" Dia	Nos.	

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Item No.	Description	Unit	Unit Rate (Rs).
8	PUDDLE FLANGE		
	Providing and fixing M.S puddle flange of the following diameters, complete in all respect as per drawing and as directed by the engineer.		
a)	152.4 mm (6") I.D	No	
b)	406.40 mm (16") I.D	No	
c)	MS Flange 4" x 4" x 4"	No	
9	STEEL LADDER		
	Providing and fixing epoxy coated M.S ladder rungs (20 mm Dia)	RM	
10	RELOCATION OF GATE VALVE		
	Relocating, fixing, jointing of Existing Flanged Gate valve including		
a)	1219.20 mm (48") I.D	L.S	
11	GATE VALVE		
	Providing, fixing, jointing and testing of Flanged Gate valve of		
a)	406.40 mm (16") I.D	No	
b)	323.85 mm (12.75") I.D	No	
c)	152.4 mm (6") I.D	No	
12	AIR RELEASE VALVE		
	Supplying, installing, jointing and fixing C.I Air Valve (Double		
a)	100 mm (4") I.D	No	
b)	75 mm (3") I.D	No	
13	SLUICE VALVE		
a)	100mm dia (4")	No	
b)	300mm dia (12")	No	
c)	450mm dia (18") Heavy Pressure	No	
14	MS DHOLKI		
a)	4" Dia	No	
b)	6" Dia	No	
c)	8" Dia	No	
d)	12" Dia	No	
15	MS TAIL PIECE		
a)	4" Dia	No	
b)	6" Dia	No	
c)	8" Dia	No	
d)	MS Inspection TEE 30" dia	No	

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Item No.	Description	Unit	Unit Rate (Rs).
16	MS REDUCER		
a)	825mm to 450mm (33" to 18")	No	
b)	450mm to 400mm (18" to 16")	No	
17	NON RETURN VALVE		
	Provide and install imported flanged non return valve with flanges		
a)	152.4 mm (6") O.D	No	
18	BUTTERFLY VALVE		
	24"	No	
	32"	No	
	36"	No	
19	MS FLANGE FOR BUTTERFLY VALVE		
	32"		
	36"		
20	MS NECK		
	32"	No	
	36"	No	
21	BLIND FLANGES		
	36"	No	
22	CHAIN PULLEY		
	Providing, installation and testing of lifting devices i.e. hoists	Set	
23	RELOCATION AND INSTALLATION OF PUMPS AND MOTORS		
	Removal and shifting of pumps, motors and all fittings from existing pump room to newly constructed pump room and installation with all	L.S	

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Item No.	Description	Unit	Unit Rate (Rs).
24	R.C.C VALVE CHAMBER		
	Construction and making of RCC Valve chamber of size as shown		
a)	3.0 m x 3.0m	No	
b)	2.4 m x 2.4 m x 2.5m	No	
c)	1.5m x 1.5m	No	
d)	1.6 m x 1.6 m x 2.5m	No	
25	Winching		
a)	12"	RM	
b)	18"	RM	
c)	24"	RM	
d)	30"	RM	
e)	33"	RM	
f)	36"	RM	
g)	42"	RM	
h)	48"	RM	
i)	60"	RM	
j)	66"	RM	
k)	72"	RM	
26	Removal of Debris/Garbage (Lead up to 20 Km)	Cum	
27	Desilting/Cleaning of Existing Nallah	Cum	
28	Repair Work		
a)	and dewatering)	Each	
b)	Repair Leakage of 304mm 12" Dia MS Pipe Line (excl. excavation and dewatering)	Each	
c)	Repair Leakage of 457mm 18" Dia MS Pipe Line (excl. excavation and dewatering)	Each	
d)	Repair Leakage of 600mm 24" Dia MS Pipe Line (excl. excavation and dewatering)	Each	
e)	Repair Leakage of 762mm 30" Dia MS Pipe Line (excl. excavation and dewatering)	Each	
f)	Repair Leakage of 1650mm 66" Dia MS Pipe Line (excl. excavation and dewatering)	Each	

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	BILL NO. 04 : BUILDING WORKS		
04-1	Excavation:- for foundation of columns walls etc in all kind of soil (Loose are hard) and rock upto any depth and lead with shoring and shuttring if required including back filling of excavated earth In foundation trenches---	Cum	
04-2	Earth filling from out side :- Providing and filling earth under floors or where required will approved earth from out side sources in layers not exceeding 200 mm in depth i/c breaking of clods leveling dressing -- as directed by the engieer.	Cum	
04-3	Provide and apply cementitious membrane AQUAFIN 2K/M / BASF / SIKA or equivalent approved water proofing over RCC concrete slabs and walls of any wet area (at any height in any floor) etc. complete as per manufacturer's specifications and to the entire satisfaction of the Engineer.	SQM	
04-4	Concrete Work:- Concrete 1:4:8 Lean Concrete below footing and under plinth Beam Beam	Cum	
04-5	Concrete 1:3:6 situ concrete (8" Thick) below Plinth Beam	Cum	
04-6	Reinforcement Cement Concrete:- Providing and placing straight or curved cast in place designed mix reinforcement concrete erecting / removing steel work leveling unbroken concrete joint		
a	Isolated Footing	Cum	
b	Stem Columns	Cum	
c	Plant Beam	Cum	
d	Super Structure Columns	Cum	
e	Slab Beam	Cum	
f	Slab	Cum	
04-7	Stone Soiling. Providing and laying stone from approved quarry including hand packing and filling voids with stone metals consolidating and compacting with power roller etc. complete in all respect as per specification relevant drawing all works to be carry	Cum	
04-8	Bitumen Coating:- Providing and applying industrial bitumen plain coating mixed with water component 2 coats on all RCC Structural directed by the engineers.	SQM	
04-9	External Paint Weather Shield:- Providing and applying 3 coat of weather shield paint approved mustered color shade texture directed by the engineers.	SQM	
04-10	Screed Floor:- Providing and laying cement concrete screed floor 1:2:4 to be laid directed by the engineers.	SQM	
04-11	Door and windows:- Making and fixing steel graded door with 1/16" thick sheeting i/c angle directed by the engineer		
a	Door	SQM	
b	Windows	SQM	

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Item No.	Description	Unit	Unit Rate (Rs).
	BILL NO. 04 : BUILDING WORKS		
04-12	Providing and Applying enamel paint (first & Subsequent coat) in position doors windows and ventilators any type at any floor and height etc. complete in all respect as per drawing and specification and to the entire satisfaction of the engineers. Doors and windows paint.	SQM	
04-13	DPC:- Providing and laying DPC 1:2:4 thick laid in proper level mixed with Pudlo 5 LBS per beg or other approved material over plinth directed by the engineers.	SQM	
04-14	Block Masonry:- Providing and laying solid concrete block wall having minimum strength 1000 to 1500 PSI to be laid in 1:4 Cement sand directed by the engineers.	Cum	
04-15	Plastering:- Providing and applying 12mm thick 1:6 cement sand plaster on ceiling, staircase (waist slab, landings & steps) etc. using expanded metal mesh on joints, electrical conduits, corner beads, chamfered edges, rounding off corner etc. including MS Plaster stop as per drawings on edges and corners etc. scaffolding, curing etc. complete in all respects, as per specification, relevant drawings and as directed by Engineer.	SQM	
04-16	Internal Flooring:- Providing and laying 3" thick pack grey cement screed concrete 1:2:4 floor temped finish as per drawing directed by the engineers.	SQM	
04-17	Providing and applying painting on all internal ceiling surface with Matt Enamel Paint of approved shade three coats over and including a coat of primer over plastered surface at any height in any floor including preparation of surface, filling depression with putty, rubbing, sand papering and cleaning etc. complete in all respects as per standard specification, drawing and entire satisfaction of the Engineer.	SQM	
	(Structure, Architecture & Allied Works)		
	All items under this head (Structure, Architecture & Allied Works) to be Carried out as per Specifications, Drawings, relevant BSI/ASTM Standards, and complete in all respect and to the entire satisfaction of the Engineer.		
4-18	Providing, cutting, fabricating, erecting, placing & installation, fixing in position of non-structural light gauge cold formed hot dipped galvanized steel parts/structure (Design built for mezzanine floor of BRTs station) with complete engineering design as per standard design criteria, method statement, shop drawings, all design calculations, and drawings to be submitted to the engineer and local authority for the approval (without any additional cost) including supplying complete 3 Nos or required sets of the design & drawing to the Engineer plus all sets to the local authority as per it's requirements. The engineering design to follow all architectural intent and details as shown in drawings (Dry partition wall/wall cladding, Decking sheet etc.) including all connections, accessories & all required hardware & materials, complete in all respects the.		
(I)	LGS Structure Complete with fall ceiling roof	Sqm	

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Item No.	Description	Unit	Unit Rate (Rs).
	BILL NO. 04 : BUILDING WORKS		
	METAL WORKS		
4-19	Providing, fabricating and fixing Aluminum frame glass door openable/sliding comprising of colored anodized premium quality aluminum sections of Pakistan Cable or equivalent approved manufacturers with 8mm thick tempered glass by (Pilkington / Emirates glass or approved equivalent), including all fixing arrangement & required hard wares such as floor hinges, locking arrangements, handles etc., whether strips, Caulking with caulking compound etc. complete in all respect as per drawing, standard, specifications and direction of the Engineer. (Note: minimum wall thickness for all sections shall be 2mm and width will not be less than 4" wide or according to the design).	Sqm	

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Item No.	Description	Unit	Unit Rate (Rs).
	BILL NO. 04 : BUILDING WORKS		
4-20	Providing, fabricating and fixing of approved colored anodized Aluminum windows openable or fixed, premium quality aluminum sections of Pakistan Cable or approved equivalent with 8mm thick tempered glass by (Pilkington or Emirates glass or approved equivalent) fixed on Rcc & masonry surface, fitted in Neoprene Gaskets including all required hardware, pivots heavy duty handles, locks, stays etc. Including silicon sealant to all external junction beam structure and windows to give water / wind proof seal. Complete in all respect as per drawings, specifications and to the entire satisfaction of the Engineer. (Note: minimum wall thickness for all sections shall be 2mm and width will not be Less than 4" wide or according to the design).		
(i)	Fixed glass window with aluminum framing.	Sqm	
4-21	Providing, making, fabricating, erecting and fixing in position MS Louvers Door/ Window / Ventilator comprising comprising of (flat and angle iron, M.S. sheet covering, hold fast, and any other sections of approved design) with all accessories and locking arrangement including approved epoxy spray paint etc., complete in all respect, as per specifications & relevant drawings and all works to be carried out the satisfaction of the Engineer. (at any height in any floor)	Kg	
4-22	Providing, fabricating, welding & fixing in position MS hallow metal door comprising 35mm x 100mm main tube frame with MS molded V.grooved sheet as shown on drawing, including door locks & hold fast and all required hard wares and epoxy spray paint of approved color & shades as per manufacturer's specification etc., complete in all respect as per drawing, standard, specifications and direction of the Engineer.		
i	The contractor shall submit shop drawings (without any additional cost) for approval prior to start of work.	Kg	
4-23	Providing, fabricating, welding & fixing in position MS Grill Door comprising M.S tube framing as shown on drawing, including all required hard wares, locking arrangement and epoxy spray paint of approved color & shades as per manufacturer's specification etc., complete in all respect as per drawing, standard, specifications and direction of the Engineer.		
	The contractor shall submit shop drawings (without any additional cost) for approval prior to start of work.	Kg	
4-24	Providing, fabricating, welding & fixing in position Stainless Steel railing SS grade 304, comprising 50mm dia SS pipe hand rail, 30mm dia intermediate rail & 50mm dia balustrades as shown on Drawing including all fixing arrangement with SS hardware etc, complete in all respects as per drawing, standard, specifications and direction of the Engineer.		
	The contractor shall submit shop drawings (without any additional cost) for approval prior to start of work.	Rm	

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Item No.	Description	Unit	Unit Rate (Rs).
	BILL NO. 04 : BUILDING WORKS		
4-25	Providing and fixing Porcelain tiles Dado / Cladding of approved make, color & size with borders, patterns and design at any floor including 1:4 screed bed mortar with Dry Bond including jointing with grouting material, of approved quality (overall thickness as shown in the drawings) complete in all respects, as per drawings, specifications and as directed by the Engineer.	Sqm	
4-26	Providing and fixing Porcelain tile Skirting 150mm high with 1:6 cement sand mortar with Dry Bond of approved color shade including cutting, jointing with cement slurry, grouting with routing materials, curing (overall thickness as shown in the drawings) etc., complete in all respects as per specifications, Drawings and instructions of the Engineer.	Rm	
4-27	Providing, laying and fixing Porcelain tiles of approved make, color & size on floor as per the finishing schedule with borders, patterns & design in any floor including 1:6 leveled screed bedding mortar, fixing with Dry Bond, chipping, cutting, jointing and grouting material of approved quality (overall thickness as shown in the drawings) complete in all respect, as per drawings, specifications and as directed by the Engineer.		
(i)	Porcelain tiles size 600 x 600mm.	Sqm	
(ii)	Porcelain tiles size 600 x 300mm.	Sqm	
4-28	Providing, cutting and fixing in position 12mm thick Cement Board of approved size, shape & design for partition where required at any height/ floor, including filling the grooves of approved material with matt enamel paint, complete as per manufacturer's specification, including all required hardware's for fixing etc., all respect as per drawing, standard, specifications and direction of the Engineer.	Sqm	
4-29	Providing and applying 12mm thick 1:6 cement sand plaster on internal walls, columns, beams, lintels etc. using expanded metal mesh on joints, electrical conduits, corner beads, chamfered edges, rounding off corner etc. including scaffolding, including MS Plaster stop as per drawings on edges and corners etc. complete in all respects as per specification, relevant drawings and as directed by Engineer.	Sqm	
4-30	Providing, fabricating and installing imported Fire Rated Cement Board Ceiling of approved size, thickness, color and shape with 3 coats of enamel paint, moisture resistant false ceiling as shown on the drawing including metal framing suspension system, required hard wears etc., all cutting for light fixers & other design feature etc., complete in all respect, as per drawings, specifications and or as directed by the consultant / Engineer.	Sqm	

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	BILL NO. 04 : BUILDING WORKS		
4-30	Providing, fabricating and installing imported Fire Rated Cement Board Ceiling of approved size, thickness, color and shape with 3 coats of enamel paint, moisture resistant false ceiling as shown on the drawing including metal framing suspension system, required hard wears etc., all cutting for light fixers & other design feature etc., complete in all respect, as per drawings, specifications and or as directed by the consultant / Engineer.	Sqm	
4-31	"Providing, fabricating and installing of Gypsum tiles false ceiling including Gypsum board border comprising of Gypsum board tiles 2'-0" x 2'-0" x 1/2" thick and Gypsum board (4'-0" x 8'-0" x 1/2" thick) border, Elephant brand or approved equivalent false ceiling including Bulkheads, light pelmets etc., adjustable metal framing suspension system, jointing tap etc., including all required hard ware & fixing arrangement, all cutting holes for light fixtures & other design feature, providing & applying three coat of matt enamel paint of approved make & color shade over and including one coat of primer over Gypsum board, filling putty etc., in any floor & any height, complete in all respects as per drawings, relevant specifications and as directed by the Engineer.	Sqm	
4-32	Providing and fixing in position Dock Rubber Bumbler size & thickness mentioned in the drawing (Typical Dock detail), complete with all required fixing arrangement etc., complete in all respect as per drawing, specification and direction of the Engineer.	Rm	
4-33	Providing, laying and fixing full body Matt Porcelain tiles of approved make, color & size on floor as per the finishing schedule with borders, patterns & design in any floor including 1:6 leveled screed bedding mortar, fixing with Dry Bond, chipping, cutting, jointing and grouting material of approved quality (overall thickness as shown in the drawings) complete in all respect, as per drawings, specifications and as directed by the Engineer.		
(i)	Directional tiles size 300 x 300mm x 15mm.	Sqm	
(ii)	Warning tiles size 300 x 300mm x 15mm.	Sqm	
4-34	Providing, fabricating and installing metal Egg crate Ceiling panels size 600 x 600 mm of THERMEC or approved equivalent, comprising of U-Shaped Steel sections , cell size 100 x 100 mm height 40 mm in stoved enamel white finish complete with adjustable hangers and edge trims. as shown on the drawing including all required hard wears etc., all cutting for light fixers & other design feature etc., complete in all respect, as per drawings, specifications and or as directed by the consultant / Engineer.	Sqm	

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	BILL NO. 04 : BUILDING WORKS		
4-35	Providing, fabricating, welding & fixing in position MS Gate comprising of M.S tube, angle iron, base plats or any other sections (ASTM-A500) as shown in the drawing including locking arrangement, heavy duty bearing wheels with track etc., including all required hard wares, including epoxy spray paint finish with primer of approved color & shades as per manufacturer's specification etc., complete in all respect as per drawing, standard, specifications and direction of the Engineer. The contractor shall submit shop drawings (without any additional cost) for approval prior to start of work.	Kg	
4-36	Providing, making and fixing 50mm thick Pre-cast C.C Ledge 250mm wide of approved design & shape as shown in drawing, fixing with mortar 1:4, maintaining proper line & level etc., at any height & in any floor where required, as per drawing complete in all respect as per drawing, specifications and direction of the Engineer.	Rm	
4-37	Providing, cutting, fabricating, erecting, placing and installing, fixing in position G.I Corrugated Sheet (Preprinted) having minimum yield strength of 36 ksi, or where required and confirming to ASTM A36, ASTM A325 or equivalent, ASTM A307, ASTM A563, ASTM A570, including cost of J hooks and bolts in any floor, including the cost of scaffolding, platforms & winches etc. The contractor shall submit coordinated and checked shop drawings (without any additional cost) for approval prior to the start of the work etc. complete in all respects as per drawing, standard, specifications and as directed by the Engineer.	Sqm	
4-38	Providing & laying complete water proofing treatment, laying 1" thick average levelling CC screed over Rcc slab & Water proofing membrane Sheet with Re-fixing Tuff Paver complete in all respect.	Sqm	
	Removal of rusting for M.S steel work (at M.S tube, pedestrail plate form deck and stairs structure,cable tray etc. With Red Oxide complete in all respect by the engineer (for Removal of Rusting)	Sqm	
	Providing and fixing porcelain tile,warning tile ,directional tile work complete in all respect by the engineer (some portion damaged at station of floor.wall and skirting etc, for some portion damaged .	Sqm	
	Providing and applying painting on internal & external surface with epoxy paint approved manufacturer's according to the finishing schedule color, shade, borders, including a coat of primer over existing door,m.s tube ,steel structure surface at any height, including, preparation of surface, filling depression with putty, rubbing, sand papering and cleaning etc. complete in all respects as per standard specification, drawing and entire satisfaction of the engineer (at m.s tube,hand rail,,portal psd door tube and pedestrail plate form deck and stairs structure,cable tray etc.complete in all respect. (for steel structure)	Sqm	
	Providing and fixing of tempard glass thickness 8 mm etc. complete in all respects as per standard specification, drawing and entire satisfaction of the engineer	Sqm	
	Providing and fixing of cable tray cover size 0.30 cm etc. complete in all respects as per standard specification, drawing and entire satisfaction of the engineer	R.M	

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Item No.	Description	Unit	Unit Rate (Rs).
	BILL NO. 04 : BUILDING WORKS		
	Providing and fixing of rubber bumper etc. complete in all respects as per standard specification, drawing and entire satisfaction of the engineer	R.M	
	Providing and fixing of corrugated sheet etc. complete in all respects as per standard specification, drawing and entire satisfaction of the engineer	S.M	
	Providing and fixing of heavy duty with iron frame manhole cover. complete in all respects as per standard specification, drawing and entire satisfaction of the engineer	Each	
	Providing and applying paint with text on sign board . complete in all respects direction as per standard specification, drawing and entire satisfaction of the engineer	S.M	
	Providing and fixing some repairing and replacement of credenza . complete in all respects direction as per standard specification, drawing and entire satisfaction of the engineer	Job	
	Providing an some revolving chairs for ticketing both . complete in all respects direction as per standard specification, drawing and entire satisfaction of the engineer	Each	
	Providing and fixing chequerd plate 6mm thickness . complete in all respects direction as per standard specification, drawing and entire satisfaction of the engineer	K.G	
	Providing ,installation an fixing of m.s louver. complete in all respects direction as per standard specification, drawing and entire satisfaction of the engineer	K.G	
	Providing and fixing treatment of chequered plate of pedestrail stairs. complete in all respects direction as per standard specification, drawing and entire satisfaction of the engineer	K.G	
	Providing and applying painting on internal & external surface with weather paint approved manufacturer's according to the finishing schedule color, shade, borders, including a coat of primer over existing door surface at any height, including, preparation of surface, filling depression with putty, rubbing, sand papering and cleaning etc. complete in all respects as per standard specification, drawing and entire satisfaction of the engineer (required at over all corridor , etc,)		
	a) From Station no. 1 to 21	S.M	
	b) Board Office Interchange	S.M	
	Providing and fixing new handel door lock.	No	
	Repairing of handel door lock in any location.	No	
	Repairing/restoration of false ceiling at ticketing booth.	S.M	
	Providing and laying first class solid block masonry in cement sand mortar 1:6 regular in shape and size with sharp and square and corner		
	a) 150mm thick Wall	Cu.m	
	Making opening in 6" thick wall for Exhaust Fan. Finishing, Painting complete.	No	
	Providing and applying 12mm thick 1:6 cement sand plaster on internal walls, columns, beams, lintels etc. using expanded metal mesh on joints, electrical conduits, corner beads, chamfered edges, rounding off corner etc.	S.M	
	Providing & fixing of Glass blocks of approved size with approved Pattern of approved manufacturer or approved equivalent, including all fixing arrangement & required hard wears etc.	No	

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	BILL NO. 04 : BUILDING WORKS		
	Providing, cutting and fixing in position Cement Board of approved size, shape & design for partition where required at any height/ floor, including filling the grooves with approved material, complete as per manufacturer's specification, including all required hardware's for fixing etc, all respect as per drawing, standard, pecifications and direction of the Engineer.	S.M	
	Providing, fabricating, welding & fixing in position G.I hallow metal door Frame comprising 35mm x 100mm with G.I molded sheet as shown on drawing, including refixing door locks & hold fast and all required hard wares and epoxy paint of approved colour & shades as per manufacturer's specification etc.	No	
	Providing, cutting and fixing in position Cement Board of approved size, shape & design for partition where required at any height/ floor, including filling the grooves with approved material, complete as per manufacturer's specification, including all required hardware's for fixing etc.	S.M	
	Servicing / repair of ATS panel at generators	Nos	
	Acrylic signs board	Nos	
	3M signage boards	Nos	
	IT room tactile sheets Funiture (counters)	S.M	
	IT room PVC sheets Funiture (counters)	S.M	

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Item No.	Description	Unit	Unit Rate (Rs).
	BILL NO. 05; ELECTRICAL WORKS		
	11 KV cable, maintenace, replacement of faulty pieces etc	Rm	
	11 KV Joint Kit, maintenace, replacement of faulty pieces etc	Nos.	
5-1-1	Providing, installing, testing and commissioning of following Tubular lighting pole, hot dipped Galvanized from inside and outside with 4mm wall thickness including base plate anchor bolt, nuts and washer, self inspection door with special keys, cable connection box etc.,as per specification and drawings.Complete in all respects.		
a	10 m High Single Arm Pole	Nos.	
b	10 m High Double Arm Pole	Nos.	
c	10 m & 6 m High Double An-n Split Type Pole	Nos.	
d	12M High Single Arm Tubular Pole (Local)	Each	
e	12M High Double Arm Tubular Pole (Local)	Each	
f	12M High Triple Arm Tubular Pole (Local)	Each	
g	Removal of existing poles (10 and 12m high)	Each	
h	Double Arm Bracket and Split Type 60mm dia, 2m long or existing pole	Each	
i	Single Arm Bracket and Split Type 60mm dia, 2m long or existing pole	Each	
05-1-2	Dismantling and shifting of existing light poles and traffic signals	Each	
05-1-3	Providing, installing, testing and commissioning of Terminal Box IP 65 including 1 No. 4A Circuit Breaker with terminals,as per specification and drawing, complete in all respect.	Nos.	
05-1-4	Providing, installing, testing and commissioning of 140 W LED, min. Luminous Flux 15500,Surge Protection min.15kV (IP-66) street light fixture , complete in all respects,os per specification and drawing. Lighting fixture samples must be submitted to Consultant for approval.	Nos.	
05-1-5	Providing, Installing, testing and commissioning of 90W LED (IP-66) Tunnel Light fixture for under Bridge lighting, surface mounted including Bracket.Complete in all respect, as per specification and drawing. Lighting fixture samples must be submitted to Consultant for approval.	Nos.	
05-1-6	Epoxy etch paint primer 10 to 15 microns for surface preparation and two coats of ultrabuild or approved epoxy liner upto 150microns, one coat shall be apply after installation at site as per approved color shade.	Nos.	

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Item No.	Description	Unit	Unit Rate (Rs).
05-1-7	Providing, installing, testing and commissioning of weather proof Pole mounted, Lighting Control Panel (LCP), as per drawing and specifications, all respect	Nos.	
05-1-8	Construction and Installation of Pole foundation in concrete class "A", reinforcement as per AASHTO M31, lean concrete etc., Excavation and backfilling for the Pole foundation shall be included in this job. Complete in all respects , as per specications and drawings,to the entire satisfaction of Engineer.	Nos.	
5-2-1	L.V. DISTRIBUTION BOARDS		
5-2-1	Supply, installation, testing and commissioning of following wall mounted surface type Main Distribution Board Form 4b Type-4 (MDB), Sub Main Distribution Boards (SMDB's)/ Distribution Board (DB's) made with 16 SWG sheet metal, dust protected, vermin proof housing coated with approved color having all the necessary switching and protections, as per specification, complete in all respect.		
i	DB-LP5	No.	
ii	DB-LP6	No.	
5-2-2	Supply, installation, testing & commissioning of following Load Break Switch etc., in 16 SWG sheet metal steel enclosure with neutral and earth terminal strips,including all accessories as per drawing and specification, complete in all respect.		
i	63A, TPN Isolator	No.	
ii	40A, TPN Isolator	No.	
iii	25A, TPN Isolator	No.	
iv	25A, SPN Isolator	No.	
v	20A, SPN Isolator	No.	
	UPS 6 KVA Repair/Maintenance/Replacement	No.	
	UPS 3 KVA Repair/Maintenance/Replacement	No.	
	UPS 1 KVA Repair/Maintenance/Replacement	No.	

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Item No.	Description	Unit	Unit Rate (Rs).
5-2-3	LV CABLES & WIRING		
5-2-3	Providing, installing, testing and commissioning of following sizes of 600/1000 volts grade copper conductor unarmored cables from Station MDB supply upto LCP,LCP to Under Bridge lighting points and LOP to Lighting Pole, Lighting Pole to Lighting Pole, in already Laid conduit Complete in all respect, as per specification and drawing.		
i	4c- 25 Sq.mm C.u.PVC/PVC +1c-16 sq.mm PVC as ECC	Mtr.	
ii	4c- 16 Sq.mm Cu.PVC/PVC +1c-16 sq. mm PVC as ECC	Mtr.	
iii	4c- 10 Sq.mm Cu.PVC/PVC +1c-10 sq.mm PVC as ECC	Mtr.	
iv	3c- 6 Sq.mm Cu.PVC/PVC	Mtr.	
5-2-4	Providing, Installing, testing and commissioning of 3 Core 2.5 Sq.mm Cu. PVC/PVC, 450/750 volts grade cable for each light, from cable terminal box to luminaries, as per specification and drawing, complete in all respect.	Mtr.	
5-2-5	Providing, installing, testing and commissioning of following sizes of 600/1000 volts grade copper conductor unarmoured cables. Complete in all respect, as per specification and drawing.		
a)	4- Core-Cu.XLPE/PVC Cable (600/1000V)		
i	4- Core - 120 Sq.mm	Mtr.	
ii	4- Core - 95 Sq.mm	Mtr.	
iii	4- Core - 50 Sq.mm	Mtr.	
iv	4- Core - 25 Sq.mm	Mtr.	
v	4- Core - 16 Sq.mm	Mtr.	
vi	4- Core - 10 Sq.mm	Mtr.	
vii	4- Core - 6 Sq.mm	Mtr.	
b)	2- Core-Cu.PVC/PVC Cable		
i	2- Core - 6 Sq.mm	Mtr.	
c)	1- Core PVC Cable As ECC		
i	1- Core - 70 Sq.mm	Mtr.	
ii	1- Core - 25 Sq.mm	Mtr.	
iii	1- Core - 16 Sq.mm	Mtr.	
iv	1- Core - 10 Sq.mm	Mtr.	
v	1- Core - 6 Sq.mm	Mtr.	
d)	Removal of ABC Cable	Mtr.	
e)	Laying g of ABC Cable 4c 16sqm (Complete in all respects)	Mtr.	

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Item No.	Description	Unit	Unit Rate (Rs).
5-2-6	PVC CONDUIT/GI PIPE		
	Supply & Installation of following PVC Conduit / GI Pipe as race ways with all accessories recessed/ surface on wall / column / under floor for Power Cable Distribution. As per drawing and specification, complete in all respect.		
i	50 mm dia PVC Conduit	Mtr.	
ii	38 mm dia PVC Conduit	Mtr.	
iii	50 mm dia GI Pipe	Mtr.	
iv	38 mm dia GI Pipe	Mtr.	
v	32 mm dia GI Pipe	Mtr.	
5-2-7	Providing and Construction of Manhole Size 1200 mm x 1200 mm x 900 mm deep, 300 mm thick, concrete 1:4:8 ratio with 1200 mm round heavy duty cast iron cover, 100% water proof, as per specification as shown on the drawing, as per drawings and specification etc. in co-ordination with all other building services, complete in all respect. (For Power cables)	No.	
5-2-8	WIRING FOR SMALL POWER		
5-2-8 i	Supply, installation, testing and commissioning of circuit wiring from DB to 1st. light point with 2 x 2.5 sq. mm. + 1 x 2.5 sq. mm as ECC single core copper conductor PVC insulated wires in 32 mm dia GI pipe surface / recessed in wall, column etc., including back boxes with all pipe accessories, as per drawing and specifications, complete in all respect.	No.	
5-2-8 ii	Supply, installation, testing & commissioning of Point wiring from light point to light point with 3 x 2.5 sq. mm. single core copper conductor PVC insulated wires in 32 mm dia GI pipe, including back boxes with all pipe accessories, as per drawing and specification, complete in all respects.	No.	
5-2-8 iii	Supply, installation, testing & commissioning of circuit wiring from DB to switchboard including wiring between switch on the same circuit with 2 x 2.5 sq. mm. + 1 x 2.5 sq. mm as ECC single core copper conductor PVC insulated wires in 25 mm dia PVC conduit/32 mm dia GI pipe on surface / recessed in wall, column etc., including back boxes with all conduit accessories, as per drawing and specifications, complete in all respect.	No.	
5-2-8 iv	Supply, installation, testing & commissioning of Point wiring for light point from switch board to light point with 3 x 1.5 sq. mm. single core copper conductor PVC insulated wires in 25 mm dia PVC conduit / 32 mm dia GI pipe on surface / recessed in wall, column etc., including back boxes with all conduit accessories, as per drawing and specification, complete in all respects.	No.	

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Item No.	Description	Unit	Unit Rate (Rs).
5-2-8 v	Supply, installation, testing & commissioning of Point wiring from light point to light point with 3 x 1.5 sq. mm. single core copper conductor PVC insulated wires in 25 mm dia PVC conduit / 32 mm dia GI pipe on surface / recessed in wall, column etc., including back boxes with all conduit accessories, as per drawing and specification, complete in all respects.	No.	
5-2-8 vi	Supply, installation, testing & commissioning of Point wiring for Exhaust fan/Wall bracket fan point from switch board to fan point with 2 x 2.5 sq. mm. + 1 x 2.5 sq. mm as ECC single core copper conductor PVC insulated wires in 32 mm dia GI pipe surface / recessed in wall, column etc., including back boxes with all pipe accessories, as per drawing and specifications, complete in all respect.	No.	
5-2-8 vii	Supply, installation, testing & commissioning of Circuit wiring for Wall bracket fan point from switch board to fan point 2 x 2.5 sq. mm. + 1 x 2.5 sq. mm as ECC single core copper conductor PVC insulated wires in 32 mm dia GI pipe surface / recessed in wall, column etc., including back boxes with all pipe accessories, as per drawing and specifications, complete in all respects.	No.	
5-2-8 viii	Supply, installation, testing & commissioning of Point wiring for Wall bracket fan point from fan point to fan point with 2 x 2.5 sq. mm. + 1 x 2.5 sq. mm as ECC single core copper conductor PVC insulated wires in 32 mm dia GI pipe surface / recessed in wall, column etc., including back boxes with all pipe accessories, as per drawing and specifications, complete in all respects.	No.	
5-2-8 ix	Supply, Installation, Testing & Commissioning of Circuit Wiring from DB to Ist. Emergency Light point with 2 x 2.5 sq. mm. + 1 x 2.5 sq. mm as ECC single core copper conductor PVC insulated wires in 32 mm dia GI pipe surface / recessed in wall, column etc., including back boxes with all pipe accessories, as per drawing and specifications, complete in all respects.	No.	
5-2-8 x	Supply, Installation, Testing & Commissioning of Point Wiring from Emergency Light point to Emergency Light point with 2 x 2.5 sq. mm. + 1 x 2.5 sq. mm as ECC single core copper conductor PVC insulated wires in 32 mm dia GI pipe surface / recessed in wall, column etc., including back boxes with all pipe accessories, as per drawing and specifications, complete in all respects.	No.	
5-2-8 xi	Supply, installation, testing and commissioning of wiring from DB to 10A, Socket outlet with 2 x 2.5 sq. mm. + 1 x 2.5 sq. mm as ECC single core copper conductor PVC insulated wires in 32 mm dia GI pipe surface / recessed in wall, column etc., including back boxes with all pipe accessories, as per drawing and specifications, complete in all respects.		
i	DB to Socket Outlet	No.	
ii	Socket Outlet to Socket Outlet	No.	

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Item No.	Description	Unit	Unit Rate (Rs).
5-2-9	Supply, installation, testing and commissioning of wiring from DB to 13/10A & 15A, Socket outlet with 2 x 4 sq. mm. + 1 x 4 sq.mm as ECC single core copper conductor PVC insulated wires in 32 mm dia GI pipe surface / recessed in wall, column etc., including back boxes with all pipe accessories, as per drawing and specifications, complete in all respects.		
i	DB to Socket Outlet	No.	
ii	Socket Outlet to Socket Outlet	No.	
5-2-10	Supply, installation, testing and commissioning of wiring for 15A,Socket of sliding door from DB to Sliding door with 2 x 4 sq. mm. + 1 x 4 sq.mm as ECC single core copper conductor PVC insulated wires in 32 mm dia GI pipe surface / recessed in wall,column etc., including back boxes with all pipe accessories, as per drawing and specifications, complete in all respects.	No.	
5-2-11	Supply, installation, testing and commissioning of wiring for 15A,Socket Outlet of Branding as following with 2 x 4 sq. mm. + 1 x 4 sq.mm as ECC single core copper conductor PVC insulated wires in 32 mm dia GI pipe surface / recessed in wall,column etc., including back boxes with all pipe accessories, as per drawing and specifications, complete in all respects.		
i	DB to Socket Outlet	No.	
ii	Socket Outlet to Socket Outlet	No.	
	LIGHTING FIXTURES		
5-2-12	Supply, installation, testing and commissioning of following Light Fixtures complete with starters, Electronic ballast (mention otherwise), lamps LED, drivers, mounting accessories etc., complete in all respects. Lighting fixtures Sample must be submitted to consultant for approval, (For complete details of Light Fixtures, please refer to drawing Lighting Fixture Schedule).		
i	Light Type 'A'	No.	
ii	Light Type 'B'	No.	
iii	Light Type 'C'	No.	
iv	Light Type 'D'	No.	
v	Light Type 'E'	No.	
vi	Exit light weatherproof 8 w LED IP 65	No.	
vii	Emergency light wall mounted weatherproof 8W LED IP 65	No.	
viii	Emergency light recessed mounted weatherproof 8W LED IP65	No.	
ix	Emergency light Wall mounted 8W LED IP 20	No.	

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Item No.	Description	Unit	Unit Rate (Rs).
5.2	Removal of Existing LED Light	No.	
5.3	Installation of existing LED Light	No.	
5-2-13	Supply, installation, testing and commissioning of following Items including all connecting accessories as per drawings and specifications, complete in all respects.		
i	18" Dia Wall Bracket Fan	No.	
5-2-14	WIRING ACCESSORIES		
	Supply, installation, testing and commissioning of following type 10 Amps, One way /Two way/Three way /Four way gang type Light Control Switch and Switch Socket outlet of 5 / 15 Amps including 16 SWG sheet steel back boxes, recessed on wall, as per drawing and specification, complete in all respect.		
i	10A, One Gang switch Weatherproof Type	No.	
ii	10A, Two Gang switch Weatherproof Type	No.	
iii	10A, Three Gang switch Weatherproof Type	No.	
iv	10A, Four Gang switch Weatherproof Type	No.	
v	10A, Switched Socket outlet Weatherproof Type	No.	
vi	13A, Switched Socket Outlet Duplex Type	No.	
vii	15A, Switched Socket Outlet for Branding Weatherproof Light Type	No.	
viii	15A, Switched Socket outlet Weatherproof Type	No.	
5-2-15	RACEWAYS		
5-2-15 i	CABLE TRAY		
a)	Providing and Installing of following size of Cable Tray with cover base perforated for Power Distribution, Fabricated with 14/16 SWG. M.S Sheet steel Hot dip Galvanized including all installation accessories (Hot Dip Galvanized) such as appropriate sizes and lengths of M.S. Rod / Angle Iron Supports and Rawl Bolts etc. Complete in all respect as shown in drawings and specification or as directed by the Engineer.		
i	600 mm x 100 mm 14 SWG	Mtr.	
ii	300 mm x 50 mm 16 SWG	Mtr.	
iii	150 mm x 50 mm 16 SWG	Mtr.	

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Item No.	Description	Unit	Unit Rate (Rs).
5-2-16	TRUNKING		
a)	Providing, fabricating, erecting, fixing and installing as below, in position 200x50mm MS Tube framing (for lights fixtures) including metal system as shown in the drawing including cutting, welding, jointing and necessary required hardware's etc. all cutting for light fixtures & other design feature with providing & applying three coats of matt enamel paint of approved make & color shade including one coat of primer coat, filling putty at any height & floor etc., as shown on drawings complete in all respect as per drawing, standard, specifications and direction of the Engineer.		
i	200 mm x 50 mm	Mtr.	
5-2-17	EARTHING SYSTEM		
	Supply, installation, testing and commissioning of following items for complete earthing system including all connecting accessories as per drawings & specifications complete in all respect.		
i	Earth pit with Rod type earth electrode, 20 mm dia and 3 meter long copper rod.	No.	
5-2-18	Providing, installation, testing and commissioning of Copper Earth Bar 300 mm x 50 mm x 10 mm for earthing system as per drawings and instruction of consultant, including all mounting accessories etc., complete in all respect.	No.	
5-2-19	Supply, installation, testing and commissioning of following items for complete clean earthing system including all connecting accessories as per drawings & specifications complete in all respect.		
i	Earth pit with Rod type earth electrode, 20 mm dia and 3 meter long copper rod.	No.	
5-2-20	Supply, installation, testing and commissioning of Earth copper bar (Server, Telecom, UPS) 300 mm x 50 mm x 10 mm for earthing system as per drawings and instruction of consultant.	No.	
5-2-21	Supply, installation, testing & commissioning for following Earthing Continuity Copper Conductor PVC cable in 38/32 mm dia size of uPVC conduit as following size, from generator to earth pit, as per specifications & drawing.		
i	2 X 150 sq.mm	Mtr.	
ii	2 X 16 sq.mm	Mtr.	
5-2-21	ADDRESSABLE FIRE ALARM SYSTEM		
5-2-21 i	Providing, laying, testing & commissioning of Wiring for complete Fire Alarm System with 2C-2.5 Sq.mm shielded, twisted pair Fire Resistant Cable in 25 mm dia PVC conduit concealed, (32 mm dia GI Pipe for surface.) etc., including any wiring between fire alarm control panel and other's systems control panel's etc. Complete in all respect.	Mtr.	

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Item No.	Description	Unit	Unit Rate (Rs).
5-2-21 ii	Providing, installation, testing and commissioning of Addressable Photoelectric Smoke Detector, complete in all respect.	No.	
5-2-21 iii	Providing, installation, testing and commissioning of Addressable Heat Detector, complete in all respect.	No.	
5-2-21 iv	Providing, installation, testing and commissioning of Short circuit Isolator, complete in all respect.	No.	
5-2-21 v	Providing, installation, testing and commissioning of Addressable Manual Call Point, complete in all respect.	No.	
5-2-21 vi	Providing, installation, testing and commissioning of Addressable Manual Call Point weatherproof type, complete in all respect.	No.	
5-2-21 vii	Providing, installation, testing and commissioning of Addressable Sounder with Flasher, complete in all respect.	No.	
5-2-21 viii	Providing, installation, testing and commissioning of Addressable Sounder with Flasher (Weatherproof), complete in all respect.	No.	
5-2-21 ix	Providing, Installation, testing and commissioning of Duct detector, complete in all respect.	No.	
5-2-21 x	Providing, installation, testing and commissioning of Addressable Input / Output Interface unit.	No.	
5-2-22	Providing, installation, testing and commissioning of 01 Loop Addressable Fire Alarm Control Panel (FACP) including all necessary accessories, identification tagging etc. and battery back up, as per specification, complete in all respect.	No.	
5-2-23	Installation, testing & commissioning, Soft wear, Programming by Manufacturer Authorized Agent / Dealer and handing over complete Fire Alarm system to owner with providing training, SOP, complete equipment's manual and warranty documents to Owner's Representative.	Job.	
5-2-24	PUBLIC ADDRESS SYSTEM		
5-2-24 i	Providing, wiring and testing of PA Microphone points with Microphone Cable in 32 mm dia GI Pipe, recessed / surface in wall and ceiling, as per drawing, complete in all respects.	Job.	
5-2-24 ii	Providing, Installing, testing & commissioning of PA System complete with all connecting accessories comprising of the following equipment.		
i	Providing & Connecting of Inter Connects Cables etc.	Job.	
5-2-25	Providing, Installing, testing and commissioning of following Light Type of Speakers for Architect Approved color.		
i	6 W Ceiling mounted Speakers with Tapping Transformers of (1, 1.5, 3, 4.5, 6W).	No.	
ii	30 W Wall mounted Speakers IP 65 with Tapping Transformers of (30, 20 & 13W).	No.	

GREEN & ORANGE LINES BRTS, KARACHI
MISCELLANEOUS REPAIR/REPLACEMENT/MAINTENANCE WORKS OF ROAD, BUILDINGS,
ELECTRICAL, HVAC AND MEP WORKS
Contract Package # SMTA/GL&OL/MAINTENANCE/CP-01
BILL OF QUANTITIES

Item No.	Description	Unit	Unit Rate (Rs).
05-3-1	EARTHING SYSTEM		
a	Providing, installing, testing and commissioning of earthing pit with 3 meter long 20 mm dia earth Copper Rod for LCP and end of every lighting pole circuit directly driven to ground to obtain earth resistance not more than 1 ohm.as per drawing and specification,, complete in all respect.	Nos.	
b	Providing, installing, testing & commissioning of Following copper PVC insulated (yellow/green) earth continuity cable in already laid Conduit from earth pit to lighting pole and between pole to pole. Complete in al: respects, as per specification and drawing.		
i	1 c- 16 Sq. mm as Cu.PVC as ECC	RM	
ii	1c- 10 Sq. mm as Cu.PVC as ECC	RM	
C	MEDIUM VOLTAGE DISTRIBUTION		
a	15kV 3 Core - AL/ XLPE /SWA/ PVC Cable		
i	3-Core 300 sq.mm	RM	
05-3-2	Providing, termination, testing and commissioning of MV Straight Joint Kits for 300 sq.mm 3 Core 15kV Al./XLPE/SWA/PVC Cable {outdoor} of approved manufacturer, as per specification and complete in all respect.	Nos.	
05-3-3	Providing, installing, testing and commissioning of 4 Core 6 Sq.mm PVC / PVC, 600/1000 volts grade cable for each light from control DB to luminaries complete in all respect.	RM	
05-3-4	Providing, installing, testing and commissioning of Flood light fixture with 250W SON-T Philips type or approved make, ballast starter, power factor improvement capacitor including appropriate size of sheet steel box for ballast accessories etc.	Nos.	
05-3-5	Painting for Existing Street lighting Pole with enamel paint of approved make and shade two coat over and including the cost of ore coat of Redoxid, complete in all respected to the entire satisfaction of the Engineer.	Nos.	
05-3-6	Panel Rehabilitation Work	Nos.	
05-3-7	Tunnel Light Cable Conduit	RM	

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BILL OF QUANTITIES

Item No.	Description	Unit	Unit Rate (Rs).
05-3-8	LIGHT FIXTURES & FANS		
	Supply, Installation, Testing and Commissioning of following Light Fixtures complete with starters, Electronic ballast (mention otherwise), lamps LED, drivers, mounting accessories etc., complete in all respects. Lighting fixtures Sample must be submitted to consultant for approval, (For complete details of Light Fixtures, please refer to drawing Lighting Fixture Schedule).		
i	Light Type 'A'		
ii	Light Type 'B'		
iii	Light Type 'C'		
iv	Light Type 'D'		
v	Light Type 'E'		
vi	Light Type 'F'		
vii	Light Type 'G'		
viii	Light Type 'H'		
ix	Light Type 'J'		
x	Light Type 'K'		
xi	Light Type 'L'		
xii	Light Type 'M'		
05-3-9	Station Transformer Complete maintainane through Authorised Firms	Job	
05-3-9a	Bus bars of Transformers	Nos	
	Generators Complete maintainane including canopy through Authorised Firms	Job	
05-3-10	Street Light Repairing (LED Dirver & SPD Change, etc)	Each	
1	Restoration, testing and commissioning of Terminal Box IP 65 including 2 no. 4A Circuit Breaker with terminals, as per specification and drawing,	Nos	
2	Providing, Installing, testing and commissioning of 140 W LED,min. Luminous Flx 15500, Surge Protection min. 15kV	Nos	
3	Providing, Installing, testing and commissioning of 90 W LED IP 66 Tunnel Light Fixture	Nos	
4	Epoxy etch paint primer 10 to 15 microns for surface prepration	S.M	
5	Restoration , testing and commissioning of following surfaces mounted Lighting Control Panel (LCP)	Nos	
6	LV Cables & Wiring		
1	Providing, Installing, testing and commissioning of following sizes of 600/1000 volts grade copper conductor unarmoured cables from station MDB supply upto LCP		
a	4c-10 Sq.mm Cu.PVC/PVC +1c-10 sq.mm PVC as ECC	R.M	
b	3c-6 Sq.mm Cu.PVC/PVC	R.M	
1.1	Providing, Installing, testing and commissioning of 3 core 2.5 Sq.mm PVC/PVC, 450/750 volts grade cable for light	R.M	
i	Supply, Installation, Testing and Commissioning of following Items		
ii	24" Dia Wall Bracket Fan	Nos	
a	8" Dia Exhaust Fan	Nos	

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BILL OF QUANTITIES

Item No.	Description	Unit	Unit Rate (Rs).
7	Escalators of Orange Line, complete maintenance with spare parts through Authorised Service firms	Nos	
8	Elevators of Orange Line, complete maintenance with spare parts through Authorised Service firms	Nos	
9	Servicing and maintenance of Sub-station	Job	
10	Maintenance/Replacement of Solar panels, inverters, batteries, wiring, etc	Job	

ISSUED UNDER ADDENDUM # 01
GREEN & ORANGE LINES BRTS, KARACHI
MISCELLANEOUS REPAIR/REPLACEMENT/MAINTENANCE WORKS OF ROAD,
BUILDINGS, ELECTRICAL, HVAC AND MEP WORKS
Contract Package # SMTA/GL&OL/MAINTENANCE/CP-01
SUMMARY OF BILLS

Item No.	Description	Unit	Unit Rate (Rs).
	BILL NO. 06; PLUMBING AND HVAC		
	Supply and Installation of Medium Duty Cover For RCC water tanks		
1	Supply and Installation of 600mmx 600mm medium duty cover as specified & as per specifications and Engineers approval.	Nos.	
2	Supply and Installation of 300mmx 300mm medium duty cover as specified & as per specifications and Engineers approval.	Nos.	
3	Supply & Replacement of wiring, valves, pressure switch, Float switch of Booster/ Submersible Pump.	Nos.	
4	Replacement of Three stage cartridge Filter by So-Safe/Collagen (1.0 Microns) with UV filter capable of 8,000 to 10,000 hours of operation. of minimum 0.8 GPM flow for with valves, piping, accessories, etc., as indicated on the drawing, as per specifications and Engineers approval.	Nos.	
5	Providing and fixing first quality European type water closet (dual flush type) with 6 liters main flush tank and 3 liters secondary flush tank, build in S-Trap, Stop cock with flexible pipe as per drawings, specifications and Engineers Approval.	Nos.	
6	Providing and fixing Pedestal type wash basin with mixer, with two (2) nos. Stop cocks, Flexible Connection, flexible drain pipe to floor drain as per drawings, specifications and engineers approval.	Nos.	
7	Providing and fixing Wash Basin mixer, with two (2) nos. Stop cocks, Flexible Connection, flexible drain pipe to floor drain as per drawings, specifications and engineers approval.	Nos.	
8	Providing and fixing of kitchen/Pantry mixer, waste trap, Stop cocks with flexible pipes, Flexible drain pipe as per drawings, specifications and engineers approval.	Nos.	
9	Providing and fixing bath toilet accessories as under:		
(i)	Hand Spray / Muslim shower	Nos.	
(ii)	double bib tap	Nos.	
(iii)	Single bib tap	Nos.	
(iv)	PPR coated gate valve	Nos.	
(v)	PVC floor trap with multiple inlet	Nos.	
10	Refilling of below mentioned Portable Fire extinguishers as per specifications and Engineers Recommendation		
(i)	5 Kg CO2 wall mounted fire extinguisher	Nos.	
(ii)	6 Kg Dry powder wall mounted fire extinguisher	Nos.	

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GREEN & ORANGE LINES BRTS, KARACHI
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SUMMARY OF BILLS

Item No.	Description	Unit	Unit Rate (Rs).
11	Supply, installation, testing and Commissioning of PPR PN - 20 Cold/Hot water pipes as per DIN 8077-8078 with molded fittings PN - 25 as per DIN 16962, including pipe supports, cutting, filling, testing/commissioning and all accessories as indicated on the drawing, as per specifications and Engineers approval.		
(i)	20mm Dia	Rm	
(ii)	25mm Dia	Rm	
12	Providing and fixing of PPR Coated PN-20 Gate valves of bronze material for diameter 2" and smaller and Cast Iron material for Diameter greater than 2" as per specifications and Engineers approval.		
(i)	20mm Dia	Rm	
(ii)	25mm Dia	Rm	
13	Providing and fixing, uPVC pipes and fittings as per DIN 8061/8062 and ISO 3633 Type B for above ground and buried installations for Soil, Waste, Vent & Rw pipes including cleanout plug, clamps, hanger collars, supports, specials (bend, tees, Y-tee etc.) as indicated on the drawing, as per specifications and Engineers approval.		
(i)	50mm Dia	Rm	
(ii)	75mm Dia	Rm	
(iii)	100mm Dia	Rm	
14	Supply and installation of below mentioned Portable Fire extinguishers with Wall mount brackets as indicated on the drawings, as per specifications and Engineers Recommendation		
(i)	5 Kg CO2 wall mounted fire extinguisher	Nos.	
(ii)	6 Kg Dry powder wall mounted fire extinguisher	Nos.	
15	Sewerage Connection to External Network, after obtaining approval from local authorities including the cost of excavation, Piping as specified and shown on the drawing, as per specifications and Engineers approval.	Job	
16	External Water Connection to Building after obtaining approval from local authorities including the cost of excavation, Piping as specified and shown on the drawing, as per specifications and Engineers approval.	Job	

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MISCELLANEOUS REPAIR/REPLACEMENT/MAINTENANCE WORKS OF ROAD,
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SUMMARY OF BILLS

Item No.	Description	Unit	Unit Rate (Rs).
	HVAC		
1	DX-SPLIT AIRCONDITIONING UNITS:		
	Supply, Installation, Testing & Commissioning of DX Split Air-conditioning Units, complete Indoor unit with all sections and components given in the schedule and specifications of DX Split Air-conditioning Units, including uplifting / lowering, loading / unloading at site, complete including copper piping with insulation, electric wiring in all respect and as directed by the Engineer in charge in following sizes and capacities.		
i	DX-Split AC Unit (Capacity 1.0 TR)	No	
ii	DX-Split AC Unit (Capacity 1.5 TR)	No	
iii	DX-Split AC Unit (Capacity 2.0 TR)	No	
2	HVAC FANS		
	Supply, installation, testing and commissioning of HVAC fans, as per equipment schedule, as shown on the drawings including all labor, material and accessories, complete in all respect and to the satisfaction of engineer in charge.		
i	EF-01(400 cfm) In-line Ducted Toilet Fan	Nos.	
3	CONDENSATE DRAIN PIPING		
	Providing and fixing, uPVC Class 'E' pipes with Foam Insulation and fittings as per BS 3505 (EN 1401) for Condensate Water including fittings, bends, cuttings, filling etc. as indicated on drawings, as per specifications and Engineers approval.		
i	1" dia	Rft	
ii	1 1/4" dia	Rft	
iii	1 1/2" dia	Rft	
4	DUCT WORKS		
	Supply, fabrication, installation, testing and commissioning of Sheet Metal hand made / machine fabricated Duct Work as shown on the drawings and as per technical specification including all labor, material, accessories, tees, plenum, transition pieces, splitter dampers, special duct test holes, duct access doors, air deflector, hanger & supports as where required complete in respect and to the satisfaction of Engineer in charge.		
i	24 - Gauge	Sq.Ft	
ii	22 - Gauge	Sq.Ft	

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SUMMARY OF BILLS

Item No.	Description	Unit	Unit Rate (Rs).
5	FLEXIBLE DUCT CONNECTOR		
	Supply and installation of rubber impregnated canvas Flexible Duct Connector (imported type) between Fans all other equipment and Duct Work as shown on the drawings including all labor, material, accessories, complete in respect and to the satisfaction of engineer in charge.	Nos.	
5a	Chillar Complete maintainane through Authorised Firms	Job	
5b	Ground Mounted Big Fans	Nos.	
5c	Water Coolers	Nos.	
5d	Fire Pumps	Job	
5e	Submersible Pumps	Nos.	
6	AIR DEVICES		
	Supply, installation, Testing & Commissioning of Air Devices included with back opposed blade volume controller with accessible key operator, as shown on the drawings and as specified in technical specifications including balancing of air flow rates, including all labor, material and accessories, complete in all respect and as directed by the Engineer in charge.		
a	Exhaust Air Diffuser with Damper		
i	6" x 6"	Nos	

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BILL OF QUANTITIES

Item No.	Description	Unit	Unit Rate (Rs).
	BILL NO. 07; MISCELLENOUS WORKS		
06-01	MS Louver Barrier with Framing, including epoxy Paint, complete in all respect	Sq.m	
06-03	Relocation of Pedestrian Bridge	L.S	
06-04	Dismantling and shifting of existing grill, including fixing to other side	RM	
06-05	Relocation shifting of existing (KE Lines, PTCL & Other),etc	RM	
06-06	Kerb Painting (Berger Oil Base NU Enamel Paint)	Sq.m	
06-07	Epoxy Paint (as per Standard)	Sq.m	
06-08	Integral Water Proofing Admixture for Concrete	Liter	
06-09	Concrete Painting	Sqm	
06-10	Manhole Raiser Ring Precast	Each	
06-11	Manhole Cover Precast	Each	
06-12	Manhole Cleaning	Each	
06-13	Excavator	P/Hr.	
06-14	Crane 45 Ton	P/Hr.	
06-15	Crane 20 Ton	P/Hr.	
06-16	Tractor 80 H.P	P/Hr.	
06-17	Tractor 50 H.P	P/Hr.	
06-18	Dumper 18 Ton	P/Hr.	
06-19	Dumper 10 Ton	P/Hr.	
06-20	Power Broom	P/Hr.	
06-21	Flat Body Truck 8 Ton	P/Hr.	
06-22	Trailer Low Bed 30 Ton	P/Hr.	
06-23	Tractor Trolley	P/Hr.	
06-24	Generator (Diesel) 150 KVA	P/Hr.	
06-25	Generator (Diesel) 250 KVA	P/Hr.	
06-26	Electric Generator 50 KVA	P/Hr.	
06-27	Electric Generator 5 KVA With Fuel	P/Hr.	
06-28	Electric Generator 2.5 KVA With Fuel	P/Hr.	
06-29	Cultus VXR	P/Month	Not Applicable
06-30	Laptop Latest Version	Each	Not Applicable
06-31	Fuel flow meter for diesel genrator, complete kit with digital guage and diesel flow meter to monitor engine supply and return lines	Each	
06-33	12mm tempered glass by (Pilkington / Emirates glass or approved equivalent), including all fixing arrangement & required hard wears etc, PVC glazing bead and whether strips, Caulking with caulking compound etc. complete in all respect, as per drawings and specifications and all works to be carried out the satisfaction of Engineer.	Sq.m	

(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, [name of Supplier/Contractor/Consultant] 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 times 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]



Sindh
Mass Transit
Authority



گورنمينت آف سنڌ

سنڌ ماس ٽرانزٽ اٿارٽي

ٽرانسپورٽ اينڊ ماس ٽرانزٽ ڊپارٽمينٽ

تصحيح

BRTS گرین ۽ اورينج لائينز جي سارسنيال

BRT گرین ۽ اورينج لائينز ڪوريدورز جي روڊ، بلڊنگز، اليڪٽريڪل،

HVAC ۽ MEP ڪمن جي متفرقه مرمت/ريپليسمينٽ/سارسنيال وارا ڪم

بحوالو سان اين آءِ تي روزاني ڊان، روزاني جنگ ۽ روزاني ڪاوش پر تاريخ 17-09-2026

تي پڙهو نمبر INF/KRY No. 4111/2026 شايع ٿيو. اهو اطلاع ٿو ڪجي ته واک ڪولڻ جي

تاريخ 07-10-2026 کان 12-10-2026 تائين وڌائي وئي آهي ۽ واک دستاويز تاريخ

24-09-2026 تي EPADS سسٽم تي ڊائون لوڊ لاءِ دستياب هوندا. هڪ ڀري بد گذجائي

تاريخ 05-10-2026 تي منجهند 03:00 وڳي SMTA آفيس ۾ منعقد ڪئي ويندي.

1.7 ساليانو سراسري ٽرن اوور تي 03 سالن جي بدران 05 سال پڙهي سگهجي ٿو.

اصل اشتهار ۽ واک دستاويزن جا سمورا ٻيا شرط ۽ ضابطا تبديل نه ٿيندا.

(ڊائريڪٽر)

انفرا اسٽرڪچر اينڊ پلاننگ

سنڌ ماس ٽرانزٽ اٿارٽي

گورنمينٽ آف سنڌ

آفيس D-43/1 شاهراهه غالب بلاڪ 2 ڪلفٽن، ويجهو بلاول چورنگي ڪراچي

فون: 8-021-99332207

INF/KRY No.4230/2026

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INFORMATION DEPARTMENT



**GOVERNMENT OF SINDH
SINDH MASS TRANSIT
AUTHORITY TRANSPORT & MASS
TRANSIT DEPARTMENT**



Sindh
Mass Transit
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CORRIGENDUM

MAINTENANCE OF BRTS GREEN AND ORANGE LINES

**“MISCELLANEOUS REPAIR/REPLACEMENT/
MAINTENANCE WORKS OF ROAD, BUILDINGS,
ELECTRICAL, HVAC AND MEP WORKS
AT BRT GREEN & ORANGE LINE CORRIDORS”**

With Reference to the **NIT** published in Daily Dawn, Daily Jang and Daily Kawish on dated 17-09-2026 vide No. *INF/KRY/4111/26*, it is informed that the Bid Opening date has been extended from 07-10-2026 to 12-10-2026 and the Bidding documents will be avail for download on 24-09-2026 on EPAD System. A pre-bid meeting will be held on 05-10-2026 @03:00 p.m. at SMTA office.

******At 1.7 Annual Average Turnover may be read as 05 years instead of 03 years

*******All other terms and conditions of the original advertisement and bidding documents shall remain unchanged.

(DIRECTOR)

**Infrastructure and Planning
Sindh Mass Transit Authority
Government of Sindh**

**Office D-43/1, Shahra-e-Ghalib, Block 2, Clifton,
near Bilawal Chowrangi, Karachi,
Phone: 021-99332207-8.**

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INFORMATION DEPARTMENT**

سندھ ماس ٹرانزٹ اتھارٹی

ٹرانسپورٹ اینڈ ماس ٹرانزٹ ڈیپارٹمنٹ

تصحیح

BRTS گرین اور اورنج لائنز کی میٹنیٹنس

BRT گرین اور اورنج لائن کوریڈورز میں سڑک، بلڈنگز، الیکٹریکل،

HVAC کی متفرق مرمت/تبدیلی/میٹنیٹنس کے کام اور **MEP** ورکس

بحوالہ این آئی ٹی شائع شدہ روزنامہ ڈان، روزنامہ جنگ اور روزنامہ کاوش
مورخہ 17-09-2026 بمطابق نمبر INF/KRY/4111/26 بذریعہ ہذا
مطلع کیا جاتا ہے کہ پیشکش کھلنے کی تاریخ 07-10-2026 سے توسیع کر کے
12-10-2026 کر دی گئی ہے اور بڈنگ دستاویزات
24-09-2026 کو EPAD سسٹم پر ڈاؤن لوڈ کیلئے دستیاب ہوں گے۔
ایک پری بڈ اجلاس 05-10-2026 کو سہ پہر 3:00 بجے SMTA آفس
میں منعقد کیا جائے گا۔

☆☆ 1.7 پر سالانہ اوسطاً ٹرن اوور 03 سال کے بجائے 5 سال پڑھا جائے
☆☆☆ اصل اشتہار اور بڈنگ دستاویزات کی دیگر شرائط و ضوابط حسب سابق
برقرار رہیں گی۔
(ڈائریکٹر)

انفراسٹرکچر اینڈ پلاننگ

سندھ ماس ٹرانزٹ اتھارٹی، حکومت سندھ

آفس D-43/1 شاہراہ غالب بلاک-2، کلفٹن

ڈنڈ بلاول چورنگی، کراچی فون: 021-99332207-8

4230/26
INF-KRY
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INFORMATION DEPARTMENT

گورنمينٽ آف سنڌ سنڌ ماس ٽرانزٽ اتھارٽي ٽرانسپورٽ اينڊ ماس ٽرانزٽ ڊپارٽمينٽ

ٽينڊر گھراڻي لاءِ نوٽيس BRTS گرین اينڊ اورينج لائنز جي سارسنيال

BRT گرین ۽ اورينج لائن ڪورڊيٽر تي روڊ، بلڊنگ، اليڪٽريڪل،
HVAC ۽ MEP ڪمن جي متفرقه مرمت/ريپليسمينٽ/سارسنيال وارا ڪم

فريم ورڪ/ايرٽ ڪانٽريڪٽ بنيادن تي مڪمل ڪيو ويندو-مقدار ۽ قيمت جي گھٽ ۾ گھٽ آرڊر جي گارنٽي نه آهي
سنڌ ماس ٽرانزٽ اتھارٽي (SMTA) گورنمينٽ آف سنڌ دلچسپي رکندڙ ساک وارين ڪمپنين کان ايس بي بي آر اي رولز 2010 (هيسٽائين ٽرمينر ٿيل) موجب BRT گرین
۽ اورينج لائنز ڪورڊيٽر تي متفرقه روڊ، بلڊنگ، اليڪٽريڪل، HVAC ۽ MEP ڪمن جي سارسنيال/حصن يا مڪمل آئتمز جي مرمت/ريپليسمينٽ تي ٻڌل سارسنيال
وارن ڪمن لاءِ سنگل اسٽيج ٽو انوئلڊ طريقڪار تحت هيٺين ڪمن لاءِ ايس بي بي آر اي جي EPAD پورٽل ۽ پرنٽ ميڊيا ذريعي مهربند واک گھراڻي ٿي.

سيريئل نمبر	ڪم جو ٽائٽل	ڪٽيل لاڳت	واڪ سيڪيورٽي	واڪن جي جمع ڪرائڻ جي آخري تاريخ	ٽيڪنيڪل واک کولڻ جي تاريخ ۽ وقت	ٽينڊر في (نفاذ واپسي)
01	BRT گرین ۽ اورينج لائنز ڪورڊيٽر تي متفرقه روڊ، بلڊنگ، اليڪٽريڪل، HVAC ۽ MEP ڪمن جي سارسنيال/حصن يا مڪمل آئتمز جي مرمت/ريپليسمينٽ تي ٻڌل سارسنيال وارا ڪم	300 M	لمپ سمر 5.5 ملين ساڻ گڏ ٽيڪنيڪل واک	07-10-2026 منجهند 3:00 وڳي	07-10-2026 منجهند 03:30 وڳي	5000 پاڪستاني رپيا

واڪ دستاويز سومر 21 سيپٽمبر، 2026 کان EPAD سسٽم تي ڏاٽون لوڊ لاءِ دستياب هوندا.
قابليت معيار:

سيريئل نمبر	تفصيل	گھرجون
1.1	اهليت: پاڪستان انجنيئرنگ ڪائونسل سان لاڳاپيل ڪيٽيگري ۽ شعبي ۾ ڪارگر رجسٽريشن	ڪيٽيگري C3 ۽ ڊسپينس CE-01، CE-10 JV ميمبر؛ PEC ڪيٽيگري C4
1.2	انڪم ٽيڪس لاءِ FBR سان رجسٽرڊ ٿيل	لازمي ملندڙ هجي
1.3	سيلز ٽيڪس لاءِ سنڌ روينيو بورڊ سان رجسٽرڊ ٿيل	لازمي ملندڙ هجي
1.4	مقدمي بازي جي فهرست (جيڪڏهن ڪا هجي) سنڌ نوعيت ۽ رتبو/نتيجا	لازمي ملندڙ هجي
1.5	حلف نامو ت فريم ڪڏهن به بليڪ لسٽ نه ڪئي وئي آهي.	لازمي ملندڙ هجي
1.6	قابليت: گذريل 05 سالن ۾ ڪنيل لاڳت (02) پروجيڪٽس سان ساڳيون اسائنمينٽس ميٽرو بس سسٽم جي سارسنيال جو تجربو اضافي فائڊو ڏيندو.	هر هڪ 240 ملين رپيا لازمي ملندڙ هجي
1.7	گذريل 03 سالن لاءِ ساليانو سراسري ٽرن اوور ڪنسنٽريشن سنگل انتاقتي: لازمي ملندڙ هجي JV جي صورت ۾ JV ۾ سندن حصي موجب سمورن JV ميمبرن سمورا JV ميمبر لاڳو ڇوڳا	400 ملين رپيا

ا. موت نه مليل ٽينڊرن کي هيٺين تاريخن تي ٻيهر جاري/جمع ڪرايو/ڪوليو ويندو.

پيرو	(اي) اجراء جي تاريخ	(بي) امائن ۽ کولڻ جي تاريخ
ٻيون	08-10-2026	26-10-2026

مالي حالت: پروجيڪٽنگ ايجنسي سان فنڊز دستياب آهن.
شرط ۽ ضابطا:

- هيٺين شرطن ۽ ضابطن تي واک رد ڪيو ويندو.
- واڪ دستاويزن ۾ ڄاڻايل گھريل رقم ۽ فارم جي واک سيڪيورٽي سان شامل نه ٿيل واک.
- ڄاڻايل تاريخ ۽ وقت کانپوءِ وصول ٿيل واک
- بليڪ لسٽڊ فرمون.
- واڪ ڪارگر هئو: 90 ڏينهن
- پروجيڪٽنگ ايجنسي سنڌ پبلڪ پروجيڪٽ مينٽ رولز 2010 جي لاڳاپيل شقن موجب سمورن يا ڪنهن به واک کي رد ڪرڻ جو پورو حق محفوظ رکي ٿي.

ڊائريڪٽر، انفراسٽرڪچر اينڊ پلاننگ

سنڌ ماس ٽرانزٽ اتھارٽي

گورنمينٽ آف سنڌ

آفيس D-43/1، شاهراهه غالب، بلاڪ 2، ڪلٽن ويجهو بلاول چورنگي، ڪراچي

فون: 021-99332207-8



GOVERNMENT OF SINDH
SINDH MASS TRANSIT AUTHORITY
TRANSPORT & MASS TRANSIT DEPARTMENT



NOTICE INVITING TENDER

MAINTENANCE OF BRTS GREEN AND ORANGE LINES **"MISCELLANEOUS REPAIR/REPLACEMENT/MAINTENANCE WORKS OF** **ROAD, BUILDINGS, ELECTRICAL, HVAC AND MEP WORKS** **AT BRT GREEN & ORANGE LINE CORRIDORS"**

(To be executed on Framework / Rate contract Basis - No minimum order of quantity or value is guaranteed)

The Sindh Mass Transit Authority (SMTA) Government of Sindh invites sealed bids from interested reputed companies for the Maintenance Works comprised of Repair/Replacement (parts or complete item/Maintenance of Miscellaneous Road, building, electrical, HVAC and MEP works at BRT Green & Orange Line Corridors as per SPPRA 2010 Rules (Amended to date) under Single Stage Two Envelope Procedure through Print media and EPAL Portal of SPPRA for the following works:

Sr. No.	Title of Work	Estimated Cost	Bid Security	Deadline for submission of bids	Technical bid Opening Date and time	Tender fee (non-refundable)
01	Maintenance Works comprised of Repair/Replacement of parts or complete item / Maintenance of Miscellaneous Road, Building, Electrical, HVAC, and MEP works at BRT Green & Orange Line Corridors	300 M	Lump sum 5.5 Million along with technical bid	07-10-2026 by 03:00 pm	07-10-2026 at 03:30 pm	PKR 5000/-

Bidding Documents will be avail for download on EPAD System from Monday 21st September, 2026.

Qualification Criteria:

Sr #	Description	Requirements
1.1	Eligibility: Valid Registration with Pakistan Engineering Council in relevant category and discipline	Category C3 and discipline CE-01, CE-10, JV Member: PEC Category C4
1.2	Registered with FBR for Income Tax	Must meet
1.3	Registered with Sindh Revenue Board for Sales Tax	Must meet
1.4	List of litigation (if any) their nature and status / outcomes;	Must meet
1.5	Affidavit that firm has never been blacklisted;	Must meet
1.6	Qualification: Similar assignments with cost (two projects), under-taken over in the past five (05) years; Experience of maintenance of Metro Bus system will give additional advantage.	Rs. 240 million each Must meet
1.7	Annual Average Turnover Construction for last 3 years Single Entity: Must Meet In case of JV: Applicable to all JV members as per their share in JV	Rs. 400 million

i. Un-responded Tenders will be again issued / submitted / opened on following dates:

Attempt	(a) Issue date:	(b) Submission & opening date
2 nd	08-10-2026	26-10-2026

Funding Position: Funds are available with the Procuring Agency,

Terms & Conditions.

- (a) Under following conditions bid will be rejected:
 - (i) Bids not accompanied by bid security of required amount and form as specified in the bidding document
 - (ii) Bids received after specified date and time;
 - (iii) Blacklisted firms.
- (b) **Bid validity period:- 90 days**

Procuring Agency reserves the right to reject all or any bids subject to the relevant provisions of Sindh Public Procurement Rules 2010.

Director, Infrastructure & Planning
Sindh Mass Transit Authority,
Government of Sindh,
Office D-43/1, Shahra-e-Ghalib, Block 2, Clifton,
near Bilawal Chowrangi, Karachi,
Phone: 021-99332207-8

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Sindh
Mass Transit
Authority

حکومت سندھ سندھ ماس ٹرانزٹ اتھارٹی ٹرانسپورٹ اینڈ ماس ٹرانزٹ ڈپارٹمنٹ



نوٹس طلبی ٹینڈر

BRTS گرین اینڈ اورنج لائنز کی مینیٹنس

"BRT" گرین اینڈ اورنج لائن کوریڈورز میں روڈ، بلڈنگز، الیکٹریکل، HVAC اور MEP ورکس کے متفرق ریجیون/اری پلیسمنٹ/مینیٹنس ورکس
(فریم ورک/اریٹ کنٹریکٹ بنیاد پر سرانجام دیے جائیں گے۔ مقدار و تعداد یا قدر و قیمت کم از کم آرڈر ضمانت شدہ نہیں ہے)

سندھ ماس ٹرانزٹ اتھارٹی (SMTA) حکومت سندھ ایک مرحلہ دو لائف کارروائی کے تحت 2010 SPPRA رولز (ترمیم شدہ) کے مطابق BRT گرین اینڈ اورنج لائن کوریڈورز میں متفرق روڈ، بلڈنگز، الیکٹریکل، HVAC اور MEP ورکس کے پارٹس کے ریجیون/اری پلیسمنٹ یا مکمل آئٹمز/مینیٹنس پر مبنی مینیٹنس کاموں کے لیے بذریعہ پرنٹ میڈ یا اور SPPRA کے EPAD پورل ڈیل کے کاموں کے لیے دلچسپی رکھنے والی معروف کمپنیز سے سربمہر پیشکشیں مدعو کرتی ہے۔

نمبر شمار	کام کا جائزہ	قیمتی لاگت	بڈ سکورنگ	آخری تاریخ برائے پیشکشوں کا جمع کرنا	پیشکش کی مکمل تاریخ اور وقت	ٹینڈر فیس
01	مینیٹنس ورکس مشمل بائیں ریجیون/اری پلیسمنٹ پارٹس/مکمل آئٹمز/مینیٹنس متفرق روڈ، بلڈنگز، الیکٹریکل HVAC اور MEP ورکس بھتام BRT گرین اینڈ اورنج لائن کوریڈورز	300 M	ٹینڈر پیشکش کے سربمہر پیشکش 5.5 ملین	07-10-2026	07-10-2026	5000/- پاکستانی روپے

** بڈنگ دستاویزات EPAD سسٹم پر 21 ستمبر 2026 سے ڈاؤن لوڈ کے لیے دستیاب ہوں گی۔

معیار اہلیت:

نمبر شمار	تفصیل	شروریتیں
1.1	اہلیت: مختصہ کمپنی اور ڈسٹریکشن میں پاکستان انجینئرنگ کونسل سے کارآمد رجسٹریشن	کمپنی C3 اور سیٹلن JV، CE-10، CE-01 ممبر: PEC کمپنی C4
1.2	انکم ٹیکس کے لیے FBR سے رجسٹرڈ	لازمہ رجسٹرڈ ہونا
1.3	سیلز ٹیکس کے لیے سندھ ریونیو بورڈ سے رجسٹرڈ	لازمہ رجسٹرڈ ہونا
1.4	مقدمہ کی فہرست (اگر کوئی ہو) اس کی نوعیت و حیثیت/انتخاب	لازمہ رجسٹرڈ ہونا
1.5	حلف نامہ کہ فرم ہمگی بلیک لسٹ نہیں رہی	لازمہ رجسٹرڈ ہونا
1.6	کوآپلیکیشن: گڈ شیپ پانچ (05) برسوں میں سرانجام دیے جانے والے لاگت کے ساتھ مساوی اسامیٹس (دو پریڈیکٹس) میٹروپس سسٹم کی مینیٹنس کے تجربہ کو اضافی قابلیت شمار کیا جائے گا۔	240 ملین روپے ہر ایک لازمی رجسٹرڈ ہونا
1.7	گڈ شیپ 3 برسوں کے لیے سالانہ اسٹاپ ٹرن اور کنسٹرکشن مسئلہ حل: لازمی رجسٹرڈ ہونا۔ JV کی صورت میں: JV میں ان کے شیئر کے مطابق جملہ JV ممبران کے لیے قابل اطلاق	400 ملین روپے

یہ تمام رجسٹرڈ والے ٹینڈر ڈون ڈیل تاریخوں پر وہ بارہ جاری/جمع کیے گئے ہوں گے۔

کوشش	(a) تاریخ احسراہ	(b) جمع کرانے اور کھلنے کی تاریخ
دوسری	08-10-2026	26-10-2026

فنانسنگ پوزیشن: فنڈز پر دیگر رٹنگ ایجنسی کے پاس دستیاب تھا۔

شرائط و ضوابط:

- درج ذیل صورتوں کے تحت پیشکش مسترد کر دی جائے گی۔
(i) مطلوبہ رقم کے بڈ سکورنگ اور بڈنگ دستاویزات میں مقرر کردہ فارم نمٹنے کے بغیر پیشکش
(ii) مقررہ وقت اور تاریخ کے بعد وصول پیشکشیں
(iii) بلیک لسٹ فرمز
(b) پیشکش کے کارآمد سبب کی مدت 90 ایم
پروویڈرنگ ایجنسی کو سندھ پبلک پروویڈرمنٹ رولز 2010 کی متعلقہ شقوں سے مشروط جملہ یا کسی پیشکش کو مسترد کر دینے کا حق حاصل ہے۔

ڈائریکٹر، انفراسٹرکچر اینڈ پلاننگ سندھ ماس ٹرانزٹ اتھارٹی، حکومت سندھ

آفس 43/1-D شاہراہ قادیان چورنگی کراچی۔ فون: 021-99332207-8

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TRANSPORT AND MASS TRANSIT
DEPARTMENT
GOVERNMENT OF SINDH
Karachi, dated: 15th September, 2026

NOTIFICATION

NO:SO (Dev)/2(45)/TMTD/2026-27: In pursuance of Rules 7 & 8 of Sindh Public Procurement Rules-2010 (Amended time to time), Government of Sindh hereby constitute Procurement Committee for Maintenance Works for Green and Orange Line with following composition and Terms of Reference (TOR) as enumerated below:

S.NO.	DESIGNATION	STATUS
1	Managing Director, SMTA, Government of Sindh	Chairman
2	Director Bus Operations, BRT SMTA, Government of Sindh	Member
3	Director, Infrastructure & Planning, SMTA, Government of Sindh	Member
4	DD Business Development, SMTA, Government of Sindh	Member
5	Officer of Excise and Taxation Department, Government of Sindh (not below a rank of BPS-18)	Member

Functions and Responsibility of Procurement Committee:

1. Preparing and/or Reviewing bidding documents;
2. Carrying out technical as well as financial evaluation of bids;
3. Preparing evaluation reports as provided in Rule 45;
4. Making recommendations for the award of the contract to the competent authority; and
5. Perform any other function ancillary and incidental to the above.

ASSAD ZAMIN
SECRETARY TO GOVERNMENT OF SINDH

NO:SO (Dev)/2(45)/TMTD/2026-27

Karachi, dated: 15th September, 2026

1. All member of the Committee;
2. The PS to Secretary, Transport and Mass Transit Department, Government of Sindh, Karachi;
3. The PS to Managing Director, SMTA, Government of Sindh, Karachi;
4. Notification File.



SECTION OFFICER (GENERAL)
Secretary to Government of Sindh



TRANSPORT AND MASS TRANSIT
DEPARTMENT
GOVERNMENT OF SINDH
Karachi dated: 15th September, 2026

NOTIFICATION

NO:SO (Dev)/2(45)/TMTD/2026-27: In pursuance of Rule 31 of Sindh Public Procurement Rules, 2010 (Amended time to time) Government of Sindh hereby constitute a Complaint Redressal Committee along with TOR's to address the complaint of the bidders that may occur during the procurement process in respect of Maintenance Works for Green and Orange line BRTS with following composition and Terms of Reference (TOR) as enumerated below:

S.NO.	DESIGNATION	STATUS
1.	Secretary, Transport and Mass Transit Department, Sindh	Chairman
2.	A Representative from Accountant General Sindh	Member
3.	Independent Professional from relevant field to be nominated by Secretary TMTD.	Member

The Complaint Redressal Committee shall handle and disposed of the complaints in accordance with provision of Rule 31 of SPPRA Rules 2010 (amended time to time)

ASSAD ZAMIN
SECRETARY TO GOVERNMENT OF SINDH

NO:SO (Dev)/2(45)/TMTD/2026-27:

Karachi, dated: 15th September, 2026

1. All member of the Committee
2. The PS to Secretary, Transport and Mass Transit Department, Government of Sindh, Karachi
3. The PS to Managing Director, SMTA, Government of Sindh, Karachi
4. Notification File.



SECTION OFFICER (GENERAL)
For Secretary to Government of Sindh

ANNUAL PROCUREMENT PLAN (2026-27)
(SINDH MASS TRANSIT AUTHORITY)

Sr. No.	Description of Procurement	Estimated total cost (Million)	Funds allocated (Million)	Source of funds (ADP/ Non ADP/others) (Million)	Type of Procurement	Proposed procurement Method	Timing of Procurement				Remarks
							1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	
01	MAINTENANCE OF BRTS GREEN AND ORANGE LINES	300	300	Green Line 150 (contingency) 150 (Fare Revenue)	NCB	Single Stage 2 Envelope			1 st		In progress
02	HIRING OF FIRM FOR INTERNAL AUDIT OF SMTA	5	5	SMTA	NCB	Single Stage 2 Envelope			2 nd		To be started

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