Standard Bidding Document

UPGRADATION AND IMPROVEMENT OF ELECTRICAL SYSTEM AT SBP BSC (BANK) NORTH NAZIMABAD
(Works)

National

Single Stage-Two Envelope

October 12, 2026

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REQUEST FOR BIDS

PROCUREMENT OF CIVIL WORKS

1. The **SBP-BSC North (SBP Banking Services Corporation (BSC))** has reserved Funds for the procurement planned for FY **2026-27**. The **SBP-BSC North (SBP Banking Services Corporation (BSC))** intends to apply part of the proceeds of this Fund to cover eligible payments under the contract for the "**UPGRADATION AND IMPROVEMENT OF ELECTRICAL SYSTEM AT SBP BSC (BANK) NORTH NAZIMABAD**" with the reference of "**P103714**".

2. The **SBP-BSC North (SBP Banking Services Corporation (BSC))** invites sealed Bids from eligible Bidders for procurement of Works **(UPGRADATION AND IMPROVEMENT OF ELECTRICAL SYSTEM AT SBP BSC (BANK) NORTH NAZIMABAD)** described in the bidding documents on **EPADS v2.0**.

3. **Single Stage-Two Envelope** will be used by adopting **Least Cost Based Selection (LCBS)** Technique for the subject procurement, in line with the Public Procurement Rules, 2004 and any Regulations, Regulatory Guides, Procurement Guidelines or Instructions issued by the Authority from time to time.

4. All Bids must be accompanied by a Bid Security amount described in Bid Security Section in Bidding Document in the form of **Pay Order, Banker's Cheque, Call at Deposit, Demand Draft**. Or all bids must be accompanied by bid securing declaration in the format specified in the Bidding documents

5. E-Bidding documents, containing detailed terms & conditions, specifications and requirements etc. are available on **e-Pak Acquisition and Disposal System (EPADS)** at **https://epads.gov.pk/opportunities/federal/procurements/103714** for all the interested bidders registered on **EPADS v2.0**. Bidders are required to get themselves registered on **EPADS v2.0** to participate in Bidding process.

6. The e-bids, prepared in accordance with the instructions in the e-Bidding documents, must be submitted through **EPADS v2.0** on or before **Wednesday, November 4, 2026 03:00 PM**. E-bids will be opened by using **EPADS v2.0** on the same day at **Wednesday, November 4, 2026 03:30**

PM. Manual submission of Bids shall not be entertained. Those vendor who have not yet registered on the new version of **EPADS v2.0**, may register themselves on **https://vendors.epads.gov.pk/**. A tutorial to explain the registeration process is available at **https://www.youtube.com/watch?v=MNW6T38v7tc.**

In terms of Rules 48 of Public Procurement Rules, 2004 Grievance Redressal Committee (GRC) is notified for the subject procurement and notification copy is available on the procuring agency's website and on Authority's website at (**www.ppra.org.pk**).

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Instructions to Bidders

A. INTRODUCTION

1. **Scope of Bid**

1.1. The Procuring agency/Employer (PA), as indicated in the Bid Data Sheet (BDS) invites Bids for the execution of Works as specified in the BDS and Section V- Works Requirements. The name, identification, and number of lots (contracts) of this National/ International Competitive Bidding process are specified in the BDS.

2. **Source of Funds**

2.1. Source of funds as referred in Clause 2 of Bid Data Sheet.

3. **Eligible Bidders**

3.1. A bidder may be natural person, company or firm or public or semi-public agency of Pakistan or any foreign country, or any combination of them with a formal existing agreement (on Judicial Papers) in the form of a joint venture or consortium. In the case of a joint venture or consortium, all members shall be jointly and severally liable for the execution of the Contract in accordance with the terms and conditions of the Contract. The joint venture or consortium shall nominate a Lead Member as nominated in the BDS, who shall have the authority to conduct all business for and on behalf of any and all the members of the joint venture or consortium during the Bidding process, and in case of award of contract, during the execution of contract. Verifiable copy of the agreement that forms a joint venture, consortium or association shall be required to be submitted as part of the Bid.

Any bid submitted by the joint venture, consortium or association shall indicate the part of proposed contract to be performed by each party and each party shall be evaluated (or post qualified if required) with respect to its contribution only, and the responsibilities of each party shall not be substantially altered without prior written approval of the Procuring Agency and in line with any instructions issued by the Authority.

(The limit on the number of members of JV or Consortium may be prescribed

in BDS, in accordance with the guidelines issued by the PPRA).

3.2. The invitation for bids is open to all prospective bidders subject to any provisions of incorporation or licensing by the respective national/ international incorporating agency or statutory body established for that particular trade or business. Procuring agencies shall specify the registration/licensing requirements for the foreign bidder keeping in view the requirement of that business.

3.3. A Bidder shall not have a conflict of interest. All Bidders found to have a conflict of interest shall be disqualified. A Bidders may be considered to have a conflict of interest with one or more parties in this Bidding process, if they:

3.3.1. are associated or have been associated in the past, directly or indirectly with a firm or any of its affiliates which have been engaged by the Procuring agency/Employer to provide consulting services for the preparation of design or technical specifications of the works that are the subject of the bid; or

3.3.2. have controlling shareholders in common; or

3.3.3. receive or have received any direct or indirect subsidy from any of them; or

3.3.4. have the same legal representative for purposes of this Bid; or

3.3.5. have a relationship with each other, directly or through common third parties, that puts them in a position to have access to information about or influence on the bid of another bidder, or influence the decisions of the Procuring agency/Employer regarding this Bidding process; or

3.3.6. Submit more than one bid in this bidding process.

3.4. A Bidder may be ineligible if –

3.4.1. he is declared bankrupt or, in the case of company or firm, insolvent;

3.4.2. payments in favor of the bidder is suspended in accordance with the judgment of a court of law other than a judgment declaring bankruptcy and resulting (in accordance with the national laws) in the total or partial loss of the right to administer and dispose of its property;

3.4.3. the bidder is convicted, by a final judgment of a Court of Law or relevant Professional Statuary Body, of any offence involving professional conduct;

3.4.4. The bidder is debarred/ blacklisted by a national level Procuring agency/Employer and hence debarred due to involvement in corrupt and fraudulent practices, or performance failure or due to breach of bid securing declaration.

3.5. As and when required, bidders shall provide to the Procuring agency/Employer evidence of their eligibility, proof of compliance with the necessary legal requirements to carry out the contract effectively.

3.6. Bidders shall submit proposal relating to the nature, conditions and modalities of sub-contracting wherever the sub-contracting of any elements of the contract is envisaged.

4. **Eligible Material and Equipment**

4.1. All the material and equipment to be mobilized under the contract shall have their origin in eligible source countries, and all expenditures made under the contract will be limited to such materials and equipment. For this purpose, ineligible countries are stated in the section-IV titled as “Eligible Countries”.

B. BIDDING DOCUMENTS

5. **Contents of Bidding Documents**

5.1. The scope of Works, bidding procedures, and terms and conditions of the contract are prescribed in the bidding documents. In addition to the Invitation for Bids, the bidding documents which should be read in

conjunction with any addenda issued in accordance with ITB 7.1 include:

Section I -Invitation for Bids

Section II Instructions to Bidders (ITBs)

Section III Bid Data Sheet (BDS)

Section IV Eligible Countries

Section V Evaluation and Qualification Criteria

Section VI Works Requirements Technical Specifications & Schedule of Requirements

Section VII Standard Bidding Forms

Section VIII General Conditions of Contract (GCC)

Section IX Particular Conditions of Contract (PCC)

Section X Contract Forms

5.2. The bidder is expected to examine all instructions, forms, specifications, terms and conditions prescribed in the bidding documents. Failure to furnish all the information required in the bidding documents will be at the bidder’s risk and may result in the rejection of his bid.

6. **Clarification of Bidding Document, Pre-bid Meeting**

6.1. A prospective bidder requiring any clarification of the bidding document may notify the Procuring agency/Employer through EPADS.

6.2. The Procuring agency/Employer shall respond to the request for clarification in accordance with Rule 31 of the Public Procurement Rules 2004.

6.3. Should the Procuring Agency deem it necessary to amend the BIDDING document as a result of a clarification, it shall do so following the procedure under ITB 7.

6.4. If indicated in the BDS, the bidder’s designated representative is invited at the bidder’s cost to attend a pre-bid meeting at the place, date and time mentioned in the BDS. During this pre-bid meeting, prospective bidders may request clarification of the schedule of requirement, the evaluation criteria or any other aspects of the bidding documents.

6.5. Minutes of the pre-bid meeting, if applicable, including the text of the questions asked by bidders, including those during the meeting (without identifying the source) and the responses given, together with any responses prepared after the meeting will be uploaded on EPADS. Any modification to the bidding documents that may become necessary as a result of the pre-bid meeting shall be made by the Procuring agency/Employer exclusively through the use of an Addendum pursuant to ITB 7. Non-attendance at the pre-bid meeting will not be a cause for disqualification of a bidder.

6.6. The bidder is advised to visit and examine the Site of Works and its surroundings and obtain for itself on its own responsibility all information that may be necessary for preparing the bid and entering into a contract for construction of the Works. The costs of visiting the Site shall be at the bidder's own expense.

6.7. The bidder and any of its authorized personnel will be granted permission by the Procuring agency/Employer to enter upon its premises and lands for the purpose of such visit, but only upon the express condition that the bidder and its personnel will release and indemnify the Procuring agency/Employer 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 the inspection.

7. **Amendment of Bidding Documents**

7.1. The procuring agency may issue notification of any change, addition, modification or deletion in accordance with Rule 23 of the Public Procurement Rules 2004 i.e. Bidding Documents.

7.2. To give prospective bidders reasonable time in which to take an addendum/corrigendum into account in preparing their bids, the Procuring agency/Employer may, at its discretion, extend the deadline for the submission of bids:

Provided that the Procuring agency/Employer shall extend the deadline for submission of bid in pursuance of Rule 27 of the Public Procurement Rules 2004, i.e. Extension of time for submission of bids, if such an addendum is

issued within last three (03) days of the bid submission deadline.

C. PREPARATION OF BIDS

8. **Language of Bid**

8.1. The bid prepared by the bidder, as well as all correspondence and documents relating to the bid exchanged by the bidder and the Procuring agency/Employer shall be written in the English language unless specified in the BDS. Supporting documents and printed literature furnished by the bidder may be in another language provided they are accompanied by an accurate translation of the relevant pages in the English language unless specified in the BDS, in which case, for purposes of interpretation of the bidder, the translation shall govern.

9. **Documents Constituting the Bids**

9.1. The Bids prepared by the Bidder shall constitute of all the documents required in the BDS.

10. **Documents Establishing Eligibility of Material, Equipment and Works, their Conformity to Bidding Documents**

10.1. The bid prepared by the bidder shall constitute the following components: -

10.1.1. Documentary evidence established in accordance with ITB 10 that the material and equipment to be utilized by the Bidder for the executions of works are eligible material and equipment and conform to the Bidding Documents;

10.1.2. Documentary evidence established in accordance with ITB 11 that the bidder has been authorized to carry out the Construction works;

10.1.3. Documentary evidence established in accordance with ITB 11 that the bidder is eligible and/or qualified for the subject bidding process;

10.1.4. Form of Bid and Bid Prices completed in accordance with ITB 12 and 13;

10.1.5. Completed schedules as required, including priced Bill of Quantities in accordance with ITB 13.

10.1.6. Technical Proposal completed in all aspects in accordance with ITB-15.

10.1.7. Bid security or Bid Securing Declaration furnished in accordance with ITB 17;

10.1.8. Any other document required in the BDS.

10.2. In addition to the requirements, bids submitted by a JV shall include a copy of the Joint Venture Agreement entered into by all members. Alternatively, a letter of intent to execute a Joint Venture Agreement in the event of a successful bid shall be signed by all members and submitted with the bid, together with a copy of the proposed Agreement.

10.3. The bidder shall furnish, as part of its bid, all those documents establishing the eligibility in conformity to the terms and conditions specified in the bidding documents for all material, equipment and works which the bidder proposes to execute.

10.4. The documentary evidence of conformity of the material, equipment and works to the Bidding Documents may be in the form of literature, drawings, and data, and shall consist of:

10.4.1. a detailed description of the work methodology, approach, schedule and resources to be mobilized at site;

10.4.2. an item-by-item commentary on the Procuring agency/Employer’s Technical Specifications demonstrating substantial responsiveness of the material, equipment and works to those specifications, or a statement of deviations and exceptions to the provisions of the Technical Specifications;

10.4.3. any other procurement specific documentation requirement as stated in the BDS.

10.5. The required documents and other accompanying documents must be in English. In case any other language than English is used the pertinent translation into English shall be attached to the original version.

11. **Documents Establishing Eligibility and Qualification of the Bidder**

11.1. The bidder shall furnish, as part of its bid, all those documents establishing the bidder's eligibility to participate in the bidding process and/or its qualification to perform the contract if its bid is accepted.

11.2. The documentary evidence of the bidder's eligibility to bid shall establish to the satisfaction of the Procuring agency/Employer that the bidder, at the time of submission of its bid, is from an eligible country as defined in Section-IV titled as "Eligible Countries".

11.3. The documentary evidence of the bidder's qualification to perform the contract if its bid is accepted shall establish to the satisfaction of Procuring agency/Employer that:

11.3.1. The bidder has the financial and technical capability necessary to perform the Contract, meets the qualification criteria specified in Section-V, Evaluation and Qualification Criteria and BDS.

11.3.2. In the case of a bidder not doing business within Pakistan, the bidder is or will be (if awarded the contract) represented by a local bidder (Joint Venture) in accordance with the PEC works bylaws, and in case of award of works such foreign firm is required to participate in the execution of works to carry out its obligations as prescribed in the Conditions of Contract and /or Technical Specifications.

11.3.3. That the bidder meets the qualification criteria listed in Section-V, Evaluation and Qualification Criteria and BDS.

12. **Forms of Bid**

12.1. The Bidder shall fill the Form of Bids furnished in the bidding documents. The Bids Form must be completed without any alterations to its format and no substitute shall be accepted.

13. **Bid Prices**

13.1. The bid prices quoted by the bidder in the Standard bid Forms, Bill of Quantities and in the Price Schedules shall conform to the requirements specified below or exclusively mentioned hereafter in the bidding documents.

13.2. The bidder shall fill in rates and prices for all items of the Works described in the Bill of Quantities. If a Price Schedule shows items listed but not priced, their prices shall be construed to be included in the prices of other items in the Bill of Quantities and will not be paid for separately by the Procuring agency/Employer.

13.3. Items not listed in the Price Schedule shall be assumed not to be included in the bid, and provided that the bid is still substantially responsive in their absence or due to their nominal nature, the corresponding average price of the respective item(s) of the remaining substantially responsive bidder(s) shall be construed to be the price of those missing item(s):
Provided that:

13.3.1. where there is only one (substantially) responsive bidder, or

13.3.2. where there is provision for alternate proposals and the respective items are not listed in the other bids,
The Procuring agency/Employer may fix the price of missing items in accordance with market survey, and the same shall be considered as final price.

13.4. The Bid price to be quoted in the Form of Bid in accordance with ITB 12 shall be the total price of the bid.

13.5. Unless otherwise specified in the BDS and the Contract, the rates and prices quoted by the bidder are subject to adjustment during the performance of the Contract in accordance with the provisions of the

Conditions of Contract.

13.6. If so specified in ITB 1.1, bids may be invited for individual lots (contracts) or for any combination of lots (packages).

13.7. Prices quoted by the Bidder shall be fixed during the bidder's performance of the contract and not subject to variation on any account. A bid submitted with an adjustable price will be treated as non-responsive and shall be rejected, pursuant to ITB 27, unless otherwise price adjustment is permissible under Conditions of the Contract.

13.8. All duties, taxes, and other levies payable by the Contractor under the Contract, or for any other cause, as of the date twenty-eight (28) days prior to the deadline for submission of bids, shall be included in the rates and prices and the total bid price submitted by the bidder.

14. **Currencies of Bid and Payment**

14.1. Prices shall be quoted in Pakistani Rupees unless otherwise specified in the BDS. Comparison of bids and tie of bid shall be treated in accordance with the Rule 30(2) of Public Procurement Rules, 2004.

15. **Documents Comprising the Technical Proposal**

15.1. The bidder shall furnish a Technical Proposal including a statement of work methods, equipment, personnel, schedule and any other information as stipulated in Section VII – Standard Bid Forms, in sufficient detail to demonstrate the adequacy of the bidder's proposal to meet the work requirements and the completion time.

16. **Bid Validity Period**

16.1. Bids shall remain valid for the period specified in the BDS after the bid submission deadline prescribed by the Procuring agency/Employer. A bid valid for a shorter period shall be rejected by the Procuring agency/Employer as non-responsive. The period of bid validity will be determined from the complementary bid securing instrument i.e. the expiry period of bid security or bid securing declaration as the case may be.

16.2. Under exceptional circumstances, prior to the expiration of the initial Bids/Bid validity period, the Procuring Agency may request the Bidders' consent to an extension of the period of validity of their Bids/Bid. Such request for extension of the period of bid validity shall be carried out in accordance with Rule 26 of the Public Procurement Rules, 2004.

17. **Bid Security or Bid Securing Declaration**

17.1. Pursuant to ITB 11.1 unless otherwise specified in the BDS, the bidder shall furnish as part of its bid, a Bid Security in accordance with Rule 25 of the Public Procurement Rules, 2004 in the amount and currency specified in the BDS or Bid Securing Declaration as specified in the BDS in the format provided in Section VII (Standard Bidding Forms).

In case Procuring agency/Employer is inviting bids in lots / packages, the bidder shall be required to submit his bid security against the respective lot/ package for which he is submitting his bid.

Until the development of functionality of auto verification of financial instrument in EPADS, the scanned copy of bid security or bid securing declaration, as the case may be, shall be uploaded on E-PADS whereas the original instrument to be submitted to the procuring agency before closing of bid submission deadline,

17.2. The Bid Security shall be denominated in the local currency or in another freely convertible currency, and it shall be in the form specified in the **BDS** which shall be in any of the following:

17.2.1. A bank guarantee, an irrevocable letter of credit issued by a Scheduled bank in the form provided in the Bidding Documents or another form acceptable to the Procuring agency/Employer and valid for twenty-eight (28) days beyond the end of the validity of the Bid. This shall also apply if the period for Bid Validity is extended. In either case, the form must include the complete name of the bidder;

17.2.2. A cashier's or certified cheque; or

17.2.3. Another security as indicated in the **BDS**.

17.3. The Bid Security or Bid Securing Declaration shall be in accordance with the Form of the Bid Security or Bid Securing Declaration included in Section VII (Standard Bidding Forms) or another form approved by the Procuring agency/Employer prior to the bid submission.

17.4. The Bid Security shall be payable promptly upon written demand by the Procuring agency/Employer in case any of the conditions listed in ITB 17.9 are invoked.

17.5. Any bid not accompanied by a Bid Security or Bid Securing Declaration in accordance with ITB 17.1 or 17.3 shall be rejected by the Procuring agency/Employer and shall be declared as non-responsive bid, pursuant to ITB 27.

17.6. Unsuccessful bidders' Bid Security will be discharged or returned as promptly as possible, however in no case later than thirty (30) days after the expiration of the period of Bid Validity prescribed by the Procuring agency/Employer pursuant to ITB 16. The Procuring agency/Employer shall make no claim to the amount of the Bid Security, and shall promptly return the Bid Security document, after whichever of the following that occurs earliest:

17.6.1. The expiry of the Bid Security;

17.6.2. The entry into force of a procurement contract and the provision of a performance security (or guarantee), for the performance of the contract if such a security (or guarantee), is required by the Biding documents;

17.6.3. The rejection by the Procuring agency/Employer of all Bids;

17.6.4. The withdrawal of the bid prior to the deadline for the submission of bids, unless the biding documents stipulate that no such withdrawal is permitted.

17.7. The successful bidder's Bid Security will be discharged upon the bidder signing the contract pursuant to ITB 40, or furnishing the performance security (or guarantee), pursuant to ITB 41.

17.8. The Bid Security may be forfeited or the Bid Securing Declaration executed:

17.8.1. if a Bidder:

17.8.1.1. Withdraws its Bid during the period of Bid Validity as specified by the Procuring agency/Employer, and referred by the bidder on the Form of Bid except as provided for in ITB 16.2; or

17.8.2. In the case of a successful bidder, if the bidder fails:

17.8.2.1. to sign the contract in accordance with ITB 40; or

17.8.2.2. to furnish performance security (or guarantee) in accordance with ITB 41.

17.9. In case of Bid Security issued by the foreign bank is allowed by the Procuring agency/Employer, the same should be counter guaranteed by a corresponding bank in Pakistan. Furthermore, in case of joint venture, it should be in the name of Joint venture to ensure joint responsibility. In case the JV is not legally constituted at the time of bid submission, the bid security or bid securing declaration shall be in the names of all future members as named in the letter of bid.

18. **Withdrawal of Bids**

18.1. Before bid submission deadline, any bidder may withdraw, substitute, or modify its bid after it has been submitted by sending a written notice, duly signed by an authorized representative, and the corresponding must accompany the respective written notice.

19. **Format and Signing of Bid**

19.1. The Bidder shall prepare and submit Bids through EPADS with due diligence after carefully reading all the terms and condition before bid submission deadline.

D. SUBMISSION OF BIDS

20. **Submission of Bids through EPADS v2.0**

20.1. All bids shall be submitted through EPADS v2.0.

21. **Deadline for Submission of Bids**

21.1. All bids shall be received through **EPADS v2.0** not later than bid submission deadline as specified in the **BDS**.

21.2. The Procuring agency/Employer may, under exceptional circumstances and at its discretion, extend the deadline for the submission of bids, pursuant to Rule 27 of the Public Procurement Rules, 2004. Extension of Time for submission of bid, by amending the Bidding Documents in accordance with ITB 7, in which case all rights and obligations of the Procuring agency/Employer and bidders previously subject to the deadline will thereafter be subject to the new deadline.

22. **Substitution and Modification of bids**

22.1. A bidder may substitute or modify his bid after it has been submitted, provided that written notice of the substitution or modification of the bid, is received by the Procuring agency/Employer prior to the deadline for submission of bids.

22.2. Revised bid may be submitted after the substitution or modification made in the original bid in accordance with the provisions referred in **ITB 18** .

E. OPENING AND EVALUATION OF BIDS

23. **Opening of Bids**

23.1. The Procuring Agency will open bids in accordance with Rule 28 of the Public Procurement Rules, 2004 and as specified in the BDS.

24. **Confidentiality**

24.1. Information relating to the examination, clarification, evaluation and comparison of bids and recommendation of contract award shall not be disclosed to bidders or any other persons not officially concerned with such process until the time of the announcement of the respective evaluation report.

25. **Clarification of Bids**

25.1. Clarification of Bidding Documents shall be carried out in accordance with Rule 31 of the Public Procurement Rules, 2004.

25.2. The alteration or modification in the bid which in any case affect the following parameters will be considered as a change in the substance of a bid:

25.2.1. evaluation & qualification criteria;

25.2.2. required scope of work;

25.2.3. contract price;

25.2.4. all securities requirements;

25.2.5. tax requirements;

25.2.6. terms and conditions of bidding documents.

25.2.7. change in the ranking of the bidder

26. **Preliminary Examination of Bids**

26.1. Prior to the detailed evaluation of bids, the Procuring agency/Employer will determine whether each bid:

26.1.1. meets the eligibility criteria defined in **ITB 3** and **ITB 4**;

26.1.2. has been prepared as per the format and contents defined by the Procuring agency/Employer in the bidding documents;

26.1.3. has been properly signed;

26.1.4. is accompanied by the required securities; and

26.1.5. is substantially responsive to the requirements of the bidding documents.

The Procuring agency/Employer's determination of a bid's substantial responsiveness will be based on the contents of the bid itself.

26.2. A substantially responsive Bid is one which conforms to all the terms, conditions, and specifications of the Bidding Documents, without material deviation or reservation. A material deviation or reservation is one that: -

26.2.1. affects in any substantial way the scope, quality, or performance of the Works;

26.2.2. limits in any substantial way, inconsistent with the bidding documents, the Procuring agency/Employer's rights or the bidders' obligations under the Contract; or

26.2.3. if rectified, would affect unfairly the competitive position of other bidders presenting substantially responsive bids.

26.3. The Procuring agency/Employer will confirm that the documents and information specified under ITB 9, 10 and 11 have been provided in the bid. If any of these documents or information is missing, or is not provided in accordance with the Instructions to Bidders, the bid shall be rejected.

26.4. The Procuring agency/Employer may waive-off any minor informality, nonconformity, or irregularity in a bid which does not constitute a material deviation, provided such waiver does not prejudice or affect the relative ranking of any Bidder.

Explanation: A minor informality, non-conformity or irregularity is one that is merely a matter of form and not of substance. It also pertains to some immaterial defect in a Bid or variation of a bid from the exact requirements of the invitation that can be corrected or waived without being prejudicial to other bidders. The defect or variation is immaterial when the effect on quantity, quality, or delivery is negligible when contrasted with the total cost or scope of the works. The Procuring agency/Employer either shall give the bidder an opportunity to cure any deficiency resulting from a minor

informality or irregularity in a bid or waive the deficiency, whichever is advantageous to the Procuring agency/Employer. Examples of minor informalities or irregularities include failure of a bidder to –

26.4.1. *Submit the number of copies of signed bids required by the invitation;*

26.4.2. *Furnish required information concerning the number of its employees;*

26.4.3. *the firm submitting a bid has formally adopted or authorized, before the date set for opening of bids, the execution of documents by typewritten, printed, or stamped signature and submits evidence of such authorization and the bid carries such a signature.*

26.5. Provided that a Technical Bid is substantially responsive, the Procuring agency/Employer may request the bidder to submit the necessary information or documentation, within a reasonable period of time, to rectify nonmaterial nonconformities or omissions in the Technical Bid related to documentation requirements. Requesting information or documentation on such nonconformities shall not be related to any such aspect of the technical Proposal linked with the ranking of the bidders. Failure of the bidder to comply with the request may result in the rejection of its bid.

26.6. Provided that a Technical Bid is substantially responsive, the Procuring agency/Employer shall rectify quantifiable nonmaterial nonconformities or omissions related to the Financial Proposal. To this effect, the Bid Price shall be adjusted, for comparison purposes only, to reflect the price of the missing or nonconforming item or component.

26.7. If a bid is not substantially responsive, it will be rejected by the Procuring agency/Employer and may not subsequently be evaluated for complete technical responsiveness.

27. **Examination of Terms and Conditions; Technical Evaluation**

27.1. The Procuring agency/Employer shall examine the bid to confirm that all terms and conditions specified in the **GCC** and the **PCC** have been

accepted by the bidder without any material deviation or reservation.

For this purpose:

“Deviation” means departure from the requirements specified in the Bidding Document.

“Reservation” means setting of limiting conditions or withholding from complete acceptance of the requirements specified in the Bidding Document.

27.2. The Procuring agency/Employer shall evaluate the technical aspects of the bid submitted in accordance with ITB 30, to confirm that all requirements specified in Section VI – Works Requirement, Technical Specifications of the Bidding Documents have been met without material deviation or reservation.

27.3. If after the examination of the terms and conditions and the technical evaluation, the Procuring agency/Employer determines that the bid is not substantially responsive in accordance with ITB 27, it shall reject the bid.

28. **Correction of Arithmetic Errors**

28.1. Bids determined to be substantially responsive will be checked for any arithmetic errors. Errors will be corrected as follows: -

28.1.1. if there is a discrepancy between unit prices and the sub-total price that is obtained by multiplying the unit price and quantity, the unit price shall prevail, and the sub-total price shall be corrected, unless in the opinion of the Procuring agency/Employer there is an obvious misplacement of the decimal point in the unit price, in which the total price as quoted shall govern and the unit price shall be corrected;

28.1.2. if there is an error in a total corresponding to the addition or subtraction of sub-totals, the sub-totals shall prevail, and the total shall be corrected; and

28.1.3. where there is a discrepancy between the amounts in figures and in words, the amount in words will govern.

28.1.4. Where there is discrepancy between grand total of price schedule and amount mentioned on the Form of Bid, the amount referred in Price Schedule shall be treated as correct subject to elimination of other errors.

28.2. The amount stated in the Bid will, be rectified by the Procuring agency/Employer in accordance with the above procedure for the correction of errors and, with, the concurrence of the bidder, shall be considered as binding upon the bidder. If the bidder does not accept the corrected amount, its bid shall be rejected after forfeiture of Bid Security or execution of the Bid Securing Declaration, as the case may be, in accordance with **ITB 41.3**.

29. **Conversion to Single Currency**

29.1. 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 from outside the Procuring agency/Employer's country (referred to as the "Foreign Currency Requirements") shall indicate the same in the letter of bid-financial proposal. 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 his bid. Comparison of bids quoted in different currencies and conversion of bids into a single currency shall be carried out in accordance with Rule 30(2) of the Public Procurement Rules, 2004**.**

30. **Evaluation of Bids**

30.1. The Procuring agency/Employer shall evaluate and compare only the bids determined to be substantially responsive, pursuant to **ITB 27**.

30.2. In evaluating the Technical Proposal of each Bid, the Procuring agency/Employer shall use the criteria and methodologies listed in the BDS

and in terms of works requirement. No other evaluation criteria or methodologies shall be permitted.

30.3. The Procuring agency/Employer's evaluation of a bid will take into account:

30.3.1. the bid price, excluding provisional sums and the provision, if any, for contingencies in the summary bill of quantities, but including day work items, where priced competitively;

30.3.2. converting the amount resulting from applying above, if relevant, to a single currency in accordance with ITB 29;

30.4. 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.

30.5. If these bidding documents allow bidders to quote separate prices for different lots, and the award to a single bidder of multiple lots, the methodology of evaluation to determine the lowest evaluated lot combinations in the Form of Bid, is specified in the **BDS**.

30.6. If the bid, which results in the Evaluated Bid Price (Successful Bid), is seriously unbalanced or front loaded in the opinion of the Employer, the Employer 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, taking into consideration the schedule of estimated Contract payments, the Employer may require that the amount of the performance security be increased at the expense of the Bidder to a level sufficient to protect the Employer against financial loss in the event of default of the successful Bidder under the Contract.

Explanation:

"Unbalanced" or "front-loaded" bids consist of deliberately submitting bids with artificially high prices or unit rates for the early stages of a construction project, offset by artificially low prices or unit rates for the later stages of the project, to improve the contractor's cash flow.

31. **Domestic Preference**

31.1. If the **BDS** so specifies, the Procuring agency/Employer will grant a margin of preference to the domestic contractor in line with the rules, regulations, regulatory guides or instructions issued by the Authority from time to time.

32. **Determination of Successful Bid**

32.1. The Procuring agency/Employer shall compare the evaluated bids in accordance with the predefined bidding procedure, of all substantially responsive bids to determine the Successful bidder.

33. **Qualification of Bidder**

33.1. The Procuring agency/Employer shall determine to its satisfaction whether the bidder is substantially responsive and whose bid is declared as Successful bid either continues to meet (if prequalification applies) or meets (if post-qualification applies) the qualifying criteria specified in Evaluation and Qualification Criteria.
Note: In case of international bidding, the parameters for incorporation or licensing within Pakistan may be fulfilled as part of post qualification.

33.2. The determination shall be based upon an examination of the documentary evidence of the bidder’s qualifications submitted by the bidder, pursuant to **ITB 11**.

33.3. Prior to contract award, the Procuring agency/Employer will verify that the successful bidder (including each member of a JV) is not blacklisted/debarred. The Procuring agency/Employer will conduct the same verification for each sub-contractor proposed by the successful bidder.

34. **Sub-Contractors**

34.1. The bidder shall provide details regarding any specialized sub-contractor to the Procuring agency/Employer. In case change of sub-contractors, the bidder shall promptly notify the Procuring agency/Employer and obtain approval for replacement of sub-contractors.

34.2. Bidders may propose sub-contracting up to the percentage of total value of contracts or the volume of works as specified in the **BDS**.

35. **Abnormally Low Financial Bid**

35.1. A procuring Agency may reject abnormally low bids. The decision of the Procuring agency/Employer to reject a bid and reasons for the decision shall be recorded in the procurement proceedings and promptly communicated to the bidder concerned. Moreover, the Procuring agency/Employer shall not incur any liability solely by rejecting abnormally bid

Guidance for Procuring agency/Employer:

An abnormally low bid means, in the light of the Procuring agency/Employer's estimate and of all the bids submitted, the bid appears to be abnormally low by not providing a margin for normal levels of profit. In order to identify the Abnormally Low Bid (ALB) following approaches can be considered to minimize the scope of subjectivity:

35.1.1. Comparing the bid price with the cost estimate;

35.1.2. Comparing the bid price with the bids offered by other bidders submitting substantially responsive bids; and

35.1.3. Comparing the bid price with prices paid in similar contracts in the recent past either government- or development partner-funded.

35.2. The Procuring agency/Employer will determine to its satisfaction whether the bidder that is selected as having submitted the successful bid is qualified to perform the contract satisfactorily, in accordance with the criteria listed in **ITB 11**

35.3. The determination will take into account the bidder's financial and technical capabilities. It will be based upon an examination of the documentary evidence of the bidder's qualifications submitted by the bidder, pursuant to **ITB 11**, as well as such other information as the Procuring agency/Employer deems necessary and appropriate. Factors not included in these bidding documents shall not be used in the evaluation of the bidders' qualifications.

35.4. Procuring agency/Employer may seek “Certificate for Independent Price Determination” from the bidder and the results of reference checks may be used in determining award of contract.

Explanation: The Certificate shall be furnished by the bidder. The bidder shall certify that the price is determined keeping in view of all the essential aspects such as raw material, its processing, value addition, optimization of resources due to economy of scale, transportation, insurance and margin of profit etc.

35.5. An affirmative determination will be a prerequisite for award of the contract to the bidder. A negative determination will result in rejection of the bidder’s bid, in which event the Procuring agency/Employer will proceed to the next ranked bidder to make a similar determination of that bidder’s capabilities to perform satisfactorily.

F. AWARD OF CONTRACT

36. **Criteria of Award**

36.1. Subject to **ITB 36 and 37**, the Procuring agency/Employer will award the Contract to the bidder whose bid has been determined to be substantially responsive to the bidding documents and who has been declared as Successful Bidder, provided that such bidder has been determined to be:

36.1.1. eligible in accordance with the provisions of **ITB 3**;

36.1.2. is determined to be qualified to perform the Contract satisfactorily; and

36.1.3. Successful negotiations have been concluded, if any.

37. **Negotiations**

37.1. The Committee of the Procuring agency/Employer may negotiate with the Most Advantageous Bidder relating to the following areas:

37.1.1. a minor alteration to the technical (drawings, design technical specifications) details of the statement of works;

37.1.2. Methodology, work plan, staffing in view to streamline the work;

37.1.3. a minor amendment to the Particular conditions of Contract;

37.1.4. finalizing payment arrangements;

37.1.5. clarifying details that were not apparent or could not be finalized at the time of Bidding;

37.2. Where negotiation fails to result into an agreement, the Procuring agency/Employer may invite the next ranked bidder for negotiations. Where negotiations are commenced with the next ranked bidder, the Procuring agency/Employer shall not reopen earlier negotiations.

38. **Procuring agency's Right to reject All Bids**

38.1. The procuring agency has the right to reject all bids in accordance with Rule 33 of the Public Procurement Rules, 2004. However, the Authority (i.e. **PPRA**) may call from the Procuring agency/Employer the justification of those grounds.

39. **Notification of Award**

39.1. The procuring agency shall announce and publish the evaluation result in accordance with Rule 35 of the Public Procurement Rules, 2004.

39.2. Where no complaints have been lodged, the bidder whose bid has been accepted will be notified of the award by the Procuring agency/Employer prior to expiration of the bid validity period through EPADS. However, the Procuring agency/Employer shall not award any procurement contract at least for five (05) days after the announcement of final evaluation report. The notification letter (herein after and in the condition of the contract and contract form called “Letter of Acceptance” will specify the sum that the Procuring agency/Employer will pay the successful bidder in consideration for the execution and completion of the

works as prescribed by the Contract (hereinafter and in the Contract called the "Contract Price).

39.3. The notification of award will constitute the formation of the Contract, subject to the bidder furnishing the Performance Security (or guarantee) in accordance with **ITB 41** and signing of the contract in accordance with **ITB 40**.

39.4. Upon the successful bidder’s furnishing of the performance security (or guarantee) pursuant to **ITB 41**, the Procuring agency/Employer will promptly notify each unsuccessful bidder, the name of the successful bidder and the Contract amount and will discharge the Bid Security or Bid Securing Declaration of the bidder(s) pursuant to **ITB 17**.

40. **Signing of Contract**

40.1. Promptly after notification of award, Procuring agency/Employer shall send the successful bidder the draft agreement, incorporating all terms and conditions as agreed by the parties to the contract.

40.2. Immediately after the Redressal of grievance by the **GRC**, and after fulfillment of all conditions precedent of the Contract Form, the successful bidder and the Procuring agency/Employer shall sign the contract.

40.3. Where no formal signing of a contract is required, work order issued to the bidder shall be construed to be the contract.

41. **Performance Security (or Guarantee)**

41.1. After the receipt of the Letter of Acceptance, the successful bidder, within the specified time, shall deliver to the Procuring agency/Employer a Performance Guarantee in the amount and in the form stipulated in the BDS and PCC, denominated in the type and proportions of currencies in the Letter of Acceptance and in accordance with the Conditions of Contract.

41.2. If the Performance Guarantee is provided by the successful bidder and it shall be in the form specified in the BDS which shall be in any of the following:

41.2.1. certified cheque, cashier's or manager's cheque, or bank draft;

41.2.2. irrevocable letter of credit issued by a scheduled bank of Pakistan or in the case of an irrevocable letter of credit issued by a foreign bank, the letter shall be confirmed or authenticated by a scheduled bank of Pakistan;

41.2.3. bank guarantee confirmed by a reputable local bank or, in the case of a successful foreign bidder, bonded by a foreign bank; or

41.2.4. surety bond callable upon demand issued by any reputable surety or insurance company.
Any Performance Guarantee submitted shall be enforceable in Pakistan.

41.3. Failure of the Most Advantageous Bidder to comply with the requirement of **ITB 40** shall constitute sufficient grounds for the annulment of the award and forfeiture of the Bid Security or declare blacklisted (in case bid securing declaration is submitted) in which event the Procuring agency/Employer may make the award to the next most advantageous bidder or reinitiate the procurement process afresh (as a case may be).

42. **Advance Payment**

42.1. Advance payment will be provided to the bidder in percentage and in the manner as agreed by the both parties in terms of Conditions of the Contract.

42.2. The Procuring agency/Employer will provide an advance payment as stipulated in the Conditions of Contract, subject to a maximum amount, as stated and/or Conditions of the Contract. The advance payment request shall be accompanied by an advance payment security (guarantee) in the form provided in Section X. For the purpose of receiving the advance payment, the bidder shall make and estimate of, and include in its bid, the expenses that will relate to the purchase of equipment, machinery, materials, and on the engagement of labor during the first month beginning with the date of the Procuring agency/Employer's "**Notice to Commence**" as specified in the **PCC**.

43. **General Performance of the Bidders**

43.1. The Procuring agency/Employer reserves the right to obtain information regarding performance of the bidders on their previously awarded contracts / works. The Procuring agency/Employer may seek information / report from the previous employer for consideration. However, the Procuring agency/Employer shall incorporate such parameters in the evaluation criteria and accordingly decide the fate of the bid submitted.

44. **Corrupt & Fraudulent Practices**

44.1. Procuring agencies (including beneficiaries of Government funded projects and procurement) as well as Bidders/Suppliers/Contractors under Government financed contracts, observe the highest standard of ethics during the procurement and execution of such contracts, and will avoid to engage in any corrupt and fraudulent practices.

G. GRIEVANCE REDRESSAL & COMPLAINT REVIEW MECHANISM

45. **Grievance Redressal**

45.1. Grievance Redressal shall be carried out in accordance with Rule 48 of the Public Procurement Rules, 2004 i.e. Redressal of grievances by the procuring agency and “Redressal of Grievances Regulations 2021”.

H. MECHANISM OF BLACKLISTING

46. **Mechanism of Blacklisting**

46.1. The Procuring agency/Employer shall proceed Blacklisting of Bidders/Contractors in accordance with Rule 19 of the Public Procurement Rules, 2004 i.e. Blacklisting and “Blacklisting and Debarment of Bidders or Contractors Regulations 2024.

Bid Data Sheet

Bids Data Sheet (BDS)

The following specific data for the procurement of Goods to be procured shall complement, supplement, or amend the provisions in the Instructions to Bidders (ITB). Whenever there is a conflict, the provisions herein shall prevail over those in ITB.

BDS Clause Number	ITB Number	Amendments of, and Supplements to, Clauses in the Instruction to Bidders
A. Introduction		
1	1.1	Name of Procuring Agency:**SBP-BSC North (SBP Banking Services Corporation (BSC))** The subject of procurement is:**UPGRADATION AND IMPROVEMENT OF ELECTRICAL SYSTEM AT SBP BSC (BANK) NORTH NAZIMABAD** Expected commencement date: **Wednesday, March 31, 2027**
2.	2.1	Financial year for the operations of the Procuring Agency:**2026-27** Name and identification number of the Contract: **P103714**
3.	3.1	JV/Consortium or AssociationAllowed: **No** Number of JV/Consortium Members: **Nil**
B. Bidding Documents		

4.	**6.2 & 6.4**	The Bidders may seek clarifications through **EPADS v2.0**: Clarification Date: Sunday, November 1, 2026
5.	**7.2**	Any addendum, in case issued, shall be published on **SBP-BSC North (SBP Banking Services Corporation (BSC))** website and on **EPADS v2.0**.
C. Preparation of Bids		
6.	**8.1**	List of documents required along with the bid: No
7.	**9.1**	The qualification criteria to establish the supply / production capability of the bidder. *see Eligibility Criteria*
8.	**11.2**	**Works and Their relateddocuments:** *See section Required Scope of Work*
9.	**11.1**	Price schedule will be provided according to the format defined and acquired. *see section price schedule.*
10.	**11.4**	**Specifications:** *see section of specifications.*
11.	**11.5 & 13.5**	The price shall be **Fixed**. The bid price shall be adjusted in accordance with Appendix provided – Formula for Price Adjustment.
12.	**14.1**	Currency of the Bids shall be : **PKR**

13.	**16.1**	The Bids/Bid Validity period shall be: **180 Days**
14.	**17.1**	The amount of Bid Security shall be as defined in Bid Security Section for items and lots given in **BDS 6**
15.	**17.2**	The Bid Security shall be in the form of: **Pay Order, Banker's Cheque, Call at Deposit, Demand Draft**
16.	**15.1**	Alternative Bids to the requirements of the bidding documents willnot be permitted.

D. Submission of Bids

17.	**18.1 & 21.1**	Bid shall be submitted online on EPADS v2.0 whereas hard copy of the bid security should be submitted to the following; **SBP BSC (Bank) Building Shahrah-e-Noor Jahan North Nazimabad,, North Nazimabad Sub-Division, Karachi Central (District), Karachi (Division), Sindh (Province).** Bids that are not submitted on EPADS v2.0 shall be disqualified. The deadline for Bids submission is: **Wednesday, November 4, 2026 03:00 PM**

E. Opening and Evaluation of Bids

18.	**24.1**	The Bids opening shall take place on **EPADS v2.0**. Day *: **Wednesday*** Date:***November 04, 2026*** Time *: **03:30 PM***
19.	**30.2**	Selection technique adopted will be: **Least Cost Based Selection (LCBS)** *see Evaluation Criteria*
F. Award of Contract		
20.	**41.1 & 41.2**	The Performance guarantee shall: **10.00%**. The Performance Guarantee shall be acceptable in the form of:**Pay Order, Banker's Cheque, Call at Deposit, Bank Guarantee, Demand Draft**
21.	**45.1**	Arbitrator shall be appointed by mutual consent of the both parties.
G. Review of Procurement Decisions		
22.	**37**	Grievance against this procurement shall be submitted online on EPADS v2.0.

Eligibility Criteria

Bidder's Type	Required Registration
Individual / Individual Consultant Sole Proprietorship Partnership Firm Company (Private Limited) Company (Public Limited) Company (Holding Company) Company (Limited by Guarantee) State Owned Enterprise (Private Limited) State Owned Enterprise (Public Limited)	FBR (NTN) PEC

Eligibility Criteria	Document
Revenue Authority Registration: The Bidder should be registered with relevant / concerned Provincial Revenue Authority. If not registered, the 100% tax shall be deducted at source as per applicable law and credited to relevant account.	No
Valid registration with Pakistan Engineering Council at least in Category C-03, or above with specialized category EE-04 and EE-05.	Yes
Undertaking/Letter of Bid (As per Format attached): The bidder is required to submit an undertaking/letter of bid as per format attached.	Yes

Evaluation Criteria

Least Cost Based Selection (LCBS)

Weightage

Technical Evaluation %
100

Technical Marks	100
Passing Marks	**100**
Technical Evaluation Criteria	
Minimum experience of the company/ firm should not less than five (05) Years for performing works related to Electrical system (The bidder shall provide documentary evidence such as work order / acceptance letter / completion certificate / Contract documents or any other tractable evidence) (Quantitative)(Doc Required)	20
The bidder should have executed minimum One (01) project of supply & installation of 1000KVA transformer or above, HT/LT Panels of cost Rs. 120 Million during last five (05) year. OR The bidder should have executed minimum Two (02) projects of electrical supply and installation works including 1000KVA transformer or above and MV/LV panels of cost 80.0M executed during last five (05) years (The bidder shall provide documentary evidence such as work order/ completion certificate / Contract documents showing scope of works) (Quantitative)(Doc Required)	20

Available Financial Capability/Liquid Assets of Rs. 80M or above. (Bank statement be submitted as evidence showing required balance at any one instant in the statement of last three months before date of publication of tender notice or available Bank Credit Line facility during same period or Liquid Assets). OR Annual Sales volume/Gross Turnover of at least Rs. 150M in any of the last 03 (three) years Attach Copy(s) of Audited Financial Statements / Sales Tax/ Income Tax return filed in FBR/ purchase orders or work orders (Quantitative)(Doc Required)	30
The bidder/contractor shall provide technical brochures of quoted equipment complying with specification mentioned in Bill of Quantities (BOQ) and Schedule of Specifications Appendix A to Bid (Quantitative)(Doc Required)	10
The Bidder shall submit a valid support/authorization letter from the OEM of the proposed Synchronization Controller(s) or its Authorized Distributor, authorizing the Bidder for supply, installation, commissioning, and after-sales support. The OEM or Authorized Distributor shall: Hold valid OEM authorization/dealership credentials for the quoted controller brand for the last three (03) consecutive years, including the current year. Have a minimum of ten (10) years' experience in synchronization controllers, power management, generator synchronization, or related automation and control systems. Maintain a technical support office in Karachi, Pakistan. Provide technical support, warranty services, and spare parts for the proposed equipment. (Quantitative)(Doc Required)	20

Jobs/Lots

Jobs Without Lots :

Job	Delivery Schedule	Quantity	Bid Security

UPGRADATION AND IMPROVEMENT OF ELECTRICAL SYSTEM AT SBP BSC (BANK) NORTH NAZIMABAD	Address: SBP BSC (Bank) Building Shahrah-e-Noor Jahan North Nazimabad,, North Nazimabad Sub-Division, Karachi Central (District), Karachi (Division), Sindh (Province). Schedule: 540 Days Quantity: 1/job	1/job	4000000 PKR

PUBLIC PROCUREMENT REGULATORY AUTHORITY (PPRA) EPADS

Related Services :

No

Work Specifications and Market Rates

Jobs Without Lots :

Job: UPGRADATION AND IMPROVEMENT OF ELECTRICAL SYSTEM AT SBP BSC (BANK) NORTH NAZIMABAD

Specifications / Requirements:

Sr. No	S.#	DESCRIPTION	UNIT	QTY	RATE	AMOUNT IN WORDS	AMOUNT
1		SECTION - A MEDIUM VOLTAGE SWITCHGEAR					
2		Minimum Two Year Warranty required, warranty period will start from the date of successful Testing & Commissioning. NOTE: - Shop drawings with complete technical details shall be submitted for approval before manufacturing. - The Contractor shall facilitate a comprehensive Factory Acceptance Test (FAT) at the manufacturer's facility for all LV/MV panels prior to dispatch. The testing shall be witnessed by the Client/Consultant.					

Sr. No	S.#	DESCRIPTION	UNIT	QTY	RATE	AMOUNT IN WORDS	AMOUNT
3	A-1/1	Supply of following 11KV Incoming MV Type Tested Switchgear (Cassette Type) comprising with motor mechanism, metering and all protection devices CTs, PTs, Over current Protection, IBMS Complied along with Energy Analyzer, earth Fault Relay including complete interlocking facility by adding blocking coils, UVT, coils etc. Panel shall have provision for Cable Entry/Exit from TOP along with cable chamber box termination of minimum 450mm x 1200mm including seperate trolly for VCB drawout, Complete with all respects having following specifications: The (80x10mm) Cu Bus Bars shall be Tin Plated using Electroplating Method and covered with Heat Shrink Color Coded Sleeves. Complete in all respect. Breaker type: VCB Rate Voltage: 12kV Rated Current : 630A TP Busbar: Pure Copper Tinned With Sleeves BIL: 75kV Supply Frequency: 50 Hz Rated Power Frequency Withstand Voltage: 28 kV Rated Short Circuit Breaking Current Rating : 20KA for 3 sec. MV Panel must be Type Tested with operator safety IAC qualification FLR All Controls of VCB shall be 220V AC AC	No.	1	6989346	Rupees Six Million Nine Hundred Eighty Nine Thousand Three Hundred Forty Six Only	6989346

Sr. No	S.#	DESCRIPTION	UNIT	QTY	RATE	AMOUNT IN WORDS	AMOUNT
4	A-1/2	Placement, Transportation, Loading/Unloading, Installation, Testing & Commissioning of above item at S.# A-1/1	No.	1	123714	Rupees One Hundred Twenty Three Thousand Seven Hundred Fourteen Only	123714

PUBLIC PROCUREMENT REGULATORY AUTHORITY (PPRA) EPADS

Sr. No	S.#	DESCRIPTION	UNIT	QTY	RATE	AMOUNT IN WORDS	AMOUNT
5	A-2/1	Supply of 11KV Phase Reversal Correction Panel (Cassette Type) comprising with motor mechanism, metering and all protection devices CTs, PTs, Over current Protection, IBMS Complied along with Energy Analyzer, earth Fault Relay including complete interlocking facility by adding blocking coils, UVT, coils etc. Panel shall have provision for Cable Entry/Exit from TOP along with cable chamber box termination of minimum 450mm x 1200mm, Complete with all respects having following specifications: The (80x10mm) Cu Bus Bars shall be Tin Plated using Electroplating Method and covered with Heat Shrink Color Coded Sleeves. Complete in all respect. Breaker type: VCB Rate Voltage: 12kV Rated Current : 630A TP Busbar: Pure Copper Tinned With Sleeves BIL: 75kV Supply Frequency: 50 Hz Rated Power Frequency Withstand Voltage: 28 kV Rated Short Circuit Breaking Current Rating : 20KA for 3 sec. MV Panel must be Type Tested with operator safety IAC qualification AFLR All Controls of VCB shall be 220V AC AC supply should be provided by client DC power supply should be supplied by supplier if required Each Panel Shall have	No.	1	6989346	Rupees Six Million Nine Hundred Eighty Nine Thousand Three Hundred Forty Six Only	6989346

PUBLIC PROCUREMENT REGULATORY AUTHORITY (PPRA) EPADS

Sr. No	S.#	DESCRIPTION	UNIT	QTY	RATE	AMOUNT IN WORDS	AMOUNT
6	A-2/2	Placement, Transportation, Loading/Unloading, Installation, Testing & Commissioning of above item at S.# A-2/1	No.	1	123714	Rupees One Hundred Twenty Three Thousand Seven Hundred Fourteen Only	123714

PUBLIC PROCUREMENT REGULATORY AUTHORITY (PPRA) EPADS

Sr. No	S.#	DESCRIPTION	UNIT	QTY	RATE	AMOUNT IN WORDS	AMOUNT
7	A-3/1	Supply of 11KV Outgoing MV Switchgear (Cassette Type) comprising with motor mechanism and all protection devices CTs, PTs, Over current Protection, IBMS Complied along with Energy Analyzer, earth Fault Relay, earthing switch, including complete interlocking facility by adding blocking coils, UVT, coils etc. Panel shall have provision for Cable Entry/Exit from TOP along with cable chamber box termination of minimum 450mm x 1200mm, Complete with all respects having following specifications: The (80x10mm) Cu Bus Bars shall be Tin Plated using Electroplating Method and covered with Heat Shrink Color Coded Sleeves. Complete in all respect. Breaker type: VCB Rate Voltage: 12kV Rated Current : 630A TP Busbar: Pure Copper Tinned With Sleeves BIL: 75kV Supply Frequency: 50 Hz Rated Power Frequency Withstand Voltage: 28 kV Rated Short Circuit Breaking Current Rating : 20KA for 3 sec. MV Panel must be Type Tested with operator safety IAC qualification FLR All Controls of VCB shall be 220V AC AC supply should be provided by client DC power supply should be supplied by supplier if required Each Panel Shall have	No.	2	6825751	Rupees Thirteen Million Six Hundred Fifty One Thousand Five Hundred Two Only	13651502

PUBLIC PROCUREMENT REGULATORY AUTHORITY (PPRA) EPADS

Sr. No	S.#	DESCRIPTION	UNIT	QTY	RATE	AMOUNT IN WORDS	AMOUNT
8	A-3/2	Placement, Transportation, Loading/Unloading, Installation, Testing & Commissioning of above item at S.# A-3/1	No.	2	123714	Rupees Two Hundred Forty Seven Thousand Four Hundred Twenty Eight Only	247428
9	A-4/1	Supply of 600mm wide, 6 mm thick Rubber mat piece to be installed all along Switchgear in substation rooms as per requirements and specifications, complete in all respect.	Rm.	15	6786	Rupees One Hundred One Thousand Seven Hundred Ninety Only	101790

PUBLIC PROCUREMENT REGULATORY AUTHORITY (PPRA) EPADS

Sr. No	S.#	DESCRIPTION	UNIT	QTY	RATE	AMOUNT IN WORDS	AMOUNT
10	A-4/2	Laying of above item at S.# A-4/1	Rm.	15	124	Rupees One Thousand Eight Hundred Sixty Only	1860
11	A-5/1	Supply of Danger Boards, Emergency Signs etc. including all mounting accessories, complete in all respects.	Job	1	26100	Rupees Twenty Six Thousand One Hundred Only	26100
12	A-5/2	Installation, Testing & Commissioning of above item at S.# A-5/1	Job	1	6186	Rupees Six Thousand One Hundred Eighty Six Only	6186

PUBLIC PROCUREMENT REGULATORY AUTHORITY (PPRA) EPADS

Sr. No	S.#	DESCRIPTION	UNIT	QTY	RATE	AMOUNT IN WORDS	AMOUNT
13	A-6/1	Supply and delivery of a loose, fully operational, truck-mounted Vacuum Circuit Breaker (VCB) trolley, completely compatible and interchangeable with the 11kV IAC AFLR switchgear panels specified above.	No.	1	55098	Rupees Fifty Five Thousand Ninety Eight Only	55098
14	A-7	Physical Factory Acceptance Test at the manufacturer's premises for 2 Persons (1 No. Client's Representative & 1 No. Consultant's Representative with supplier)	Job	1	61857	Rupees Sixty One Thousand Eight Hundred Fifty Seven Only	61857
15		Note: ● Vendor is advised to inform missing items (if any) in BOQ at time of submitting this tender. No escalation will be considered at time of execution of work. ● Vendor to check placement of MV switch gear on substation room and make necessary arrangement for it accordingly as per site condition.					
16		SECTION - B OIL FILLED TRANSFORMER					

Sr. No	S.#	DESCRIPTION	UNIT	QTY	RATE	AMOUNT IN WORDS	AMOUNT
17	B-1/1	Supply of Oil Filled Step Down Distribution Transformers including all protection devices CTs, PTs, PRD relay etc. Complete in all respects and having following specifications: Rated power: 1000kVA Phase: 3 Phase Rated frequency: 50 Hz Rated primary voltage: 11 kV Secondary voltage (at no-load): 415 V Vector group: Dyn11 Basic Insulation Level: 95kV Dielectric liquid: Mineral oil Cooling mode: ONAN (oil natural air natural) Type of installation: Indoor Mounting mode: Ground / Pad Mounted Degree of protection: IP00 no enclosure IEC	No.	2	9487089	Rupees Eighteen Million Nine Hundred Seventy Four Thousand One Hundred Seventy Eight Only	18974178
18	B-1/2	Placement, Transportation, Loading/Unloading, Installation, Testing & Commissioning of above item at S.# B-1/1	No.	2	309285	Rupees Six Hundred Eighteen Thousand Five Hundred Seventy Only	618570

PUBLIC PROCUREMENT REGULATORY AUTHORITY (PPRA) EPADS

Sr. No	S.#	DESCRIPTION	UNIT	QTY	RATE	AMOUNT IN WORDS	AMOUNT
19	B-2/1	Supply of wiring for bucholz relay, alarm control etc. for above Transformers from transformers to MV Panels with 3x1C-2.5 Sqmm Cu/PVC cables in 25mm dia G.I conduit with all accessories, complete as per drawing and specification.	Rm.	50	1044	Rupees Fifty Two Thousand Two Hundred Only	52200
20	B-2/2	Installation, laying, tagging, termination, testing and commissioning of above item at S.# B-2/1	Rm.	50	118	Rupees Five Thousand Nine Hundred Only	5900
21	B-3	Physical Factory Acceptance Test at the manufacturer's premises for 2 Persons (1 No. Client's Representative & 1 No. Consultant's Representative with supplier)	Job	1	309285	Rupees Three Hundred Nine Thousand Two Hundred Eighty Five Only	309285
22		SECTION - C LV PANELS & DISTRIBUTION BOARDS					

PUBLIC PROCUREMENT REGULATORY AUTHORITY (PPRA) EPADS

Sr. No	S.#	DESCRIPTION	UNIT	QTY	RATE	AMOUNT IN WORDS	AMOUNT
23		Supply, Placement, Installation, Transportation, Loading/Unloading, Testing & Commissioning of the following LV Panels/Distribution boards made with 14 SWG Sheet Steel Enclosure including all installation accessories such as Rawal bolt etc. Complete in all respects. Note: - Imported Bi-Mettalic Lugs and Connectors shall be used in existing LV Cables. - Manual crimping of lugs is not allowed. Proper hydraulic lug presser should be used. - All the DBs should be front accessible and maintainable. - The transportation & unloading of Panels is to be done by Panel Supplier. - Laser engraved tags required as mention in SLDs - Space for circuit tagging required with permanent installation on protective sheet via rivets - 20% space required in DB for future provision - Tin platted Imported Cu bus bar with heat shrink color coded sleeves to be used. - Hindged protective metallic door is required with knob/handle. - Braided Door earth required. - Lockable handle required for main door. - As-built drawing pocket. - Cable hanging arrangement. - Shop drawings with complete technical details					

Sr. No	S.#	DESCRIPTION	UNIT	QTY	RATE	AMOUNT IN WORDS	AMOUNT
24	C-1/1	Supply of Main L.V Panels with PFI and Synchronization system (Form3B - Type 2 minimum). The scope comprehensively includes all necessary control cabling, an automation system featuring a remote monitoring synchronization module, a dedicated Microgrid Controller for PV system control, and an integrated HMI display module for real-time synchronization management. (Sync. Module must be COMAP) Note: -Refer Technical Specification Section V-05 (Annexure A) for control philosophy. -All Rigid Connection (Busbar links between Busway Flange and Panel) of following Busways are in Panel Builder Scope a- 1600A Main Incoming 1 b- 1600A Main Incoming 2	No.	1	32707602	Rupees Thirty Two Million Seven Hundred Seven Thousand Six Hundred Two Only	32707602

PUBLIC PROCUREMENT REGULATORY AUTHORITY (PPRA) EPADS

Sr. No	S.#	DESCRIPTION	UNIT	QTY	RATE	AMOUNT IN WORDS	AMOUNT
25	C-1/2	Placement, Installation, Transportation, Loading/Unloading, Testing & Commissioning of above item at S.# C-1/1	No.	1	371142	Rupees Three Hundred Seventy One Thousand One Hundred Forty Two Only	371142
26	C-2/1	Supply of Genset LTO Panel with Synchronization system (Form3B - Type 2 minimum). The scope comprehensively includes all necessary control cabling, an automation system featuring a remote monitoring synchronization module, complete in all respects. (Sync. Module must be COMAP)	No.	1	17963754	Rupees Seventeen Million Nine Hundred Sixty Three Thousand Seven Hundred Fifty Four Only	17963754

PUBLIC PROCUREMENT REGULATORY AUTHORITY (PPRA) EPADS

Sr. No	S.#	DESCRIPTION	UNIT	QTY	RATE	AMOUNT IN WORDS	AMOUNT
27	C-2/2	Placement, Installation, Transportation, Loading/Unloading, Testing & Commissioning of above item at S.# C-2/1	No.	1	371142	Rupees Three Hundred Seventy One Thousand One Hundred Forty Two Only	371142
28	C-3/1	Supply of LT-5 PANEL (GF)	No.	1	2890810	Rupees Two Million Eight Hundred Ninety Thousand Eight Hundred Ten Only	2890810

PUBLIC PROCUREMENT REGULATORY AUTHORITY (PPRA) EPADS

Sr. No	S.#	DESCRIPTION	UNIT	QTY	RATE	AMOUNT IN WORDS	AMOUNT
29	C-3/2	Placement, Installation, Transportation, Loading/Unloading, Testing & Commissioning of above item at S.# C-3/1	No.	1	123714	Rupees One Hundred Twenty Three Thousand Seven Hundred Fourteen Only	123714
30	C-4/1	Supply of ELT-1 PANEL (GF)	No.	1	1979336	Rupees One Million Nine Hundred Seventy Nine Thousand Three Hundred Thirty Six Only	1979336

PUBLIC PROCUREMENT REGULATORY AUTHORITY (PPRA) EPADS

Sr. No	S.#	DESCRIPTION	UNIT	QTY	RATE	AMOUNT IN WORDS	AMOUNT
31	C-4/2	Placement, Installation, Transportation, Loading/Unloading, Testing & Commissioning of above item at S.# C-4/1	No.	1	123714	Rupees One Hundred Twenty Three Thousand Seven Hundred Fourteen Only	123714
32	C-5/1	Supply of EDB-1 (GF)	No.	1	323458	Rupees Three Hundred Twenty Three Thousand Four Hundred Fifty Eight Only	323458

PUBLIC PROCUREMENT REGULATORY AUTHORITY (PPRA) EPADS

Sr. No	S.#	DESCRIPTION	UNIT	QTY	RATE	AMOUNT IN WORDS	AMOUNT
33	C-5/2	Placement, Installation, Transportation, Loading/Unloading, Testing & Commissioning of above item at S.# C-5/1	No.	1	37115	Rupees Thirty Seven Thousand One Hundred Fifteen Only	37115
34	C-6/1	Supply of DB-1 (GF)	No.	1	414129	Rupees Four Hundred Fourteen Thousand One Hundred Twenty Nine Only	414129

PUBLIC PROCUREMENT REGULATORY AUTHORITY (PPRA) EPADS

Sr. No	S.#	DESCRIPTION	UNIT	QTY	RATE	AMOUNT IN WORDS	AMOUNT
35	C-6/2	Placement, Installation, Transportation, Loading/Unloading, Testing & Commissioning of above item at S.# C-6/1	No.	1	37115	Rupees Thirty Seven Thousand One Hundred Fifteen Only	37115
36	C-7/1	Supply of DB-AC (FF)	No.	1	414745	Rupees Four Hundred Fourteen Thousand Seven Hundred Forty Five Only	414745

PUBLIC PROCUREMENT REGULATORY AUTHORITY (PPRA) EPADS

Sr. No	S.#	DESCRIPTION	UNIT	QTY	RATE	AMOUNT IN WORDS	AMOUNT
37	C-7/2	Placement, Installation, Transportation, Loading/Unloading, Testing & Commissioning of above item at S.# C-7/1	No.	1	37115	Rupees Thirty Seven Thousand One Hundred Fifteen Only	37115
38	C-8/1	Supply of EDB-4 (FF)	No.	1	339734	Rupees Three Hundred Thirty Nine Thousand Seven Hundred Thirty Four Only	339734

PUBLIC PROCUREMENT REGULATORY AUTHORITY (PPRA) EPADS

Sr. No	S.#	DESCRIPTION	UNIT	QTY	RATE	AMOUNT IN WORDS	AMOUNT
39	C-8/2	Placement, Installation, Transportation, Loading/Unloading, Testing & Commissioning of above item at S.# C-8/1	No.	1	37115	Rupees Thirty Seven Thousand One Hundred Fifteen Only	37115
40	C-9/1	Supply of SLT-1 & DB-2 (FF)	No.	1	646607	Rupees Six Hundred Forty Six Thousand Six Hundred Seven Only	646607
41	C-9/2	Placement, Installation, Transportation, Loading/Unloading, Testing & Commissioning of above item at S.# C-9/1	No.	1	37115	Rupees Thirty Seven Thousand One Hundred Fifteen Only	37115

PUBLIC PROCUREMENT REGULATORY AUTHORITY (PPRA) EPADS

Sr. No	S.#	DESCRIPTION	UNIT	QTY	RATE	AMOUNT IN WORDS	AMOUNT
42	C-10/1	Supply of SLT-2 & DB-5 (SF)	No.	1	621186	Rupees Six Hundred Twenty One Thousand One Hundred Eighty Six Only	621186
43	C-10/2	Placement, Installation, Transportation, Loading/Unloading, Testing & Commissioning of above item at S.# C-10/1	No.	1	37115	Rupees Thirty Seven Thousand One Hundred Fifteen Only	37115

PUBLIC PROCUREMENT REGULATORY AUTHORITY (PPRA) EPADS

Sr. No	S.#	DESCRIPTION	UNIT	QTY	RATE	AMOUNT IN WORDS	AMOUNT
44	C-11/1	Supply of LPDB-SF (SF)	No.	1	349495	Rupees Three Hundred Forty Nine Thousand Four Hundred Ninety Five Only	349495
45	C-11/2	Placement, Installation, Transportation, Loading/Unloading, Testing & Commissioning of above item at S.# C-11/1	No.	1	37115	Rupees Thirty Seven Thousand One Hundred Fifteen Only	37115

PUBLIC PROCUREMENT REGULATORY AUTHORITY (PPRA) EPADS

Sr. No	S.#	DESCRIPTION	UNIT	QTY	RATE	AMOUNT IN WORDS	AMOUNT
46	C-12/1	Supply of DB-HALL-1 (SF)	No.	1	368872	Rupees Three Hundred Sixty Eight Thousand Eight Hundred Seventy Two Only	368872
47	C-12/2	Placement, Installation, Transportation, Loading/Unloading, Testing & Commissioning of above item at S.# C-12/1	No.	1	37115	Rupees Thirty Seven Thousand One Hundred Fifteen Only	37115

PUBLIC PROCUREMENT REGULATORY AUTHORITY (PPRA) EPADS

Sr. No	S.#	DESCRIPTION	UNIT	QTY	RATE	AMOUNT IN WORDS	AMOUNT
48	C-13/1	Supply of DB-HALL-2 (SF)	No.	1	368872	Rupees Three Hundred Sixty Eight Thousand Eight Hundred Seventy Two Only	368872
49	C-13/2	Placement, Installation, Transportation, Loading/Unloading, Testing & Commissioning of above item at S.# C-13/1	No.	1	37115	Rupees Thirty Seven Thousand One Hundred Fifteen Only	37115

PUBLIC PROCUREMENT REGULATORY AUTHORITY (PPRA) EPADS

Sr. No	S.#	DESCRIPTION	UNIT	QTY	RATE	AMOUNT IN WORDS	AMOUNT
50	C-14/1	Supply of LPDB-SUB	No.	1	312767	Rupees Three Hundred Twelve Thousand Seven Hundred Sixty Seven Only	312767
51	C-14/2	Placement, Installation, Transportation, Loading/Unloading, Testing & Commissioning of above item at S.# C-14/1	No.	1	37115	Rupees Thirty Seven Thousand One Hundred Fifteen Only	37115

PUBLIC PROCUREMENT REGULATORY AUTHORITY (PPRA) EPADS

Sr. No	S.#	DESCRIPTION	UNIT	QTY	RATE	AMOUNT IN WORDS	AMOUNT
52	C-15/1	Supply of MCC Panel	No.	1	8497748	Rupees Eight Million Four Hundred Ninety Seven Thousand Seven Hundred Forty Eight Only	8497748
53	C-15/2	Placement, Installation, Transportation, Loading/Unloading, Testing & Commissioning of above item at S.# C-15/1	No.	1	123714	Rupees One Hundred Twenty Three Thousand Seven Hundred Fourteen Only	123714

PUBLIC PROCUREMENT REGULATORY AUTHORITY (PPRA) EPADS

Sr. No	S.#	DESCRIPTION	UNIT	QTY	RATE	AMOUNT IN WORDS	AMOUNT
54	C-16	Physical Factory Acceptance Test at the manufacturer's premises for 2 Persons (1 No. Client's Representative & 1 No. Consultant's Representative with supplier)	Job	1	30929	Rupees Thirty Thousand Nine Hundred Twenty Nine Only	30929
55		Note: - The contractor shall provision and install temporary Distribution Board (DB) as required to minimize system downtime during the transition and swapping of existing units.					
56		SECTION - D CENTRALIZED ENERGY MONITORING SYSTEM					

PUBLIC PROCUREMENT REGULATORY AUTHORITY (PPRA) EPADS

Sr. No	S.#	DESCRIPTION	UNIT	QTY	RATE	AMOUNT IN WORDS	AMOUNT
57		Supply, Installation, Testing & Commissioning of complete Central Energy monitoring System, including with wiring, software, terminations, complete in all respect. Note: - Energy Analyzers with protocols like Modbus RTU/TCP, BACnet, and INCOM are already installed in the DBs. - Warranty period will start from the date of successful Testing & Commissioning					
58	D-1/1	IoT Gateway / Data Logger for transmission of energy analyzer data to server including housing (if required)	Job	1	340971	Rupees Three Hundred Forty Thousand Nine Hundred Seventy One Only	340971

PUBLIC PROCUREMENT REGULATORY AUTHORITY (PPRA) EPADS

Sr. No	S.#	DESCRIPTION	UNIT	QTY	RATE	AMOUNT IN WORDS	AMOUNT
59	D-1/2	Installation, Testing & Commissioning of above item at S.# D-1/1	Job	1	72781	Rupees Seventy Two Thousand Seven Hundred Eighty One Only	72781
60	D-2/1	Software Interface with Complete Dashboard for live remote monitoring of all electrical and energy parameters as well as data logging of complete data. including 1 year license for all nodes from the date of successful commissioning of system.	Job	1	968665	Rupees Nine Hundred Sixty Eight Thousand Six Hundred Sixty Five Only	968665

PUBLIC PROCUREMENT REGULATORY AUTHORITY (PPRA) EPADS

Sr. No	S.#	DESCRIPTION	UNIT	QTY	RATE	AMOUNT IN WORDS	AMOUNT
61	D-2/2	Installation, Testing & Commissioning of above item at S.# D-2/1	Job	1	27298	Rupees Twenty Seven Thousand Two Hundred Ninety Eight Only	27298
62	D-3/1	Workstation PC with complete accessories (if required for software installation / server set-up to be quoted by supplier as per their system requirement)	No.	1	232484	Rupees Two Hundred Thirty Two Thousand Four Hundred Eighty Four Only	232484
63	D-3/2	Installation, Testing & Commissioning of above item at S.# D-3/1	No.	1	7281	Rupees Seven Thousand Two Hundred Eighty One Only	7281

Sr. No	S.#	DESCRIPTION	UNIT	QTY	RATE	AMOUNT IN WORDS	AMOUNT
64	D-4/1	Supply and Wiring for interconnecting from Energy Analyzer to Energy Analyzer with CAT-6 UTP 23 AWG in 25mm dia PVC conduit including all accessories Complete in all respect as per drawings and technical Specifications.	Rm	150	851	Rupees One Hundred Twenty Seven Thousand Six Hundred Fifty Only	127650
65	D-4/2	Laying, Tagging, Termination, Testing & Commissioning of above item at S.# D-4/1	Rm	150	279	Rupees Forty One Thousand Eight Hundred Fifty Only	41850

PUBLIC PROCUREMENT REGULATORY AUTHORITY (PPRA) EPADS

Sr. No	S.#	DESCRIPTION	UNIT	QTY	RATE	AMOUNT IN WORDS	AMOUNT
66	D-5	Programming, testing and commissioning of complete system including on site demonstration and training of client's representative upto the entire satisfaction of consultant/client	Job	1	247428	Rupees Two Hundred Forty Seven Thousand Four Hundred Twenty Eight Only	247428
67		Note: - Contractor is advised to confirm the cable running lengths and termination as per site conditions before commencement of work.					
68		SECTION - E MEDIUM VOLTAGE CABLES & TERMINATION KITS					
69		Supply, Laying Termination, Testing and Commissioning of following 8.7/15kV, MV Cables in already installed Cable trench / Cable ladder / Cable tray / Duct Bank including all accessories. Complete in all respects as per drawing and specification.					

Sr. No	S.#	DESCRIPTION	UNIT	QTY	RATE	AMOUNT IN WORDS	AMOUNT
70	E-1/1	From MV Switch to 1000kVA Transformer # 1 3C-300 Sqmm 8.7/15kV AL/XLPE/PVC	Rm	25	17378	Rupees Four Hundred Thirty Four Thousand Four Hundred Fifty Only	434450
71	E-1/2	Laying, Tagging, Termination, Testing & Commissioning of above item at S.# E-1/1	Rm	25	1807	Rupees Forty Five Thousand One Hundred Seventy Five Only	45175
72	E-2/1	From MV Switch to 1000kVA Transformer # 2 3C-300 Sqmm 8.7/15kV AL/XLPE/PVC	Rm	25	17378	Rupees Four Hundred Thirty Four Thousand Four Hundred Fifty Only	434450

PUBLIC PROCUREMENT REGULATORY AUTHORITY (PPRA) EPADS

Sr. No	S.#	DESCRIPTION	UNIT	QTY	RATE	AMOUNT IN WORDS	AMOUNT
73	E-2/2	Laying, Tagging, Termination, Testing & Commissioning of above item at S.# E-2/1	Rm	25	1807	Rupees Forty Five Thousand One Hundred Seventy Five Only	45175
74	E-3/1	Supply, installation, testing and commissioning of 11KV, XLPE-AL, MV Cable Termination Kit at both ends with 3M, Raychem or equivalent approved brand termination kit etc. 3C-300 Sqmm Indoor Type MV Cable Termination kits with Boots including all termination accessories like HT tape etc.	No	7	63324	Rupees Four Hundred Forty Three Thousand Two Hundred Sixty Eight Only	443268

PUBLIC PROCUREMENT REGULATORY AUTHORITY (PPRA) EPADS

Sr. No	S.#	DESCRIPTION	UNIT	QTY	RATE	AMOUNT IN WORDS	AMOUNT
75	E-3/2	Installation, Testing & Commissioning of above item at S.# E-3/1	No	7	24743	Rupees One Hundred Seventy Three Thousand Two Hundred One Only	173201
76	E-4	Physical Factory Acceptance Test at the manufacturer's premises for 2 Persons (1 No. Client's Representative & 1 No. Consultant's Representative with supplier)	Job	1	30929	Rupees Thirty Thousand Nine Hundred Twenty Nine Only	30929
77		Note: - Contractor is advised to confirm the cable running lengths and termination as per site conditions before commencement of work. - HIPOT Testing of MV Cables to be done by the Contractor.					
78		SECTION - F LOW VOLTAGE CABLES					

PUBLIC PROCUREMENT REGULATORY AUTHORITY (PPRA) EPADS

Sr. No	S.#	DESCRIPTION	UNIT	QTY	RATE	AMOUNT IN WORDS	AMOUNT
79		Supply, Laying, Termination, Testing & Commissioning of the following ratings of LV Cables along with complete installation and termination accessories to be laid in already installed Cable trench / Cable ladder / Cable tray / Duct Bank including all accessories. Complete in all respects. -Imported Bi-Mettalic Lugs and Connectors shall be used in LV Cables. -Manual crimping of lugs is not allowed. Proper lug presser for smaller lugs and hydraulic lug presser for large size lugs should be used.					
80	F-1/1	From 500kVA Generator to Generator Load Take-Off Panel 8 No. 1C-300 Sqmm Cu/PVC+ ECC 2 No. 1C-150 Sqmm Cu/PVC	Rm	65	212334	Rupees Thirteen Million Eight Hundred One Thousand Seven Hundred Ten Only	13801710

PUBLIC PROCUREMENT REGULATORY AUTHORITY (PPRA) EPADS

Sr. No	S.#	DESCRIPTION	UNIT	QTY	RATE	AMOUNT IN WORDS	AMOUNT
81	F-1/2	Laying, Tagging, Termination, Testing & Commissioning of above item at S.# F-1/1	Rm	65	11209	Rupees Seven Hundred Twenty Eight Thousand Five Hundred Eighty Five Only	728585
82	F-2/1	From 600kVA Generator to Generator Load Take-Off Panel 12 No. 1C-240 Sqmm Cu/PVC+ ECC 3 No. 1C-120 Sqmm Cu/PVC	Rm	55	254658	Rupees Fourteen Million Six Thousand One Hundred Ninety Only	14006190

PUBLIC PROCUREMENT REGULATORY AUTHORITY (PPRA) EPADS

Sr. No	S.#	DESCRIPTION	UNIT	QTY	RATE	AMOUNT IN WORDS	AMOUNT
83	F-2/2	Laying, Tagging, Termination, Testing & Commissioning of above item at S.# F-2/1	Rm	55	13442	Rupees Seven Hundred Thirty Nine Thousand Three Hundred Ten Only	739310
84	F-3/1	From 200kVA Generator to Generator Load Take-Off Panel 04 No. 1C-300 Sqmm Cu/PVC+ ECC 1 No. 1C-150 Sqmm Cu/PVC	Rm	100	106170	Rupees Ten Million Six Hundred Seventeen Thousand Only	10617000
85	F-3/2	Laying, Tagging, Termination, Testing & Commissioning of above item at S.# F-3/1	Rm	100	5605	Rupees Five Hundred Sixty Thousand Five Hundred Only	560500

PUBLIC PROCUREMENT REGULATORY AUTHORITY (PPRA) EPADS

Sr. No	S.#	DESCRIPTION	UNIT	QTY	RATE	AMOUNT IN WORDS	AMOUNT
86	F-4/1	From Generator Load Take-off Panel O/G-1 to Main LV Panel 8 No. 1C-300 Sqmm Cu/PVC+ ECC 2 No. 1C-150 Sqmm Cu/PVC	Rm	30	212334	Rupees Six Million Three Hundred Seventy Thousand Twenty Only	6370020
87	F-4/2	Laying, Tagging, Termination, Testing & Commissioning of above item at S.# F-4/1	Rm	30	11209	Rupees Three Hundred Thirty Six Thousand Two Hundred Seventy Only	336270

PUBLIC PROCUREMENT REGULATORY AUTHORITY (PPRA) EPADS

Sr. No	S.#	DESCRIPTION	UNIT	QTY	RATE	AMOUNT IN WORDS	AMOUNT
88	F-5/1	From Generator Load Take-off Panel O/G-2 to Main LV Panel 12 No. 1C-240 Sqmm Cu/PVC+ ECC 3 No. 1C-120 Sqmm Cu/PVC	Rm	30	254658	Rupees Seven Million Six Hundred Thirty Nine Thousand Seven Hundred Forty Only	7639740
89	F-5/2	Laying, Tagging, Termination, Testing & Commissioning of above item at S.# F-5/1	Rm	30	13442	Rupees Four Hundred Three Thousand Two Hundred Sixty Only	403260
90	F-6/1	From Main LV Panel to LT-5 Panel (GF) 8 No. 1C-240 Sqmm Al/XLPE/PVC+ ECC 2 No. 1C-120 Sqmm Cu/PVC	Rm	140	37250	Rupees Five Million Two Hundred Fifteen Thousand Only	5215000

PUBLIC PROCUREMENT REGULATORY AUTHORITY (PPRA) EPADS

Sr. No	S.#	DESCRIPTION	UNIT	QTY	RATE	AMOUNT IN WORDS	AMOUNT
91	F-6/2	Laying, Tagging, Termination, Testing & Commissioning of above item at S.# F-6/1	Rm	140	1968	Rupees Two Hundred Seventy Five Thousand Five Hundred Twenty Only	275520
92	F-7/1	From Main LV Panel to ELT-1 Panel (GF) 8 No. 1C-240 Sqmm Al/XLPE/PVC+ ECC 2 No. 1C-120 Sqmm Cu/PVC	Rm	140	37250	Rupees Five Million Two Hundred Fifteen Thousand Only	5215000

PUBLIC PROCUREMENT REGULATORY AUTHORITY (PPRA) EPADS

Sr. No	S.#	DESCRIPTION	UNIT	QTY	RATE	AMOUNT IN WORDS	AMOUNT
93	F-7/2	Laying, Tagging, Termination, Testing & Commissioning of above item at S.# F-7/1	Rm	140	1968	Rupees Two Hundred Seventy Five Thousand Five Hundred Twenty Only	275520
94	F-8/1	From Main LV Panel to MCC Panel (Basement) 16 No. 1C-240 Sqmm Al/XLPE/PVC+ ECC 3 No. 1C-150 Sqmm Cu/PVC	Rm	170	71608	Rupees Twelve Million One Hundred Seventy Three Thousand Three Hundred Sixty Only	12173360

PUBLIC PROCUREMENT REGULATORY AUTHORITY (PPRA) EPADS

Sr. No	S.#	DESCRIPTION	UNIT	QTY	RATE	AMOUNT IN WORDS	AMOUNT
95	F-8/2	Laying, Tagging, Termination, Testing & Commissioning of above item at S.# F-8/1	Rm	170	3780	Rupees Six Hundred Forty Two Thousand Six Hundred Only	642600
96	F-9/1	4C-35 Sqmm Cu/PVC/PVC + 1C-16 Sqmm Cu/PVC	Rm	50	11704	Rupees Five Hundred Eighty Five Thousand Two Hundred Only	585200
97	F-9/2	Laying, Tagging, Termination, Testing & Commissioning of above item at S.# F-9/1	Rm	50	1238	Rupees Sixty One Thousand Nine Hundred Only	61900

PUBLIC PROCUREMENT REGULATORY AUTHORITY (PPRA) EPADS

Sr. No	S.#	DESCRIPTION	UNIT	QTY	RATE	AMOUNT IN WORDS	AMOUNT
98	F-10/1	4C-25 Sqmm Cu/PVC/PVC + 1C-16 Sqmm Cu/PVC	Rm	50	8833	Rupees Four Hundred Forty One Thousand Six Hundred Fifty Only	441650
99	F-10/2	Laying, Tagging, Termination, Testing & Commissioning of above item at S.# F-10/1	Rm	50	935	Rupees Forty Six Thousand Seven Hundred Fifty Only	46750
100	F-11/1	4C-16 Sqmm Cu/PVC/PVC + 1C-16 Sqmm Cu/PVC	Rm	50	6097	Rupees Three Hundred Four Thousand Eight Hundred Fifty Only	304850

PUBLIC PROCUREMENT REGULATORY AUTHORITY (PPRA) EPADS

Sr. No	S.#	DESCRIPTION	UNIT	QTY	RATE	AMOUNT IN WORDS	AMOUNT
101	F-11/2	Laying, Tagging, Termination, Testing & Commissioning of above item at S.# F-11/1	Rm	50	644	Rupees Thirty Two Thousand Two Hundred Only	32200
102	F-12/1	4C-10 Sqmm Cu/PVC/PVC + 1C-10 Sqmm Cu/PVC	Rm	50	4124	Rupees Two Hundred Six Thousand Two Hundred Only	206200
103	F-12/2	Laying, Tagging, Termination, Testing & Commissioning of above item at S.# F-12/1	Rm	50	440	Rupees Twenty Two Thousand Only	22000

PUBLIC PROCUREMENT REGULATORY AUTHORITY (PPRA) EPADS

Sr. No	S.#	DESCRIPTION	UNIT	QTY	RATE	AMOUNT IN WORDS	AMOUNT
104	F-13/1	2.5 Sqmm Cu/PVC (Red & Black coil for temporary works)	Rm	50	215	Rupees Ten Thousand Seven Hundred Fifty Only	10750
105	F-13/2	Laying, Tagging, Termination, Testing & Commissioning of above item at S.# F-13/1	Rm	50	25	Rupees One Thousand Two Hundred Fifty Only	1250

PUBLIC PROCUREMENT REGULATORY AUTHORITY (PPRA) EPADS

Sr. No	S.#	DESCRIPTION	UNIT	QTY	RATE	AMOUNT IN WORDS	AMOUNT
106	F-14	Supply and installation of Heat Shrinkable Straight-Through Jointing Kits suitable for 0.6/1kV or 11kV (as per site requirement) XLPE/PVC insulated, armored/unarmored power cables. Includes high-conductivity tinned copper/aluminum ferrules (as per conductor material), stress control tubing, adhesive-lined outer sealing sleeve, and earth continuity braid with constant force springs. The kits must be designed to provide a complete moisture-proof seal and mechanical protection equivalent to the original cable sheath. Complete in all respects.					
107	F-14/1	4C-300 sq.mm	Job	1	40962	Rupees Forty Thousand Nine Hundred Sixty Two Only	40962

PUBLIC PROCUREMENT REGULATORY AUTHORITY (PPRA) EPADS

Sr. No	S.#	DESCRIPTION	UNIT	QTY	RATE	AMOUNT IN WORDS	AMOUNT
108	F-14/1A	Installation, Testing & Commissioning of above item at S.# F-14/1	Job	1	6186	Rupees Six Thousand One Hundred Eighty Six Only	6186
109	F-14/2	4C-240 sq.mm	Job	1	40962	Rupees Forty Thousand Nine Hundred Sixty Two Only	40962
110	F-14/2A	Installation, Testing & Commissioning of above item at S.# F-14/2	Job	1	6186	Rupees Six Thousand One Hundred Eighty Six Only	6186

PUBLIC PROCUREMENT REGULATORY AUTHORITY (PPRA) EPADS

Sr. No	S.#	DESCRIPTION	UNIT	QTY	RATE	AMOUNT IN WORDS	AMOUNT
111	F-14/3	4C-35 sq.mm	Job	1	24524	Rupees Twenty Four Thousand Five Hundred Twenty Four Only	24524
112	F-14/3A	Installation, Testing & Commissioning of above item at S.# F-14/3	Job	1	3712	Rupees Three Thousand Seven Hundred Twelve Only	3712
113	F-14/4	4C-25 sq.mm	Job	1	24524	Rupees Twenty Four Thousand Five Hundred Twenty Four Only	24524

PUBLIC PROCUREMENT REGULATORY AUTHORITY (PPRA) EPADS

Sr. No	S.#	DESCRIPTION	UNIT	QTY	RATE	AMOUNT IN WORDS	AMOUNT
114	F-14/4A	Installation, Testing & Commissioning of above item at S.# F-14/4	Job	1	3712	Rupees Three Thousand Seven Hundred Twelve Only	3712
115	F-14/5	4C-16 sq.mm	Job	1	13797	Rupees Thirteen Thousand Seven Hundred Ninety Seven Only	13797
116	F-14/5A	Installation, Testing & Commissioning of above item at S.# F-14/5	Job	1	2475	Rupees Two Thousand Four Hundred Seventy Five Only	2475

PUBLIC PROCUREMENT REGULATORY AUTHORITY (PPRA) EPADS

Sr. No	S.#	DESCRIPTION	UNIT	QTY	RATE	AMOUNT IN WORDS	AMOUNT
117	F-15	Physical Factory Acceptance Test at the manufacturer's premises for 2 Persons (1 No. Client's Representative & 1 No. Consultant's Representative with supplier)	Job	1	30929	Rupees Thirty Thousand Nine Hundred Twenty Nine Only	30929
118		Note: - Contractor is instructed to confirm the cable running lengths and termination as per site conditions before commencement of work. - Imported Lugs and Connectors shall be used in LV Cables. - Megger Test of all LV Cables to be done by contractor.					
119		SECTION - G CABLE CONTAINMENT					

PUBLIC PROCUREMENT REGULATORY AUTHORITY (PPRA) EPADS

Sr. No	S.#	DESCRIPTION	UNIT	QTY	RATE	AMOUNT IN WORDS	AMOUNT
120	G-1	Supply & Laying of following sizes of UPVC pipe sleeves embedded under the floor/slab, including all necessary couplers, solvent cement, end bells, and termination accessories, to form smooth cable routing paths connecting various handholes/manholes; including necessary excavation, trenching, backfilling, compacting, and installation of a 2mm galvanized steel draw wire inside each sleeve for future cable pulling. Provide Handhole where ever required. Note: The below mentioned conduits will be used for items where description of the item clearly states that the conduit is not inclusive or already laid/installed. This section will also cover empty conduit runs, sleeves, conduit risers etc.					

PUBLIC PROCUREMENT REGULATORY AUTHORITY (PPRA) EPADS

Sr. No	S.#	DESCRIPTION	UNIT	QTY	RATE	AMOUNT IN WORDS	AMOUNT
121	G-1/1	150mm dia UPVC Conduit (Class-D)	Rm.	600	7857	Rupees Four Million Seven Hundred Fourteen Thousand Two Hundred Only	4714200
122	G-1/1a	Laying, Installation, Testing & Commissioning of above item at S.# G-1/1	Rm.	600	829	Rupees Four Hundred Ninety Seven Thousand Four Hundred Only	497400

PUBLIC PROCUREMENT REGULATORY AUTHORITY (PPRA) EPADS

Sr. No	S.#	DESCRIPTION	UNIT	QTY	RATE	AMOUNT IN WORDS	AMOUNT
123	G-2	Making of RCC Handhole 600mm x 600mm x 900mm internal size, made with 150 mm thick Fiber walls and 200mm thick bed & top slabs, including cost of heavy duty 450mm square cover & angle iron frame (made 2”x2”x1/4” size angle iron) complete in all respects as per site requirements, as per drawing & details and as directed by the consultant.	No.	10	92786	Rupees Nine Hundred Twenty Seven Thousand Eight Hundred Sixty Only	927860

PUBLIC PROCUREMENT REGULATORY AUTHORITY (PPRA) EPADS

Sr. No	S.#	DESCRIPTION	UNIT	QTY	RATE	AMOUNT IN WORDS	AMOUNT
124	G-3	Supply and Installation of following sizes G.I Powder Coated Perforated Cable Tray with 4 feet covers duly Painted after degreesing, derusting, phosphating and antirust primer complete in all respect with supporting hangers, brackets, elbows, tee & mounting accessories etc. Note: - Color Printed Tags to be provided at every 3 Meter Length. - Threaded Rods & Base Plate to be used for hanging from ceiling. - Wall Hanger Supports to be provided moving with walls. - U-shaped fischer plates to be used for joints. - Earth bonding to be done with every joint using flexible braided copper. - Color to be decided with consent of client. - Imported mounting accessories to be used make mungo or fischer.					

PUBLIC PROCUREMENT REGULATORY AUTHORITY (PPRA) EPADS

Sr. No	S.#	DESCRIPTION	UNIT	QTY	RATE	AMOUNT IN WORDS	AMOUNT
125	G-3/1	450mm x 100mm (16 SWG Tray and 18 SWG Cover) With Accessories (Power Cables)	Rm.	40	11657	Rupees Four Hundred Sixty Six Thousand Two Hundred Eighty Only	466280
126	G-3/1a	Installation, Testing & Commissioning of above item at S.# G-3/1	Rm.	40	1485	Rupees Fifty Nine Thousand Four Hundred Only	59400
127	G-3/2	300mm x 100mm (16 SWG Tray and 18 SWG Cover) With Accessories (Power Cables)	Rm.	100	8707	Rupees Eight Hundred Seventy Thousand Seven Hundred Only	870700

PUBLIC PROCUREMENT REGULATORY AUTHORITY (PPRA) EPADS

Sr. No	S.#	DESCRIPTION	UNIT	QTY	RATE	AMOUNT IN WORDS	AMOUNT
128	G-3/2a	Installation, Testing & Commissioning of above item at S.# G-3/2	Rm.	100	1485	Rupees One Hundred Forty Eight Thousand Five Hundred Only	148500
129		Note: Contractor is advised to confirm the sizes, running lengths and termination as per site conditions before commencement of work.					
130		SECTION - H ENCLOSED BUS ASSEMBLIES					

PUBLIC PROCUREMENT REGULATORY AUTHORITY (PPRA) EPADS

Sr. No	S.#	DESCRIPTION	UNIT	QTY	RATE	AMOUNT IN WORDS	AMOUNT
131		Supply, Installation, Testing and Commissioning must be included in quoted price of the following imported TP+N+E Compact Busway including imported accessories like elbows, flange ends, U Shape supporting hangers, mounting accessories, complete in all respects and having attached specifications. Material : Aluminium Type : Compact Note: - The contract will be on item rate basis, therefore amount for only items being used at site will be paid. - Separate earth bar on 100% (50% Housing + 50% Bar) is required for all busways. - Expansion joints for straight length feeders shall be added in cost as per manufacturer standard without any additional cost. - All Power Busway shall be Sandwich Type. - All Power Busway shall be IP-65 and IK-09 rated. - All type test certificates are required; site tests shall be carried out in accordance with the provided specifications. - Supplier is advised to confirm the busway running lengths as per site conditions before final ordering to the principal. - Bidder shall submit the shop drawings with isometric views in hard copy and soft copy as well. - All the mounting heights have been					

PUBLIC PROCUREMENT REGULATORY AUTHORITY (PPRA) EPADS

Sr. No	S.#	DESCRIPTION	UNIT	QTY	RATE	AMOUNT IN WORDS	AMOUNT
132	H-1	Busway-Main (IP-65 Rated, 1600A TP+N+E) for Main Incoming 1 Location: From Transformer 1 to LV Panel					
133	H-1/1	Straight Lengths 1600A TP+N+E (5 Bar)	Rm.	30	133502	Rupees Four Million Five Thousand Sixty Only	4005060
134	H-1/1a	Installation, Testing & Commissioning of above item at S.# H-1/1	Rm.	30	7058	Rupees Two Hundred Eleven Thousand Seven Hundred Forty Only	211740

PUBLIC PROCUREMENT REGULATORY AUTHORITY (PPRA) EPADS

Sr. No	S.#	DESCRIPTION	UNIT	QTY	RATE	AMOUNT IN WORDS	AMOUNT
135	H-1/2	Elbow 1600A	No.	3	96884	Rupees Two Hundred Ninety Thousand Six Hundred Fifty Two Only	290652
136	H-1/2a	Installation, Testing & Commissioning of above item at S.# H-1/2	No.	3	5122	Rupees Fifteen Thousand Three Hundred Sixty Six Only	15366

PUBLIC PROCUREMENT REGULATORY AUTHORITY (PPRA) EPADS

Sr. No	S.#	DESCRIPTION	UNIT	QTY	RATE	AMOUNT IN WORDS	AMOUNT
137	H-1/3	Flange for LV Panel Connection	No.	1	87587	Rupees Eighty Seven Thousand Five Hundred Eighty Seven Only	87587
138	H-1/3a	Installation, Testing & Commissioning of above item at S.# H-1/3	No.	1	4634	Rupees Four Thousand Six Hundred Thirty Four Only	4634

PUBLIC PROCUREMENT REGULATORY AUTHORITY (PPRA) EPADS

Sr. No	S.#	DESCRIPTION	UNIT	QTY	RATE	AMOUNT IN WORDS	AMOUNT
139	H-1/4	Flange for Transformer Connection	No.	1	87587	Rupees Eighty Seven Thousand Five Hundred Eighty Seven Only	87587
140	H-1/4a	Installation, Testing & Commissioning of above item at S.# H-1/4	No.	1	4634	Rupees Four Thousand Six Hundred Thirty Four Only	4634

PUBLIC PROCUREMENT REGULATORY AUTHORITY (PPRA) EPADS

Sr. No	S.#	DESCRIPTION	UNIT	QTY	RATE	AMOUNT IN WORDS	AMOUNT
141	H-1/5	Flexible Connection (Insulated Braided Copper) 1600A TP+N+E (Busbar links between Flange and Transformer)	No.	1	464962	Rupees Four Hundred Sixty Four Thousand Nine Hundred Sixty Two Only	464962
142	H-1/5a	Installation, Testing & Commissioning of above item at S.# H-1/5	No.	1	24570	Rupees Twenty Four Thousand Five Hundred Seventy Only	24570
143	H-1/6	Imported Galvanized Fixing Bracket with threaded rods, bolts and all other required accessories.	Job	1	48964	Rupees Forty Eight Thousand Nine Hundred Sixty Four Only	48964

PUBLIC PROCUREMENT REGULATORY AUTHORITY (PPRA) EPADS

Sr. No	S.#	DESCRIPTION	UNIT	QTY	RATE	AMOUNT IN WORDS	AMOUNT
144	H-1/6a	Installation, Testing & Commissioning of above item at S.# H-1/6	Job	1	2592	Rupees Two Thousand Five Hundred Ninety Two Only	2592
145	H-2	Busway-Main (IP-65 Rated, 1600A TP+N+E) for Main Incoming 2 Location: From Transformer 2 to LV Panel					
146	H-2/1	Straight Lengths 1600A TP+N+E (5 Bar)	Rm.	30	133502	Rupees Four Million Five Thousand Sixty Only	4005060
147	H-2/1a	Installation, Testing & Commissioning of above item at S.# H-2/1	Rm.	30	7058	Rupees Two Hundred Eleven Thousand Seven Hundred Forty Only	211740

PUBLIC PROCUREMENT REGULATORY AUTHORITY (PPRA) EPADS

Sr. No	S.#	DESCRIPTION	UNIT	QTY	RATE	AMOUNT IN WORDS	AMOUNT
148	H-2/2	Elbow 1600A	No.	3	96884	Rupees Two Hundred Ninety Thousand Six Hundred Fifty Two Only	290652
149	H-2/2a	Installation, Testing & Commissioning of above item at S.# H-2/2	No.	3	5122	Rupees Fifteen Thousand Three Hundred Sixty Six Only	15366

PUBLIC PROCUREMENT REGULATORY AUTHORITY (PPRA) EPADS

Sr. No	S.#	DESCRIPTION	UNIT	QTY	RATE	AMOUNT IN WORDS	AMOUNT
150	H-2/3	Flange for LV Panel Connection	No.	1	87587	Rupees Eighty Seven Thousand Five Hundred Eighty Seven Only	87587
151	H-2/3a	Installation, Testing & Commissioning of above item at S.# H-2/3	No.	1	4634	Rupees Four Thousand Six Hundred Thirty Four Only	4634

PUBLIC PROCUREMENT REGULATORY AUTHORITY (PPRA) EPADS

Sr. No	S.#	DESCRIPTION	UNIT	QTY	RATE	AMOUNT IN WORDS	AMOUNT
152	H-2/4	Flange for Transformer Connection	No.	1	87587	Rupees Eighty Seven Thousand Five Hundred Eighty Seven Only	87587
153	H-2/4a	Installation, Testing & Commissioning of above item at S.# H-2/4	No.	1	4634	Rupees Four Thousand Six Hundred Thirty Four Only	4634

PUBLIC PROCUREMENT REGULATORY AUTHORITY (PPRA) EPADS

Sr. No	S.#	DESCRIPTION	UNIT	QTY	RATE	AMOUNT IN WORDS	AMOUNT
154	H-2/5	Flexible Connection (Insulated Braided Copper) 1600A TP+N+E (Busbar links between Flange and Transformer)	No.	1	464962	Rupees Four Hundred Sixty Four Thousand Nine Hundred Sixty Two Only	464962
155	H-2/5a	Installation, Testing & Commissioning of above item at S.# H-2/5	No.	1	24570	Rupees Twenty Four Thousand Five Hundred Seventy Only	24570
156	H-2/6	Imported Galvanized Fixing Bracket with threaded rods, bolts and all other required accessories.	Job	1	48964	Rupees Forty Eight Thousand Nine Hundred Sixty Four Only	48964

PUBLIC PROCUREMENT REGULATORY AUTHORITY (PPRA) EPADS

Sr. No	S.#	DESCRIPTION	UNIT	QTY	RATE	AMOUNT IN WORDS	AMOUNT
157	H-2/6a	Installation, Testing & Commissioning of above item at S.# H-2/6	Job	1	2592	Rupees Two Thousand Five Hundred Ninety Two Only	2592
158	H-3	Transportation, Loading & Unloading, Placement and Storing material at site	Job	1	61857	Rupees Sixty One Thousand Eight Hundred Fifty Seven Only	61857
159		SECTION - I IMPORTED EARTHING / GROUNDING SYSTEM					

PUBLIC PROCUREMENT REGULATORY AUTHORITY (PPRA) EPADS

Sr. No	S.#	DESCRIPTION	UNIT	QTY	RATE	AMOUNT IN WORDS	AMOUNT
160		Supply, Installation, Testing & Commissioning of the following items required for Earthing, Lightning Protection and Grounding of other systems including all material, boring, labor, tools, transportation, installation accessories etc. Complete in all respects as per drawings and specifications. - The contractor will also submit detailed earth test reports for approval.					
161	I-1/1	Chemical Enhanced Earth using 20mm dia, 10ft long imported copper cladded steel Rod filled with soil conditioning material including 6" dia, 11' deep boring and back filled chemical to enhance conductivity. Complete with termination clamps, 12" dia heavy duty tin plated round cover as per details given in drawings.	No.	14	104855	Rupees One Million Four Hundred Sixty Seven Thousand Nine Hundred Seventy Only	1467970

PROCUREMENT REGULATORY AUTHORITY (PPRA) EPADS

Sr. No	S.#	DESCRIPTION	UNIT	QTY	RATE	AMOUNT IN WORDS	AMOUNT
162	I-1/2	Installation, Testing & Commissioning of above item at S.# I-1/1	No.	14	24743	Rupees Three Hundred Forty Six Thousand Four Hundred Two Only	346402
163	I-2/1	Earth Connecting Point (ECP) or Equipotential bar made with 450 mm wide, 75 mm high and 5 mm thick tin plated Copper, as shown in drawings. Bar shall be provided with holes suitable for installation of 6 No. 95 sqmm bare copper conductor. ECP shall be enclosed in appropriate size of powder coated metal enclosure with front accessible cover.	No.	20	49371	Rupees Nine Hundred Eighty Seven Thousand Four Hundred Twenty Only	987420

PUBLIC PROCUREMENT REGULATORY AUTHORITY (PPRA) EPADS

Sr. No	S.#	DESCRIPTION	UNIT	QTY	RATE	AMOUNT IN WORDS	AMOUNT
164	I-2/2	Installation, Testing & Commissioning of above item at S.# I-2/1	No.	20	3712	Rupees Seventy Four Thousand Two Hundred Forty Only	74240
165	I-3	Stranded bare copper conductors of the following sizes in 38mm dia UPVC Class-D conduit to be laid in floor/raft from Earth Station to ECP as shown in drawings. Complete in all respects including termination at ECP.					
166	I-3/1	95 Sqmm Bare Copper Conductor	Rm.	400	6599	Rupees Two Million Six Hundred Thirty Nine Thousand Six Hundred Only	2639600

PUBLIC PROCUREMENT REGULATORY AUTHORITY (PPRA) EPADS

Sr. No	S.#	DESCRIPTION	UNIT	QTY	RATE	AMOUNT IN WORDS	AMOUNT
167	I-3/1a	Laying, Tagging, Termination, Testing & Commissioning of above item at S.# I-3/1	Rm.	400	693	Rupees Two Hundred Seventy Seven Thousand Two Hundred Only	277200
168	I-4	Supply, installation, testing & commissioning of following size of single core PVC cables in appropriate size of exposed / concelled conduit from ECP to several equipments as per details given below, including all material, labor, tools, transportation, accessories etc. Complete in all respects with detailed test reports.					

PUBLIC PROCUREMENT REGULATORY AUTHORITY (PPRA) EPADS

Sr. No	S.#	DESCRIPTION	UNIT	QTY	RATE	AMOUNT IN WORDS	AMOUNT
169	I-4/1	1C-95 Sqmm Cu/PVC	Rm.	50	6672	Rupees Three Hundred Thirty Three Thousand Six Hundred Only	333600
170	I-4/1a	Laying, Tagging, Termination, Testing & Commissioning of above item at S.# I-4/1	Rm.	50	699	Rupees Thirty Four Thousand Nine Hundred Fifty Only	34950
171	I-4/2	1C-70 Sqmm Cu/PVC	Rm.	50	6014	Rupees Three Hundred Thousand Seven Hundred Only	300700

PUBLIC PROCUREMENT REGULATORY AUTHORITY (PPRA) EPADS

Sr. No	S.#	DESCRIPTION	UNIT	QTY	RATE	AMOUNT IN WORDS	AMOUNT
172	I-4/2a	Laying, Tagging, Termination, Testing & Commissioning of above item at S.# I-4/2	Rm.	50	631	Rupees Thirty One Thousand Five Hundred Fifty Only	31550
173	I-4/3	1C-35 Sqmm Cu/PVC	Rm.	50	3080	Rupees One Hundred Fifty Four Thousand Only	154000
174	I-4/3a	Laying, Tagging, Termination, Testing & Commissioning of above item at S.# I-4/3	Rm.	50	328	Rupees Sixteen Thousand Four Hundred Only	16400

PUBLIC PROCUREMENT REGULATORY AUTHORITY (PPRA) EPADS

Sr. No	S.#	DESCRIPTION	UNIT	QTY	RATE	AMOUNT IN WORDS	AMOUNT
175		Note: - Contractor is advised to confirm the cable running lengths and termination as per site conditions before commencement of work. - The bidder shall submit complete technical literature of the quoted system for approval before procurement.					
176		SECTION - J SUBSTATION ELECTRIFICATION					

PUBLIC PROCUREMENT REGULATORY AUTHORITY (PPRA) EPADS

Sr. No	S.#	DESCRIPTION	UNIT	QTY	RATE	AMOUNT IN WORDS	AMOUNT
177	J-1	Supply, Installation, Testing & Commissioning of the following wiring items including all material, labour & tools required for completion of work as per item description, specifications & drawings including cutting, chiseling, making good and all necessary accessories such as bends, junction boxes, conduit sockets, earth connecting point connectors, etc. as shown on drawings, specifications and approval by the Engineer. Complete in all respects. Note: 1) The cost of wiring items shall includes Imported Polycarbonate Connectors and High Quality flexible PVC conduit as per LOAM of appropriate size on each light point. 2) Insulation Resistance Test of each circuit to be done by the Contractor. 3) All General Wiring grade should be 450/750 copper. 4) Surface conduiting shall be done in decorative / aesthetic manner. 5) Wherever the circuits are running in cable tray, it will enter / leave tray using proper PVC glands / Junction boxes (IP44). The cost of all such accessories to be included in wiring cost. 6) All electrical circuits and power outlets shall be numbered (i.e. circuit number and distribution board number shall be					

PUBLIC PROCUREMENT REGULATORY AUTHORITY (PPRA) EPADS

Sr. No	S.#	DESCRIPTION	UNIT	QTY	RATE	AMOUNT IN WORDS	AMOUNT
178	J-1/1	Circuit wiring from DB to Switchboard including any wiring from switch board to switch board with 2x2.5 Sq.mm + ECC 1x2.5 Sqmm, Cu/PVC wires in 25mm dia PVC conduit as shown in drawings.	No	2	14329	Rupees Twenty Eight Thousand Six Hundred Fifty Eight Only	28658
179	J-1/1a	Laying, Tagging, Termination, Testing & Commissioning of above item at S.# J-1/1	No	2	1485	Rupees Two Thousand Nine Hundred Seventy Only	2970
180	J-1/1b	Wiring for light point from Switchboard to first light point with phase 2.5 Sq.mm, common neutral 2.5 Sq.mm and common ECC 2.5 Sq.mm, Cu/PVC wires in 25mm dia PVC conduit as shown on drawings.	No	15	7168	Rupees One Hundred Seven Thousand Five Hundred Twenty Only	107520

Sr. No	S.#	DESCRIPTION	UNIT	QTY	RATE	AMOUNT IN WORDS	AMOUNT
181	J-1/1c	Laying, Tagging, Termination, Testing & Commissioning of above item at S.# J-1/1b	No	15	743	Rupees Eleven Thousand One Hundred Forty Five Only	11145
182	J-1/1d	Point to Point wiring with phase 1.5 Sq.mm, common neutral 2.5 Sq.mm and common ECC 2.5 Sq.mm Cu/PVC in 25mm dia PVC conduit as shown in drawings.	No	5	3169	Rupees Fifteen Thousand Eight Hundred Forty Five Only	15845
183	J-1/1e	Laying, Tagging, Termination, Testing & Commissioning of above item at S.# J-1/1d	No	5	335	Rupees One Thousand Six Hundred Seventy Five Only	1675

PUBLIC PROCUREMENT REGULATORY AUTHORITY (PPRA) EPADS

Sr. No	S.#	DESCRIPTION	UNIT	QTY	RATE	AMOUNT IN WORDS	AMOUNT
184	J-1/2	Wiring for Group Control light fixtures from DB to first light point with 2x1.5 Sq.mm + ECC 1x1.5 Sq.mm Cu/PVC wires in 25mm dia PVC conduit as shown on drawings.	No	1	7011	Rupees Seven Thousand Eleven Only	7011
185	J-1/2a	Laying, Tagging, Termination, Testing & Commissioning of above item at S.# J-1/2	No	1	737	Rupees Seven Hundred Thirty Seven Only	737
186	J-1/2b	Point to Point wiring using the same wires & conduit size as mentioned in the above item.	No	5	4672	Rupees Twenty Three Thousand Three Hundred Sixty Only	23360

PUBLIC PROCUREMENT REGULATORY AUTHORITY (PPRA) EPADS

Sr. No	S.#	DESCRIPTION	UNIT	QTY	RATE	AMOUNT IN WORDS	AMOUNT
187	J-1/2c	Laying, Tagging, Termination, Testing & Commissioning of above item at S.# J-1/2b	No	5	495	Rupees Two Thousand Four Hundred Seventy Five Only	2475
188	J-1/3	Circuit Wiring of 13A/15A Switch Socket units (RAW Power) from DB to first outlet including wiring within same technology box / adjacent power outlets in separate back boxes with following size of 1-core wires in 25mm dia of PVC conduits as shown in the drawings.					
189	J-1/3a	2 x 4 Sq.mm Cu/PVC + ECC 1 x 4 Sq.mm Cu/PVC	No	4	15875	Rupees Sixty Three Thousand Five Hundred Only	63500

PUBLIC PROCUREMENT REGULATORY AUTHORITY (PPRA) EPADS

Sr. No	S.#	DESCRIPTION	UNIT	QTY	RATE	AMOUNT IN WORDS	AMOUNT
190	J-1/3b	Laying, Tagging, Termination, Testing & Commissioning of above item at S.# J-1/3a	No	4	1640	Rupees Six Thousand Five Hundred Sixty Only	6560
191	J-1/3c	Outlet to Outlet wiring including adjacent outlet wiring using 3 x 2.5 Sqmm Cu/PVC wires & in 25mm dia PVC conduit as mentioned in the drawings.	No	22	5158	Rupees One Hundred Thirteen Thousand Four Hundred Seventy Six Only	113476
192	J-1/3d	Laying, Tagging, Termination, Testing & Commissioning of above item at S.# J-1/3c	No	22	526	Rupees Eleven Thousand Five Hundred Seventy Two Only	11572

PUBLIC PROCUREMENT REGULATORY AUTHORITY (PPRA) EPADS

Sr. No	S.#	DESCRIPTION	UNIT	QTY	RATE	AMOUNT IN WORDS	AMOUNT
193	J-1/4	Circuit Wiring of 4 TON Floor Standing Air Conditioner from DB to equipment with following size of wires in 25mm dia size of exposed / concealed PVC conduit as shown on drawings.					
194	J-1/4a	2 x 4 Sq.mm Cu/PVC + ECC 1 x 4 Sq.mm Cu/PVC	No	1	21168	Rupees Twenty One Thousand One Hundred Sixty Eight Only	21168
195	J-1/4b	Laying, Tagging, Termination, Testing & Commissioning of above item at S.# J-1/4a	No	1	2184	Rupees Two Thousand One Hundred Eighty Four Only	2184

PUBLIC PROCUREMENT REGULATORY AUTHORITY (PPRA) EPADS

Sr. No	S.#	DESCRIPTION	UNIT	QTY	RATE	AMOUNT IN WORDS	AMOUNT
196	J-2	Supply & Laying of the following sizes of PVC/UPVC/EMT Conduits including all accessories such as bends, sockets, j-boxes, flexible conduits, metal saddles e.t.c as per design drawings, complete in all respect.					
197	J-2/1	25mm dia PVC Conduit	Rm	100	220	Rupees Twenty Two Thousand Only	22000
198	J-2/1a	Installation, Testing & Commissioning of above item at S.# J-2/1	Rm	100	25	Rupees Two Thousand Five Hundred Only	2500
199	J-2/2	38mm dia UPVC Conduit (Class-D)	Rm	100	700	Rupees Seventy Thousand Only	70000

PUBLIC PROCUREMENT REGULATORY AUTHORITY (PPRA) EPADS

Sr. No	S.#	DESCRIPTION	UNIT	QTY	RATE	AMOUNT IN WORDS	AMOUNT
200	J-2/2a	Installation, Testing & Commissioning of above item at S.# J-2/2	Rm	100	75	Rupees Seven Thousand Five Hundred Only	7500
201	J-3/1	Supply & Installation of 16 SWG MS Sheet Steel Back Boxes for installation of Switches, Sockets, Voice & Data Outlets, Isolators as per drawings and details including all accessories.	Rm	35	449	Rupees Fifteen Thousand Seven Hundred Fifteen Only	15715
202	J-3/2	Installation, Testing & Commissioning of above item at S.# J-3/1	Rm	35	50	Rupees One Thousand Seven Hundred Fifty Only	1750

PUBLIC PROCUREMENT REGULATORY AUTHORITY (PPRA) EPADS

Sr. No	S.#	DESCRIPTION	UNIT	QTY	RATE	AMOUNT IN WORDS	AMOUNT
203	J-4	Supply and installation of following sizes 16 SWG Galvanized Cable Ladder with 16 SWG G.I Cover as per details given in the drawings and specifications with prime quality japanese standard JIS 3302 36-38 microns Galvanized iron steel in line with NEMA standards with min. 36 microns Zinc overlap coating. Complete with all supporting hangers, brackets, elbows, tee & mounting accessories etc. Note: - Color Printed Tags to be provided at every 3 Meter Length. - Threaded Rods & Base Plate to be used for hanging from ceiling & vertical accessories. - Wall Hanger Supports to be provided moving with walls. - U-shaped fischer plates to be used for joints. - Earth bonding to be done with every joint using flexible braided copper. - Imported mounting accessories to be used make mungo or fischer.					

PUBLIC PROCUREMENT REGULATORY AUTHORITY (PPRA) EPADS

Sr. No	S.#	DESCRIPTION	UNIT	QTY	RATE	AMOUNT IN WORDS	AMOUNT
204	J-4/1	300mm x 100mm (MV Cable)	Rm.	40	8504	Rupees Three Hundred Forty Thousand One Hundred Sixty Only	340160
205	J-4/1a	Installation, Testing & Commissioning of above item at S.# J-4/1	Rm.	40	1238	Rupees Forty Nine Thousand Five Hundred Twenty Only	49520

PUBLIC PROCUREMENT REGULATORY AUTHORITY (PPRA) EPADS

Sr. No	S.#	DESCRIPTION	UNIT	QTY	RATE	AMOUNT IN WORDS	AMOUNT
206	J-5	Supply & Installation of following Switches and socket outlets recessed / surface on wall or as per design drawings. Following makes and models are suggested in white color but the final recommendation and approval to be given by the Architect on physical samples. Switches: Schneider Vivace, Legrand Eloe, or approved equiv. Sockets : Schneider Vivace Legrand Eloe, or approved equiv. Isolators : Schneider, Gewiss, Walther Industrial Sockets : Schneider, Gewiss, Walther, PCE					
207	J-5/1	One Gang Light Switch	No	1	1097	Rupees One Thousand Ninety Seven Only	1097
208	J-5/1a	Installation, Testing & Commissioning of above item at S.# J-5/1	No	1	433	Rupees Four Hundred Thirty Three Only	433

PUBLIC PROCUREMENT REGULATORY AUTHORITY (PPRA) EPADS

Sr. No	S.#	DESCRIPTION	UNIT	QTY	RATE	AMOUNT IN WORDS	AMOUNT
209	J-5/2	Two Gang Light Switch	No	1	1655	Rupees One Thousand Six Hundred Fifty Five Only	1655
210	J-5/2a	Installation, Testing & Commissioning of above item at S.# J-5/2	No	1	433	Rupees Four Hundred Thirty Three Only	433
211	J-5/3	Three Gang Light Switch	No	4	2600	Rupees Ten Thousand Four Hundred Only	10400

PUBLIC PROCUREMENT REGULATORY AUTHORITY (PPRA) EPADS

Sr. No	S.#	DESCRIPTION	UNIT	QTY	RATE	AMOUNT IN WORDS	AMOUNT
212	J-5/3a	Installation, Testing & Commissioning of above item at S.# J-5/3	No	4	433	Rupees One Thousand Seven Hundred Thirty Two Only	1732
213	J-5/4	13A, International Switch Socket Unit	No	13	2772	Rupees Thirty Six Thousand Thirty Six Only	36036
214	J-5/4a	Installation, Testing & Commissioning of above item at S.# J-5/4	No	13	433	Rupees Five Thousand Six Hundred Twenty Nine Only	5629

PUBLIC PROCUREMENT REGULATORY AUTHORITY (PPRA) EPADS

Sr. No	S.#	DESCRIPTION	UNIT	QTY	RATE	AMOUNT IN WORDS	AMOUNT
215	J-5/5	15A 3-Pin Round Switch Socket unit	No	13	2772	Rupees Thirty Six Thousand Thirty Six Only	36036
216	J-5/5a	Installation, Testing & Commissioning of above item at S.# J-5/5	No	13	433	Rupees Five Thousand Six Hundred Twenty Nine Only	5629
217	J-5/6	32A DP Isolator	No	1	14194	Rupees Fourteen Thousand One Hundred Ninety Four Only	14194

PUBLIC PROCUREMENT REGULATORY AUTHORITY (PPRA) EPADS

Sr. No	S.#	DESCRIPTION	UNIT	QTY	RATE	AMOUNT IN WORDS	AMOUNT
218	J-5/6a	Installation, Testing & Commissioning of above item at S.# J-5/6	No	1	743	Rupees Seven Hundred Forty Three Only	743
219	J-5/7	16A 3-Pin (Single Phase) Industrial Socket with Plug	No	1	3910	Rupees Three Thousand Nine Hundred Ten Only	3910
220	J-5/7a	Installation, Testing & Commissioning of above item at S.# J-5/7	No	1	1238	Rupees One Thousand Two Hundred Thirty Eight Only	1238

PUBLIC PROCUREMENT REGULATORY AUTHORITY (PPRA) EPADS

Sr. No	S.#	DESCRIPTION	UNIT	QTY	RATE	AMOUNT IN WORDS	AMOUNT
221	J-5/8	32A 3-Pin (Single Phase) Industrial Socket with Plug	No	1	6197	Rupees Six Thousand One Hundred Ninety Seven Only	6197
222	J-5/8a	Installation, Testing & Commissioning of above item at S.# J-5/8	No	1	1238	Rupees One Thousand Two Hundred Thirty Eight Only	1238
223	J-6	Supply, Installation, Testing & Commissioning of the following Light fixtures complete with the supply of all hanging accessories including clips, suspension rods / wires, ceiling frame etc.					

PUBLIC PROCUREMENT REGULATORY AUTHORITY (PPRA) EPADS

Sr. No	S.#	DESCRIPTION	UNIT	QTY	RATE	AMOUNT IN WORDS	AMOUNT
224	J-6/1	Wall/Surface Mounted 18W LED Batten Light Fixture, 4000K, L=1200mm	No.	20	3952	Rupees Seventy Nine Thousand Forty Only	79040
225	J-6/1a	Installation, Testing & Commissioning of above item at S.# J-6/1	No.	20	749	Rupees Fourteen Thousand Nine Hundred Eighty Only	14980
226	J-6/2	NON-MAINTAINED TYPE WALL MOUNT EMERGENCY LIGHT WITH 5W LED LAMP AND 1.5 HOUR BUILT-IN BATTERY BACK-UP	No.	6	24101	Rupees One Hundred Forty Four Thousand Six Hundred Six Only	144606

PUBLIC PROCUREMENT REGULATORY AUTHORITY (PPRA) EPADS

Sr. No	S.#	DESCRIPTION	UNIT	QTY	RATE	AMOUNT IN WORDS	AMOUNT
227	J-6/2a	Installation, Testing & Commissioning of above item at S.# J-6/2	No.	6	749	Rupees Four Thousand Four Hundred Ninety Four Only	4494
228		SECTION - K MISC. WORKS					
229	K-1	Preparation & Submission of As-Built drawings for all electrical and allied works after getting final approval from the Client/Consultant. Note: 2 sets of as-built drawings after work completion of each floor, and 3 sets with a soft copy of complete electrical works after final commissioning of project to be submitted. Approval of bills are subject to the completion of as built drawings upto the entire satisfaction ot site engineer.	Job	1	110106	Rupees One Hundred Ten Thousand One Hundred Six Only	110106

PUBLIC PROCUREMENT REGULATORY AUTHORITY (PPRA) EPADS

Sr. No	S.#	DESCRIPTION	UNIT	QTY	RATE	AMOUNT IN WORDS	AMOUNT
230	K-2	Disconnection, professional rigging, craneage, and transportation of the existing 200kVA Diesel Generator from the substation to the new outdoor location. This item includes the construction of a reinforced concrete (RCC) foundation pad with vibration isolators and the provision of a 110% capacity fuel/oil spill containment bund. The scope covers all mechanical and electrical re-connections, cable containment, and full testing and commissioning, ensuring the system is complete in all respects.	Job	1	556713	Rupees Five Hundred Fifty Six Thousand Seven Hundred Thirteen Only	556713
231	K-3	Supply and installation of an IP-rated acoustic weather-proof canopy for the existing 200kVA Diesel Generator. The item includes all necessary mounting, sealing, and integration with the generator unit to ensure protection against environmental factors and compliance with noise reduction requirements, complete in all respects.	Job	1	618570	Rupees Six Hundred Eighteen Thousand Five Hundred Seventy Only	618570

PUBLIC PROCUREMENT REGULATORY AUTHORITY (PPRA) EPADS

Sr. No	S.#	DESCRIPTION	UNIT	QTY	RATE	AMOUNT IN WORDS	AMOUNT
232	K-4	Disconnection, professional rigging, craneage, and transportation of the existing 2,400-liter fuel storage tank to the designated new location. Item includes the construction of a heavy-duty reinforced concrete (RCC) foundation pad and a 110% capacity secondary fuel/oil spill containment bund (dyke wall) to comply with environmental safety standards. Scope covers the relocation, modification, and extension of all fuel supply, return, and vent piping, including the re-installation of all valves, strainers, and level sensing equipment. Work includes all mechanical/electrical integration, earth bonding, and comprehensive pressure and leak testing of the entire fuel delivery system. Complete in all respects as per job requirements or as directed by the Engineer.	Job	1	742284	Rupees Seven Hundred Forty Two Thousand Two Hundred Eighty Four Only	742284

PUBLIC PROCUREMENT REGULATORY AUTHORITY (PPRA) EPADS

Sr. No	S.#	DESCRIPTION	UNIT	QTY	RATE	AMOUNT IN WORDS	AMOUNT
233	K-5	Dismantling/pulling/removal, loading, shifting, unloading and transportation to SBP Store of existing Consumer MV Switchgears including with all required materials, equipment, machines, removal of any debris etc. related to complete the job. Complete in all respects as per job requirements or as directed by the Engineer / as per Client instructions. Notes: 1) Contractor has been advised to make a detailed site visit for this job. 2) Contractor shall handover all dismantled items to SBP Store with signed inventory. 3) A clearly marked plan to be prepared for dismantling / disconnection work by the contractor for approval of consultant / client before commencement of work.	Job	1	309285	Rupees Three Hundred Nine Thousand Two Hundred Eighty Five Only	309285

PUBLIC PROCUREMENT REGULATORY AUTHORITY (PPRA) EPADS

Sr. No	S.#	DESCRIPTION	UNIT	QTY	RATE	AMOUNT IN WORDS	AMOUNT
234	K-6	Dismantling/pulling/removal, loading, shifting, unloading and transportation to SBP Store of existing 02 Nos Transfomers including with all required materials, equipment, machines, removal of any debris etc. related to complete the job. Complete in all respects as per job requirements or as directed by the Engineer / as per Client instructions. Notes: 1) Contractor has been advised to make a detailed site visit for this job. 2) Contractor shall handover all dismantled items to SBP Store with signed inventory. 3) A clearly marked plan to be prepared for dismantling / disconnection work by the contractor for approval of consultant / client before commencement of work.	Job	1	371142	Rupees Three Hundred Seventy One Thousand One Hundred Forty Two Only	371142

PUBLIC PROCUREMENT REGULATORY AUTHORITY (PPRA) EPADS

Sr. No	S.#	DESCRIPTION	UNIT	QTY	RATE	AMOUNT IN WORDS	AMOUNT
235	K-7	Dismantling/pulling/removal, loading, shifting, unloading and transportation to SBP Store of existing Main LV Panels and Distribution Boards (DBs) shall include a comprehensive technical execution plan where the contractor performs systematic tracing and tagging of all incoming and outgoing feeders using permanent, legible identifiers prior to any disconnection. This process must be supported by a detailed re-termination and interconnection schedule, including a clearly marked plan for cable re-routing to ensure seamless integration into the new LV panels. The scope further encompasses the safe disconnection and pulling of all power and control cables from existing ducts or trays, the physical removal of panel structures, and all associated logistics including loading, shifting, and transportation of dismantled components to the SBP Store, followed by the complete disposal of electrical debris and site clearance as directed by the Consultant and Client.	Job	1	371142	Rupees Three Hundred Seventy One Thousand One Hundred Forty Two Only	371142

PUBLIC PROCUREMENT REGULATORY AUTHORITY (PPRA) EPADS

Sr. No	S.#	DESCRIPTION	UNIT	QTY	RATE	AMOUNT IN WORDS	AMOUNT
236	K-8	Arrangment of temporary cables and installation, connection to energize the system during dismantling and shifting of MV Switches to avoid shutdowns and to provide smooth power supply to building. Work also includes temporary site facilities, required materials & equipments to complete the job as per job requirements / directed by the Engineer / Client instructions. Complete in all respects to maintain zero downtime.	Job	1	309285	Rupees Three Hundred Nine Thousand Two Hundred Eighty Five Only	309285
237	K-9	Arrangment of temporary cables and installation, connection to energize the system during dismantling and shifting of Transformers to avoid shutdowns and to provide smooth power supply to building. Work also includes temporary site facilities, required materials & equipments to complete the job as per job requirements / directed by the Engineer / Client instructions. Complete in all respects to maintain zero downtime.	Job	1	309285	Rupees Three Hundred Nine Thousand Two Hundred Eighty Five Only	309285

PUBLIC PROCUREMENT REGULATORY AUTHORITY (PPRA) EPADS

Sr. No	S.#	DESCRIPTION	UNIT	QTY	RATE	AMOUNT IN WORDS	AMOUNT
238	K-10	Careful pulling out of existing cable from Main LV panel to LT-5, ELT-1 and MCC panel of 4C-240 sqmm Cu/XLPE/PVC power cable with associated ECC from existing indoor/outdoor cable trays, vertical risers, and under-floor UPVC sleeves/handholes; including safe disconnecting, sealing of cable ends using waterproof PVC insulation tape or heat-shrinkable end caps to prevent moisture ingress, coiling/drumming, transportation, and safe stacking/handing over at the client's designated storage location within the facility premises.	Job	1	556713	Rupees Five Hundred Fifty Six Thousand Seven Hundred Thirteen Only	556713

PUBLIC PROCUREMENT REGULATORY AUTHORITY (PPRA) EPADS

Sr. No	S.#	DESCRIPTION	UNIT	QTY	RATE	AMOUNT IN WORDS	AMOUNT
239	K-11	Careful dismantling, relocation, and re-installation of the existing 60kVA Automatic Transfer Switch (ATS) DB from its current position to a new location designated by the client. The scope of work includes marking/tagging of existing wires, safe electrical disconnection, structural unmounting, safe transit within the facility premises, rigid wall or floor mounting at the new location, extending/rerouting existing power/control cables if necessary, proper dressing, re-termination using appropriate copper lugs and glands, testing, and final commissioning to ensure seamless functionality.	Job	1	185571	Rupees One Hundred Eighty Five Thousand Five Hundred Seventy One Only	185571

PUBLIC PROCUREMENT REGULATORY AUTHORITY (PPRA) EPADS

Sr. No	S.#	DESCRIPTION	UNIT	QTY	RATE	AMOUNT IN WORDS	AMOUNT
240	K-12	Dismantling, relocation, reinstallation, testing and recommissioning of the existing 110 kWe Solar PV system equipment, including solar inverters, AC/DC combiner boxes, energy meters, associated accessories and cabling, from the existing location to the new inverter room as directed by the Consultant/Client. The work shall include tagging and disconnection of existing cables, dismantling, internal transportation, mounting at the new location, cable rerouting/extensions as required, termination with suitable lugs and glands, reconnection of earthing and control circuits, testing, commissioning, and handing over the complete system in fully functional condition.	Job	1	247428	Rupees Two Hundred Forty Seven Thousand Four Hundred Twenty Eight Only	247428
241		SECTION - L CIVIL WORKS					
242		Dismantling Works					

PUBLIC PROCUREMENT REGULATORY AUTHORITY (PPRA) EPADS

Sr. No	S.#	DESCRIPTION	UNIT	QTY	RATE	AMOUNT IN WORDS	AMOUNT
243	L-1	Dismantling of the existing walls and floors using mechanical means and manual labour as per site requirements, including the cost of dismantling existing installations necessary to remove for dismantling and to complete the job, including the cost of disposal of debris away from premises, complete in all respects.	Cft	650	178	Rupees One Hundred Fifteen Thousand Seven Hundred Only	115700
244	L-2	Dismantling of existing doors carefully without any damages, stacking them at a designated location carefully within Bank Premises, cost of all labour, tools required to complete the job successfully is included, complete in all respects.	Job	2	17775	Rupees Thirty Five Thousand Five Hundred Fifty Only	35550
245		Sub Flooring Works					
246	L-3	Providing, mixing, laying, vibrating & curing cement concrete 1:3:6 in floors, in trenches in required levels & slopes complete in all respects as per site requirements and as directed by the Engineer Incharge.	Cft	480	948	Rupees Four Hundred Fifty Five Thousand Forty Only	455040

PUBLIC PROCUREMENT REGULATORY AUTHORITY (PPRA) EPADS

Sr. No	S.#	DESCRIPTION	UNIT	QTY	RATE	AMOUNT IN WORDS	AMOUNT
247	L-4	Backfilling & compaction of approved quality sand in under floors, trenches, etc. including breaking clods, dressing, watering, compaction etc, complete in all respects as per site requirements and as directed by the Engineer In-Charge.	Cft	250	237	Rupees Fifty Nine Thousand Two Hundred Fifty Only	59250
248	L-5	Providing, mixing, laying, vibrating & curing RCC 1:2:4 in foundation beam and columns for gate using SR cement, including the cost of required formwork, including the cost of using mechanical vibrator for concrete compaction as per site requirements. The contractor shall be responsible for providing fairface concrete after removing formwork, free from all defects e.g honey combing etc. Complete in all respects as per site requirements and as directed by the Engineer In-Charge	Cft	210	1185	Rupees Two Hundred Forty Eight Thousand Eight Hundred Fifty Only	248850

PROCUREMENT REGULATORY AUTHORITY (PPRA) EPADS

Sr. No	S.#	DESCRIPTION	UNIT	QTY	RATE	AMOUNT IN WORDS	AMOUNT
249	L-6	Providing, straightening, cutting, bending and binding of grade-60 deformed steel bars in beams, columns, foundations etc. including the cost of required binding wire, spacers etc. complete in all respects as per site requirements and as directed by the Engineer In-Charge	Kg	400	593	Rupees Two Hundred Thirty Seven Thousand Two Hundred Only	237200
250	L-7	Providing, mixing, laying, vibrating & curing cement concrete 1:2:4 cost of required formwork, in required levels & slopes, including the cost of concrete pouring in panels in flooring, including the cost of glass strips in floor panels, complete in all respects as per site requirements and as directed by the Engineer Incharge.	Cft	600	1185	Rupees Seven Hundred Eleven Thousand Only	711000
251		Masonry & Plaster Works					

PUBLIC PROCUREMENT REGULATORY AUTHORITY (PPRA) EPADS

Sr. No	S.#	DESCRIPTION	UNIT	QTY	RATE	AMOUNT IN WORDS	AMOUNT
252	L-8	Providing & laying 6 inch thick block masonry having minimum compressive strength of 700 psi in walls with 1:4 cement-sand mortar including cost of precast lintel, curing etc. complete in all respects as per site requirements and as directed by the Engineer incharge.	Cft	1200	948	Rupees One Million One Hundred Thirty Seven Thousand Six Hundred Only	1137600
253	L-9	Providing and fixing lintel of precast beam a minimum of 6 inch high above doors as per site requirements, covering full width of wall or as diercted by the engineer incharge.	Rft	18	1304	Rupees Twenty Three Thousand Four Hundred Seventy Two Only	23472

PUBLIC PROCUREMENT REGULATORY AUTHORITY (PPRA) EPADS

Sr. No	S.#	DESCRIPTION	UNIT	QTY	RATE	AMOUNT IN WORDS	AMOUNT
254	L-10	Providing & laying ½” to ¾” thick 1:4 cement-sand plaster including curing etc. working at any height, complete in all respects as per site requirements and as directed by the Engineer incharge.	Sft	2600	237	Rupees Six Hundred Sixteen Thousand Two Hundred Only	616200
255	L-11	Providing and fixing door frames made of about 10 swg MS sheet as per existing design and pattern, including the cost of cutting, bending, grinding, fixing in position, including the cost of red oxide, including the cost of enamel paint, complete in all respects as per site requirements and as directed by the engineer incharge.	Job	2	93615	Rupees One Hundred Eighty Seven Thousand Two Hundred Thirty Only	187230
256	L-12	Refixing of doors at the designated location including cost of any repairs required, complete in all respects as per site requirements and as directed by the engineer incharge.	Job	2	23700	Rupees Forty Seven Thousand Four Hundred Only	47400

PUBLIC PROCUREMENT REGULATORY AUTHORITY (PPRA) EPADS

Sr. No	S.#	DESCRIPTION	UNIT	QTY	RATE	AMOUNT IN WORDS	AMOUNT
257	L-13	Dismantling of existing rain water pipe completely, including disposal of debris away from municipal limits, including stacking serviceable items at a designated location inside bank premises as per directions of the engineer incharge.	Job	4	5925	Rupees Twenty Three Thousand Seven Hundred Only	23700
258	L-14	Providing and fixing 4 inch dia pvc pipe schedule 40, inlcuding cost of any fittings, including cost of pvc strainer, inlcuding cost of clips, nails required to fix the pipe, including the cost of providing khurrah, complete in all respects as per site requirements and as directed by the engineer incharge.	Rft	65	1067	Rupees Sixty Nine Thousand Three Hundred Fifty Five Only	69355

PUBLIC PROCUREMENT REGULATORY AUTHORITY (PPRA) EPADS

Sr. No	S.#	DESCRIPTION	UNIT	QTY	RATE	AMOUNT IN WORDS	AMOUNT
259	L-15	Leveling/repairing of slab surface with about ¾” average thick layer of slurry comprising of Cement + Sand (in 1:3 ratio) using latex based concrete bonding agent from Sika, ICPL, Fospak or other approved manufacturer @ 3 liters per bag of cement or as per the directions of the manufacturer/ supplier, smooth trowel finished top surface, curing with damp jute cloth, complete in all respects as per site requirements and as directed by the Engineer In-Charge.	Sft	2030	104	Rupees Two Hundred Eleven Thousand One Hundred Twenty Only	211120

PUBLIC PROCUREMENT REGULATORY AUTHORITY (PPRA) EPADS

Sr. No	S.#	DESCRIPTION	UNIT	QTY	RATE	AMOUNT IN WORDS	AMOUNT
260	L-16	Making of PCC edge fillet (triangular/parabolic shape gola) of approximately 4” x 4” size along the outer walls with plain cement in 1:2:4 ratio using OP cement, clean sand and coarse aggregate of 10mm and down sizes mixed with latex based bonding agent SBR from Sika, ICPL, Fospak or other approved manufacturer @ 3 liters per bag of cement or as per the directions of the manufacturer/ supplier with smooth trowel finished top surface, curing, complete in all respects as per site requirements and as directed by the Engineer In-Charge.	Rft	110	115	Rupees Twelve Thousand Six Hundred Fifty Only	12650

PUBLIC PROCUREMENT REGULATORY AUTHORITY (PPRA) EPADS

Sr. No	S.#	DESCRIPTION	UNIT	QTY	RATE	AMOUNT IN WORDS	AMOUNT
261	L-17	Providing and torch applying 4mm thick layer of modified bitumen & non-woven spun-bond polyester fibers reinforcement based water proofing membrane of Derma Bit (ECOGUM SP) or other approved equivalent KSA make, with slated type top surface finish, in accordance with the directions of the manufacturer/supplier including the cost of approved primer (DERMAPRIMER or other approved equivalent) applied @ about 4m2/liter or as recommended by the manufacturer, all required overlaps of minimum 3” width, complete in all respects as per site requirements and as directed by the Engineer In-Charge. Measurement for payment shall be made on the basis of top surface only without considering any overlaps. (The contractor shall have to submit samples along with technical data sheets of materials for approval by the Engineer In-Charge before application at site.)	Sft	2030	415	Rupees Eight Hundred Forty Two Thousand Four Hundred Fifty Only	842450
262		Paint Works					

Sr. No	S.#	DESCRIPTION	UNIT	QTY	RATE	AMOUNT IN WORDS	AMOUNT
263	L-18	Providing & applying two coats of plastic emulsion paint of Burger Robbialac or other approved equivalent over walls & ceiling application of wall putty, sand papering, etc. complete in all respects as per site requirements and as directed by the Engineer In-charge.	Sft	6700	107	Rupees Seven Hundred Sixteen Thousand Nine Hundred Only	716900
264	L-19	Providing & applying two coats of weather coat paint of Burger Robbialac or other approved equivalent over walls , application of wall putty, sand papering, etc. complete in all respects as per site requirements and as directed by the Engineer In-charge.	Sft	2800	119	Rupees Three Hundred Thirty Three Thousand Two Hundred Only	333200
265	L-20	Providing and applying enamel paint of nippon or approved equivalent on doors, ventilators and anyother metal frame as directed by the engineer incharge.	Sft	1000	143	Rupees One Hundred Forty Three Thousand Only	143000

PUBLIC PROCUREMENT REGULATORY AUTHORITY (PPRA) EPADS

Sr. No	S.#	DESCRIPTION	UNIT	QTY	RATE	AMOUNT IN WORDS	AMOUNT
266	L-21	Providing and fixing 100 x 100 x 10mm angle along the edge of the cable trench, including the cost of enamel paint on angle, complete in all respects as per site requirements and as directed by the engineer incharge.	Rft	110	2489	Rupees Two Hundred Seventy Three Thousand Seven Hundred Ninety Only	273790
267	L-22	Providing and fixing precast RCC slabs over cable trench having varying widths of 2 ft, 2.5 ft and 4 ft. Each slab must have two hooks at top for ease of lifting, minimum width of slab be about 1 ft, minimum thickness of slab is about 4 inch, with about 2 bars at top and 2 bars at bottom of 3/8" steel, with distribution steel as well, complete in all respects. payment will be made on top surface area of slab.	Sft	180	1422	Rupees Two Hundred Fifty Five Thousand Nine Hundred Sixty Only	255960
						GRAND TOTAL:	Rs240,285,841.00

PROCUREMENT REGULATORY AUTHORITY (PPRA) EPADS

Scope of Work

1. **Major Items of Contract:**

1. Dismantling/pulling/removal, loading, shifting, unloading and transportation of existing 02x750kVA transformers, MV Switchgears, LV Panels, DBs, HT/LT cables etc. to designated location within premises

2. Installation, testing and commissioning and Sifting of DG Set to designated location within the premises.

3. Supply, installation, testing and commissioning of 2x1000kVA oil type transformers along with construction of oil pits.

4. Supply, Installation, testing and commissioning of MV and LV panels including ATS, PFI panels and distribution boards (DB’s)

5. Supply, Installation, testing and commissioning of MV and LT cables in existing/proposed Cable trays/underground pvc pipes/underground cable trench as per site requirements

6. Supply, installation, testing and commissioning of light fixtures & Fans including wiring etc.

7. Civil Works i.e. extension of existing Electrical Room after dismantling of existing walls. Construction of oil pits, excavation for cable trench etc

8. Earthing works.

9. Submission of drawings and schematics in hardcopy and softcopy form detailing operating procedure and showing system failure scenarios.

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10. The samples shall be submitted to the Engineer at his office in North Nazimabad as specified in Preamble to Conditions of Contract. The rejected sample(s) shall be recollected by the Contractor and fresh sample(s) shall be submitted. The Engineer shall formally intimate the Employer and the Contractor of the reasons of rejection of sample(s).

11. The Contractor shall submit one set in form of softcopy and two sets in hard form of shop drawings to the Engineer, under intimation to the Employer. The Engineer shall retain one set of the commented/approved shop drawing for his record and return the other set to the Contractor.

PUBLIC PROCUREMENT REGULATORY AUTHORITY (PPRA) EPADS

Price Schedule

For Individual Jobs

#	Job Title	Quantity	Unit Price (PKR)	Total Price (PKR)	Delivery Location	Delivery Period / Year	Country of Origin
1							
2							

For Lots

#	Lot Title	Total Lot Price (PKR)	Country of Origin
1	[Lot 1 Title]		

PUBLIC PROCUREMENT REGULATORY AUTHORITY (PPRA) EPADS

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General Conditions of Contract

A. General

1. **Definitions**

1.1. Unless the context otherwise requires, the following terms whenever used in this Contract shall have the same meaning and shall be interpreted as indicated

1.1.1. “Applicable Law” means the laws and any other instruments having the force of law in the Government’s Country, or in such other country as may be specified in the Special Conditions of the Contract (SC), as they may be issued and in force from time to time;

1.1.2. “The Contract” means an agreement enforceable by law;

1.1.3. “The Contract Price” means the price payable to the Contractor under the Contract for the full and proper performance of its contractual obligations;

1.1.4. “The Services” means the work to be performed by the Contractor pursuant to this Contract and as prescribed in the Specifications and Schedule of Activities included in the Contractor’s Bid;

1.1.5. “Ancillary Services” means those services ancillary to the provision of Services, such as transportation and insurance, and any other incidental services, such as installation, commissioning, provision of technical assistance, training, and other such obligations of the Contractor covered under the Contract;

1.1.6. “GCC” means the General Conditions of Contract contained in this section;

1.1.7. “SCC” means the Special Conditions of Contract by which the GCC may be amended or supplemented;

1.1.8. **“**Day” means calendar day unless indicated otherwise;

1.1.9. “Effective Date” means the date on which this Contract comes into force and effect;

1.1.10. “The Contractor” means the individual or corporate body whose Bids to provide the Services has been accepted by the Procuring Agency;

1.1.11. “The Project Site,” where applicable, means the place or places named in Bid Data Sheet and technical Specifications;

1.1.12. “Government” means the Government of Pakistan;

1.1.13. “Local Currency” means the currency of Pakistan;

1.1.14. “In Writing” means communicated in written form with proof of receipt;

1.1.15. “Completion Date” means the date of completion of the Services by the Contractor as certified by the Procuring Agency;

1.1.16. “Foreign Currency” means any currency other than the currency of the country of the Procuring Agency;

1.1.17. “Party” means the Procuring Agency or the Contractor, as the case may be, and “Parties” means both of them;

1.1.18. "Service" means any object of procurement other than goods or works;

1.1.19. “Subcontractor” means any entity to which the Bidder subcontracts any part of the Services.

2. **Applicable Law**

2.1. The contract shall be governed and interpreted in accordance with the laws of Pakistan, unless otherwise specified in SCC.

3. **Language**

3.1. The Contract as well as all correspondence and documents relating to the Contract exchanged between the Contractorand the Procuring Agency, shall be written in the **English language** unless otherwise stated in the **SCC** . Supporting documents and printed literature that are part of the Contract may be in another language provided these are accompanied by an accurate translation of the relevant passages in English, in which case, for purposes of interpretation of the Contract, this translation shall govern.

4. **Notices**

4.1. Any notice, request, or consent made pursuant to this Contract shall be in writing and shall be deemed to have been made when delivered in person to an authorized representative of the Party to whom the communication is addressed, or when sent by registered mail, telex, telegram, or facsimile to such Party at the address specified in the **SCC**.

5. **Location**

5.1. The Services shall be performed at such locations as the Procuring Agency may approve and as specified in **SCC.**

5.2. A {DOCUMENTS}

6. **Authorized Representatives / Authority of Member in charge**

6.1. Any action required or permitted to be taken, and any document required or permitted to be executed, under this Contract by the Procuring Agency or the Contractor may be taken or executed by the officials specified in the **SCC**.

B. Commencement, Completion, Modification, and Termination of Contract

7. **Effectiveness of Contract**

7.1. This Contract shall come into effect on the date the Contract is signed by both parties and such other later date as may be stated in the **SCC.**

8. **Commencement of Services**

8.1. The Contractor shall confirm availability of Key Experts and begin carrying out the Services not later than the number of days after the Effective Date specified in the **SCC.**

9. **Program schedule**

9.1. Before commencement of the Services, the Contractor shall submit to the Procuring Agency for approval a Program showing the general methods, arrangements, order and timing for all activities. The Services shall be carried out in accordance with the approved Program as updated.

10. **Starting Date/Expiration Date**

10.1. The Contractor shall start carrying out the Services Five (05) days after the date the Contract becomes effective, or at such other date as may be specified in the **SCC.**

10.2. Unless terminated earlier pursuant to Clause **GCC 14** hereof, this Contract shall expire at the end of such time period after the Effective Date as specified in the **SCC.**

11. **Entire Agreement**

11.1. This Contract contains all covenants, stipulations and provisions agreed by the Parties. No agent or representative of either Party has authority to make, and the Parties shall not be bound by or be liable for, any statement, representation, promise or agreement not set forth herein.

12. **Modification**

12.1. Any modification or variation of the terms and conditions of this Contract, including any modification or variation of the scope of the Services, may only be made by written agreement between the Parties. However, each Party shall give due consideration to any modification(s) or variation(s) made by the other Party.

12.2. In cases of any modification(s) or variation(s), the prior written consent of the Procuring Agency is required.

13. **Force Majeure**

13.1. **Definition**
For the purposes of this Contract, “Force Majeure” means an event which is beyond the reasonable control of a Contractor and which makes a Contractor’s performance of its obligations under the Contract impossible or so impractical as to be considered impossible under the circumstances.

13.2. **No Breach of Contract**
The failure of a Party to fulfill any of its obligations under the contract shall not be considered to be a breach of, or default under, this Contract in so far as such inability arises from an event of Force Majeure, provided that the Party affected by such an event (a) has taken all reasonable precautions, due care and reasonable alternative

measures in order to carry out the terms and conditions of this Contract, and (b) has informed the other Party as soon as possible about the occurrence of such an event.

13.3. **Extension of Time**
Any period within which a Contractor shall, pursuant to this Contract, complete any action or task, shall be extended for a period equal to the time during which such Party was unable to perform such action as a result of Force Majeure.

13.4. **Payments**
During the period of their inability to perform the Services as a result of an event of Force Majeure, the Contractor shall be entitled to continue to be paid under the terms of this Contract, as well as to be reimbursed for additional costs reasonably and necessarily incurred by them during such period for the purposes of the Services and in reactivating the Service after the end of such period.

14. **Termination**

14.1. **By the Procuring Agency**
The Procuring Agency may terminate this Contract in case of the occurrence of any of the events specified in paragraphs (a) through (e) of this Clause. In such an occurrence the Procuring Agency shall give at least thirty (30) calendar days' written notice of termination to the Contractor in case of the events referred to in (a) through (d); at least sixty (60) calendar days' written notice in case of the event referred to in (e);

14.1.1. If the Contractor fails to remedy a failure in the performance of its obligations hereunder, as specified in a notice of suspension;

14.1.2. If the Contractor becomes (or, if the Contractor consists of more than one entity, if any of its members becomes) insolvent or bankrupt or enter into any agreements with their creditors for relief of debt or take advantage of any law for the benefit of debtors or go into liquidation or receivership whether compulsory or voluntary;

14.1.3. If the Contractor fails to comply with any final decision reached as a result of arbitration proceedings;

14.1.4. If, as the result of Force Majeure, the Contractor is unable to perform a material portion of the Services for a period of not less than sixty (60) calendar days;

14.1.5. If the Procuring Agency, in its sole discretion and for any reason whatsoever, decides to terminate this Contract;

14.2. **By the Contractor**
The Contractor may terminate this Contract, by not less than thirty (30) calendar days' written notice to the Procuring Agency, in case of the occurrence of any of the events specified in paragraphs (a) through (d) of this Clause.

14.2.1. If the Procuring Agency fails to pay any money due to the Contractor pursuant to this Contract and not subject to dispute within forty-five (45) calendar days after receiving written notice from the Contractor that such payment is overdue;

14.2.2. If, as the result of Force Majeure, the Contractor is unable to perform a material portion of the Services for a period of not less than sixty (60) calendar days;

14.2.3. If the Procuring Agency fails to comply with any final decision reached as a result of arbitration;

14.2.4. If the Procuring Agency is in material breach of its obligations pursuant to this Contract and has not remedied the same within forty-five (45) days (or such longer period as the Bidder may have subsequently approved in writing) following the receipt by the Procuring Agency of the Contractor's notice specifying such breach.

C. Obligations of the Contractor

15. **General**

15.1. **Standard of Performance**

15.1.1. The Contractor shall perform the Services and carry out the Services with all due diligence, efficiency and economy, in accordance with generally accepted professional standards and practices, and shall observe sound management practices, and employ appropriate technology and safe and effective equipment, machinery, materials and methods. The Contractor shall always act, in respect of any matter relating to this Contract or to the Services, as a faithful adviser to the Procuring Agency, and shall at all times support and safeguard the Procuring Agency's legitimate interests in any dealings with the third parties;

15.1.2. The Contractor shall employ and provide such qualified and experienced Experts and Sub-Contractors as are required to carry out the Services.

15.2. **Law Applicable to Services**

The Contractor shall perform the Services in accordance with the Contract and in accordance with the Law of Pakistan and shall take all practicable steps to ensure that any of its Experts and Sub-Bidders, comply with the Applicable Law.

16. **Conflict of Interests**

16.1. **Contractor Not to Benefit from Commissions and Discounts**

The remuneration of the Contractor shall constitute the Contractor's sole remuneration in connection with this Contract or the Services, and the Contractor shall not accept for their own benefit any trade commission, discount, or similar payment in connection with activities pursuant to this Contract or to the Services or in the discharge of their obligations under the Contract, and the Contractor shall use their best efforts to ensure that the Personnel, any Subcontractors, and agents of either of them similarly shall not receive any such additional remuneration.

16.2. **Contractor and Affiliates Not to be Otherwise Interested in Project**

The Contractor agree that, during the term of this Contract and after its termination, the Contractor and its affiliates, as well as any Subcontractor and any of its affiliates, shall be disqualified from providing Services (other than the Services and any continuation thereof) for any project resulting from or closely related to the Services.

16.3. **Prohibition of Conflicting Activities**
Neither the Bidder nor its Subcontractors nor the Personnel shall engage, either directly or indirectly, in any of the following activities:

16.3.1. during the term of this Contract, any business or professional activities in the Government's country which would conflict with the activities assigned to them under this Contract;

16.3.2. during the term of this Contract, neither the Contractor nor their Subcontractors shall hire public employees in active duty or on any type of leave, to perform any activity under this Contract;

16.3.3. after the termination of this Contract, such other activities as may be specified in the **SCC.**

17. **Insurance to be Taken Out by the Contractor**

17.1. The Contractor(a) shall take out and maintain, and shall cause any Subcontractors to take out and maintain, at its (or the Sub-contractors', as the case may be) own cost but on terms and conditions approved by the Procuring Agency, insurance against the risks, and for the coverage, as shall be specified in the **SCC**; and (b) at the Procuring Agency's request, shall provide evidence to the Procuring Agency showing that such insurance has been taken out and maintained and that the current premiums have been paid.

18. **Contractor's Actions Requiring Procuring Agency's Prior Approval**

18.1. The Contractor shall obtain the Procuring Agency's prior approval in writing before taking any of the following actions:

18.1.1. appointing such members of the Personnel not provided by the Contractor;

18.1.2. changing the Program of activities; and

18.1.3. any other action that may be specified in the **SCC.**

19. **Reporting Obligations**

19.1. The Contractor shall submit to the Procuring Agency the reports and documents in the numbers, and within the periods as prescribed by the Procuring Agency.

20. **Liquidated Damages**

20.1. **Payments of Liquidated Damages**
The Contractor shall pay liquidated damages to the Procuring Agency at the rate per day stated in the **SCC** for each day that the Completion Date is later than the Intended Completion Date. The total amount of liquidated damages shall not exceed the amount defined in the **SCC**. The Procuring Agency may deduct liquidated damages from payments due to the Contractor. Payment of liquidated damages shall not affect the Contractor's liabilities.

20.2. **Correction for Over-payment**
If the Intended Completion Date is extended after liquidated damages have been paid, the Procuring Agency shall correct any overpayment of liquidated damages by the Contractor by adjusting the next payment certificate. The

Contractor shall be paid interest on the overpayment, calculated from the date of payment to the date of repayment, at the rates specified in **SCC.**

20.3. **Lack of performance penalty**
If the Contractor has not corrected a Defect within the time specified in the Procuring Agency's notice, a penalty for Lack of performance will be paid by the Contractor. The amount to be paid will be calculated as a percentage of the cost of having the Defect corrected, assessed as specified in the Contractor

21. **Performance Guarantee**

21.1. Within the time stipulated in the acceptance letter from the Procuring Agency, the successful Bidder shall furnish the Performance Guarantee in shape and amount **specified in SCC.**

21.2. The proceeds of the Performance Guarantee shall be payable to the Procuring agency as compensation for any loss resulting from the Supplier's failure to complete its obligations under the Contract.

21.3. The Performance Guarantee shall be denominated in the currency of the Contract, or in a freely convertible currency acceptable to the Procuring agency and shall be in the acceptable form as specified in **SCC**.

21.4. The Performance Guarantee will be discharged by the Procuring agency and returned to the Supplier not later than thirty (30) days following the date of completion of the Supplier's performance obligations under the Contract, including any warranty obligations, unless otherwise **specified in SCC.**

22. **Sustainable Procurement**

22.1. The Contractor shall conform to the sustainable procurement contractual provisions, if and as specified in the **SCC.**

D. Contractor's Personnel

23. **Description of Personnel**

23.1. The titles, agreed job descriptions, minimum qualifications, and estimated periods of engagement in the carrying out of the Services of the Contractor's Key Personnel. The Key Personnel listed by title as well as by name are hereby approved by the Procuring Agency.

24. **Removal and / or Replacement of Personnel**

24.1. Except as the Procuring Agency may otherwise agree, no changes shall be made in the Key Personnel. If, for any reason beyond the reasonable control of the Contractor, it becomes necessary to replace any of the Key Personnel, the Contractor shall provide as a replacement a person of equivalent or better qualifications.

24.2. If the Procuring Agency finds that any of the Personnel have (i) committed serious misconduct or have been charged with having committed a criminal action, or (ii) have reasonable cause to be dissatisfied with the performance of any of the Personnel, then the Contractor shall, at the Procuring Agency's written request specifying the grounds thereof, provide as a replacement a person with qualifications and experience acceptable to the Procuring Agency.

24.3. The Contractor shall have no claim for additional costs arising out of or incidental to any removal and/or replacement of Personnel.

E. Obligations of the Procuring Agency

25. **Change in the Applicable Law**

25.1. If, after the date of this Contract, there is any change in the Applicable Law with respect to taxes and duties which increases or decreases the cost of the Services rendered by the Contractor, then the remuneration and reimbursable expenses otherwise payable to the Contractor under this Contract shall be increased or decreased accordingly by agreement between the Parties, and corresponding adjustments shall be made to the amounts referred in the **SCC.**

26. **Services and Facilities**

26.1. The Procuring Agency shall make available to the Contractor and the Experts, for the purposes of the Services and free of any charge, the services, facilities and property described in the Terms of Reference, at the times and in the manner specified in the Terms of Reference.

26.2. In case that such services, facilities and property shall not be made available to the Contractor, the Parties shall agree on (i) any time extension that it may be appropriate to grant to the Contractor for the performance of the Services, (ii) the manner in which the Contractor shall procure any such services, facilities and property from other sources, and (iii) the additional payments, if any, to be made to the Contractor as a result thereof.

F. Payments to the Contractor

27. **Contract Price**

27.1. The price payable shall be in Pakistani Rupees unless otherwise specified in the **SCC**.

28. **Terms and Conditions of Payment**

28.1. Payments will be made to the Contractor according to the payment schedule stated in the **SCC** and as per actual invoice submitted by the Contractor.

28.2. Unless otherwise stated in the **SCC**, the advance payment shall be made against the provision by the Contractor of a bank guarantee for the same amount, and shall be valid for the period stated in the **SCC.** Any other payment shall be made after the conditions listed in the **SCC** for such payment have been met, and the Contractor have submitted an invoice to the Procuring Agency specifying the amount due.

29. **Quality Control Identifying Defects**

29.1. The principle and modalities of Inspection of the Services by the Procuring Agency shall be as indicated in the **SCC.** The Procuring Agency shall check the Contractor’s performance and notify him of any Defects that are

found. Such checking shall not affect the Contractor's responsibilities. The Procuring Agency may instruct the Contractor to search for a Defect and to uncover and test any service that the Procuring Agency considers may have a Defect. Defect Liability Period is as defined in the **SCC**.

29.2. A {INSPECTION}

30. **Correction of Defects, and Lack of Performance Penalty**

30.1. The Procuring Agency shall give notice to the contractor of any Defects before the end of the Contract. The Defects liability period shall be extended for as long as Defects remain to be corrected.

30.2. Every time notice a Defect is given; the contractor shall correct the notified Defect within the length of time specified by the Procuring Agency's notice.

30.3. If the contractor has not corrected a Defect within the time specified in the Procuring Agency's notice, the Procuring Agency will assess the cost of having the Defect corrected, the contractor will pay this amount, and a Penalty for Lack of Performance.

31. **Settlement of Disputes Amicable Settlement**

31.1. The Parties shall use their best efforts to settle amicably all disputes arising out of or in connection with this Contract or its interpretation.

32. **Dispute Settlement**

32.1. **Arbitration**

If any dispute of any kind whatsoever shall arise between the procuring agency and the contractor in connection with or arising out of the Contract, including without prejudice to the generality of the foregoing, any question regarding its existence, validity or termination, or the execution of the contract, the parties shall seek to resolve any such dispute or difference by mutual consultation. If the parties fail to resolve such a dispute or difference even after negotiations or mediation, then the dispute shall be referred within fourteen (14) days in writing by either party to the Arbitrator, with a copy to the other party.

Any dispute in respect of which a notice of intention to commence arbitration has been given, in accordance with **GCC sub-clause 32.1**, shall be finally settled by arbitration. Arbitration may be commenced prior to or after completion of the Contract. Arbitration proceedings shall be conducted in accordance with Arbitration Act 1940. Notwithstanding any reference to arbitration herein, the parties shall continue to perform their respective obligations under the Contract unless otherwise agreed. The Procuring Agency shall continue to pay the Contractor any undisputed amounts due under the Contract during the resolution of any dispute.

Special Conditions of Contract

SECTION VIII. SPECIAL CONDITIONS OF CONTRACT

The following Special Conditions of Contract shall supplement the General Conditions of Contract. Whenever there is a conflict, the provisions herein shall prevail over those in the Conditions of Contract. The corresponding clause number of the GCC is indicated in parentheses.

Number of GC Clause

Amendments of, and Supplements to, Clauses in the General Conditions of Contract

Number of GC Clause 1

Definitions

The Procuring Agency is: SBP-BSC North (SBP Banking Services Corporation (BSC)), Senior Officer SBP BSC (Bank) Building Shahrah-e-Noor Jahan North Nazimabad,, North Nazimabad Sub-Division, Karachi Central (District), Karachi (Division), Sindh (Province).

The Supplier is:

The title of the subject procurement is: UPGRADATION AND IMPROVEMENT OF ELECTRICAL SYSTEM AT SBP BSC (BANK) NORTH NAZIMABAD

Number of GC Clause 2

Applicable/Governing Law:

The Contract shall be interpreted in accordance with the laws of Islamic Republic of Pakistan

Number of GC Clause 3

Language:

The language of the Contract, all correspondence and communications to be given, and all other documentation to be prepared and supplied under the Contract shall be in **English.**

Number of GC Clause 4

Notices:

The addresses for the notices are:

Procuring Agency:

SBP-BSC North (SBP Banking Services Corporation (BSC)), Senior Officer
SBP BSC (Bank) Building Shahrah-e-Noor Jahan North Nazimabad,, North Nazimabad Sub-Division, Karachi Central (District), Karachi (Division), Sindh (Province).
+92-315-720-2000
akhtar.munir@sbp.org.pk

Contractor/ Bidder:

[Name, address and telephone number]

The Contractor/ Bidder's Representative(s)

[Name, address, telephone number and e-mail address]

Number of GC Clause 6.1

The Authorized Representatives are:

For the Procuring Agency:

SBP-BSC North (SBP Banking Services Corporation (BSC)), Senior Officer
SBP BSC (Bank) Building Shahrah-e-Noor Jahan North Nazimabad,, North Nazimabad Sub-Division, Karachi Central (District), Karachi (Division), Sindh (Province).
+92-315-720-2000
akhtar.munir@sbp.org.pk

For the Bidder:

Name: ……

Designation: ……..

Address: ……..

Number of GC Clause 7

Effectiveness of the contract

The Contractor/Bidder shall be effective within ….. days from the date of signature of the Contract by both parties

Number of GC Clause 8

Commencement of Contract:

The Contractor/Bidder shall provide Non-Consultancy Services from the effective date of contract.

Number of GC Clause 10.2

Expiration of Contract:

The time period shall be ……

Number of GC Clause 14

Termination

In the event of termination of the contract due to any reason as already defined in the General Conditions of Contract, the Bidder shall be responsible for providing to the Authority the Goods till the time of alternate arrangements.

Number of GC Clause 16

Conflict of Interest:

The Procuring Agency reserves the right to determine on a case-by-case basis whether the Bidder should be disqualified from providing goods or services due to a conflict of a nature described in Clause GCC 17.

Number of GC Clause 20

Liquidated Damages

If the Bidder fails to provide services as required under the contract or in case of any data loss/data breach or any incident compromising the data security or other such failures related to any services, the Bidder shall pay to the Procuring Agency as Liquidated Damages at a rate of **0.10%** to **10.00%** of the Contract value, in accordance with the extent of performance failure & the cost of investigating such incidents as judged by the Authority.

Number of GC Clause 21

Performance Guarantee:

The amount of performance guarantee shall be **10.00%** of the contract price in acceptable form of **Pay Order, Banker's Cheque, Call at Deposit, Bank Guarantee, Demand Draft**

Number of GC Clause 27

Currency of Payment:

All the payment to be released to the contractor/Bidder shall be in Pakistani Rupees.

Number of GC Clause 28

Payment terms:

Payment will be made to the Bidder against the procured Goods and services according to the actual invoice or running bills submitted by the Bidder against the services provided within the time given in the conditions of the contract.

Number of GC Clause 29

Identifying Defects:

The Authority reserves the right at any time to inspect the premises of the provider to inspect the goods and monitor the goods being provided.

Inspections & Tests Requirements

For being Brand New, bearing relevant reference numbers of the equipment (Certificate from supplier)

For Physical Fitness having No Damages (Certificate from supplier)

For the Country of Origin as quoted by the Supplier (Certificate from manufacturer)

For conformance to specifications and performance parameters, through Prior to delivery inspection (Inspection Report by Procurement Committee / Inspection Team)

For successful operation at site after complete installation, testing and commissioning of the equipment (Installation, Testing and Commissioning Report by Procurement Committee / Inspection Team)

Delivery & Documents

Copies of the Supplier’s invoice showing Goods’ description, quantity, unit price, and total amount;

Original and two copies of the usual transport document (for example, a negotiable bill of lading, a non-negotiable sea waybill, an inland waterway document, an air waybill, a railway consignment note, a road consignment note, or a multimodal transport document) which the buyer may require to take the goods;

Copies of the packing list identifying contents of each package;

Insurance Certificate;

Manufacturer’s or Supplier’s Valid Warranty Certificate;

Inspection Certificate issued by the Nominated Inspection Agency (if any), and the Supplier’s Factory Inspection Report;

Certificate of Origin.

The above documents would be required even if the equipment has already been imported and is available with the supplier ex-stock

Number of GC Clause 31

Following is the guidance for Dispute Resolution

i. If any dispute of any kind whatsoever shall arise between the Authority and the Bidder in connection with or arising out of the Contract... (full clause unchanged)

ii. At future of negotiation the dispute shall be resolved through mediation...

iii. At failure of mediation, arbitration under Arbitration Act 1940...

iv. Cost sharing equally...

v. Proceedings may commence before/after completion...

Notwithstanding any reference to the arbitration herein, the parties shall continue to perform their respective obligations under the Contract.

Rules of procedure for arbitration proceedings:

Any dispute between the Authority and a Bidder shall be referred to arbitration under the laws of Pakistan including Arbitration Act 1940.

Place of Arbitration and Award:

The arbitration shall be conducted in English language and place shall be Islamabad. The award shall be final and binding.

Bid Securing Declaration

Form 9: Bid Securing Declaration

Date: *[insert date (as day, month and year)]*

Bid No.:***P103714***

To: **SBP-BSC North (SBP Banking Services Corporation (BSC)), Senior Officer SBP BSC (Bank) Building Shahrah-e-Noor Jahan North Nazimabad,, North Nazimabad Sub-Division, Karachi Central (District), Karachi (Division), Sindh (Province).**

We, the undersigned, declare that:

We understand that, according to your conditions, Bids must be supported by a Bid Securing Declaration.

We accept that we will be blacklisted and henceforth cross debarred for participating in respective category of public procurement proceedings for a period of (not more than) six months, if fail to abide with a bid securing declaration, however without indulging in corrupt and fraudulent practices, if we are in breach of our obligation(s) under the Bid conditions, because we:

1. have withdrawn or modified our Bid during the period of Bid Validity specified in the Form of Bid;

2. Disagreement to arithmetical correction made to the Bid price; or

3. having been notified of the acceptance of our Bid by the Procuring Agency during the period of Bid Validity, (i) failure to sign the contract if required by Procuring Agency to do so or (ii) fail or refuse to furnish the Performance Security or to comply with any other condition precedent to signing the contract specified in the Bidding Documents.

We understand this Bid Securing Declaration shall expire if we are not the successful

Bidder, upon the earlier of (i) our receipt of your notification to us of the name of the successful Bidder; or (ii) twenty-eight (28) days after the expiration of our Bid.

Contract Form

SECTION IX: CONTRACT FORMS

THIS AGREEMENT made the _____ day of _____ 20_____ between **SBP-BSC North (SBP Banking Services Corporation (BSC)), Senior Officer SBP BSC (Bank) Building Shahrah-e-Noor Jahan North Nazimabad,, North Nazimabad Sub-Division, Karachi Central (District), Karachi (Division), Sindh (Province).**

(hereinafter called "the Procuring Agency") of the one part and *[name of Bidder]* of *[city and country of Bidder]* (hereinafter called "the Bidder") of the other part:

WHEREAS the Procuring Agency invited Bids for provision of goods, viz., **UPGRADATION AND IMPROVEMENT OF ELECTRICAL SYSTEM AT SBP BSC (BANK) NORTH NAZIMABAD (*P103714*)** and has accepted a Bids by the Bidder for the provision of Goods in the sum of *[contract price in words and figures]* (hereinafter called "the Contract Price").

NOW THIS CONTRACT WITNESSETH AS FOLLOWS:

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

2. The following documents shall be deemed to form and be read and construed as part of this Contract, In the event of any ambiguity or conflict between the Contract Documents listed below, the order of precedence shall be the order in which the Contract Documents are listed below:-

1. This form of Contract;
2. the Form of Bids and the Price Schedule submitted by the Bidder;
3. the Schedule of Requirements;
4. the Technical Specifications;
5. the Special Conditions of Contract;
6. the General Conditions of the Contract;
7. the Procuring Agency's Letter of Acceptance; and
8. [*add here: any other documents*]

3. In consideration of the payments to be made by the Procuring Agency to the Bidder as hereinafter mentioned, the Bidder hereby covenants with the Procuring Agency to provide the Goods related services and to remedy defects therein in conformity in all respects with the provisions of the Contract.

4. The Procuring Agency hereby covenants to pay the Bidder in consideration of the provision of Goods and the remedying of defects therein, 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 Contract to be executed in accordance with their respective laws the day and year first above written.

Signed, sealed, delivered by _____the _____ (for the Procuring Agency)

Witness to the signatures of the Procuring Agency:

……

Signed, sealed, delivered by _____the _____ (for the Procuring Agency)

Witness to the signatures of the Bidder: ……

PUBLIC PROCUREMENT REGULATORY AUTHORITY (PPRA) EPADS

Integrity Pact

Integrity Pact

DECLARATION OF FEES, COMMISSION AND BROKERAGE ETC. PAYABLE BYTHE SUPPLIERS OF GOODS, SERVICES & WORKS IN CONTRACTS WORTH RS.10.00 MILLION OR MORE

Contract Number: Contract Value: Contract Title:

Dated:

[Name of Supplier] 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 Pakistan or any administrative subdivision or agency thereof or any other entity owned or controlled by it (GoP) through any corrupt business practice.

Without limiting the generality of the foregoing [Name of Supplier] represents and warrants that it has fully declared the brokerage, commission, fee 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 consultations 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 GoP, except that which has been expressly declared pursuant hereto.

[Name of Supplier] certifies 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 GoP and has not taken any action or will not take any action to circumvent the above declaration, representative or warranty.

[Name of Supplier] accepts full responsibility and strict liability for making and false declaration, not making full disclosure, misrepresenting fact 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 right and remedies available to GoP under any law, contract or other instrument, be voidable at the option of GoP.

Notwithstanding any rights and remedies exercised by GoP in this regard, [Name of Supplier] agrees to indemnify GoP for any loss or damage incurred by it on account of its corrupt business practices and further pay compensation to GoP in an amount equivalent to ten time the sum of any commission, gratification, bribe, finder's fee or kickback given by [Name of Supplier] 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 GoP.

Performance Guarantee Form

Performance Guarantee Form

To: **SBP-BSC North (SBP Banking Services Corporation (BSC)), Senior Officer SBP BSC (Bank) Building Shahrah-e-Noor Jahan North Nazimabad,, North Nazimabad Sub-Division, Karachi Central (District), Karachi (Division), Sindh (Province).**

WHEREAS *[name of Bidder]* (hereinafter called "the Bidder") has undertaken, in pursuance of Contract No. *[reference number of the contract]* dated *[insert date]* for provision of Goods*(*hereinafter called "the Contract").

AND WHEREAS it has been stipulated by you in the said Contract that the Bidder shall furnish you with a Bank Guarantee by a reputable bank for the sum specified therein as security for compliance with the Bidder's performance obligations in accordance with the Contract.

AND WHEREAS we have agreed to give the Bidders guarantee:

THEREFORE, WE hereby affirm that we are Guarantors and responsible to you, on behalf of the Bidder, up to a total of *[amount of the guarantee in words and figures]*, and we undertake to pay you, upon your first written demand declaring the Bidder to be in default under the Contract and without cavil or argument, any sum or sums within the limits of *[amount of guarantee]* as aforesaid, without your needing to prove or to show grounds or reasons for your demand or the sum specified therein.

This guarantee is valid until the: *[insert date]*

Signature and seal of the Guarantors

_____

[name of bank or financial institution]

_____

[address]

_____

[date}

PUBLIC PROCUREMENT REGULATORY AUTHORITY (PPRA) EPADS

Annexure

PUBLIC PROCUREMENT REGULATORY AUTHORITY (PPRA) EPADS

Annexure-01-Bidding Data Sheet (BDS) – Part-B

Information (Read-Only)

See Form Under Additional Forms and Documents: **Annexure-01-Bidding Data Sheet (BDS) – Part-B** (page number: 193)

Annexure-02-Section VIII - SCC (Part-B)

Annexure-02 - Section VIII - SCC (Part-B).pdf

Information (Read-Only)

See Form Under Additional Forms and Documents: **Annexure-02-Section VIII - SCC (Part-B)** (page number: 194)

Annexure-03- Formula for Price Adjustment

Annexure-3-Formula for Price Adjustment.pdf

Information (Read-Only)

See Form Under Additional Forms and Documents: **Annexure-03- Formula for Price Adjustment** (page number: 202)

Annexure-04-Scope of work & Appendix-A to Bid

Information (Read-Only)

See Form Under Additional Forms and Documents: **Annexure-04-Scope of work & Appendix-A to Bid** (page number: 203)

Annexure-05-Construction Schedule & KPIs

Information (Read-Only)

See Form Under Additional Forms and Documents: **Annexure-05-Construction Schedule & KPIs** (page number: 209)

Annexure-06-Supplier Account Details

Information (Read-Only)

See Form Under Additional Forms and Documents: **Annexure-06-Supplier Account Details** (page number: 210)

Annexure-09-Drawings

Information (Read-Only)

See Form Under Additional Forms and Documents: **Annexure-09-Drawings** (page number: 211)

Annexure-07-Undertaking

Technical Submission (Vendor)

Document Required

See Form Under Additional Forms and Documents: **Annexure-07-Undertaking** (page number: 220)

Annexure-08- Technical Specifications Appendix-B to Bid

Information (Read-Only)

See Form Under Additional Forms and Documents: **Annexure-08- Technical Specifications Appendix-B to Bid** (page number: 221)

Procurement Forms

PUBLIC PROCUREMENT REGULATORY AUTHORITY
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Additional Forms and Documents

Bidding Data Sheet (BDS) – Part-B

The following specific data shall complement, supplement, or amend the provisions in the Instructions to Bidders (ITB) and Bidding Data Sheet. Whenever there is a conflict, the provisions herein shall prevail over those in ITB and Bidding Data Sheet.

ITB No.	Amendments of, and Supplements
Preparing of Bids	
11.5 & 13.5	The bid price shall be adjusted in accordance with Annexure-03 – Formula for Price Adjustment and Clause 28.8 of SCC Part B - Price Adjustment.
13.3.2	Alternative Bids to the requirements of the bidding documents will not be permitted.
28.	**Determination of Unit Rates** The total quoted Bid Price shall be apportioned among the individual BOQ items in proportion to their respective employer's / engineer's estimated unit rates, and the corresponding individual unit rates shall be determined accordingly, without altering the total quoted Bid Price. The Bidder shall be deemed to have accepted such determination and adjustment of the individual unit rates. In the event that the Bidder fails or refuses to accept the aforesaid determination or adjustment, the Bid shall be treated as non-responsive, and the Bid Security shall be forfeited.
41.1	**Performance Security (or Guarantee)** Add the following at the end Performance Guarantee shall be valid till successful completion of Defect Liability Period
42.2	**Advance Payment** The Procuring agency/Employer will provide an advance payment as stipulated in the Conditions of Contract.

Section VIII – Special Conditions of Contract (SCC) – Part-B

The following Special Conditions of Contract (SCC) shall supplement the GCC. Whenever there is a conflict, the provisions herein shall prevail over those in the GCC and SCC.

GCC Clause No.	Amendments of, and Supplements to, Clauses in the GCC
	Goods/Works Terminology For this procurement, references to 'Goods', 'Supplier' and 'Bidder' in the prescribed/system-generated bidding documents shall, where applicable and in the context of the subject procurement, be read as references to the subject Works and Contractor
6.1	**Authorized Representatives / Authority of Member in charge** The Authorized representative will be mentioned in Notice to Commence / Work Order
8.1	**Commencement of Services** The Commencement date will be mentioned in Notice to Commence / Work Order
9.1	**Program schedule** Contract Duration is: **540 days,** from start of commencement of Contract. Refer Annexure - Scope of Works & KPI
12	**VARIATIONS AND CLAIMS** **12.1 Right to Vary** The Employer/Engineer may issue Variation Order(s) in writing. Where for any reason it has not been possible for the Employer/Engineer to issue such Variations Order(s), the Contractor may confirm any verbal orders given by the Employer/Engineer in writing and if the same are not refuted/denied by the Employer/Engineer within seven (7) days of the receipt of such confirmation the same shall be deemed to be a Variation Orders for the purposes of this Sub-Clause. **12.2 Valuation of Variations** Variations shall be valued as follows: a) at a lump sum price agreed between the Parties, or b) where appropriate, at rates in the Contract, or c) rates notified by the Government Departments/agencies, or d) in the absence of appropriate rates, the rates in the Contract shall be used as the basis for valuation, or failing which e) at appropriate new rates, as may be agreed or which the Engineer/Employer considers appropriate For the valuation of variations and determination of rates for non-BOQ/extra items, the approval of the Head/Director Engineering shall be obtained. The decision of the Head/Director Engineering in this regard shall be final and binding upon both parties. **12.3 Early Warning** The Contractor shall notify the Engineer/Employer in writing as soon as he is aware of any circumstance which may delay or disrupt the Works, or which may give rise for Extension in time. To the extent of the Contractor's failure to notify, which results to the Engineer/Employer being unable to keep all relevant records or not taking steps to minimize any delay, disruption, the Contractor's entitlement to extension of the Time for Completion may be reduced/rejected.

Section VIII – Special Conditions of Contract (SCC) – Part-B

	12.4 Variation Procedure The Contractor shall submit to the Engineer/Employer an itemized make-up of the value of variations within twenty-eight (28) days of the instruction. The Engineer/Employer shall check and if possible agree the value. In the absence of agreement, the Employer shall determine the value.
13.3	**Extension of Time** The Contractor shall, within such time as may be reasonable under the circumstances, notify the Employer of any event(s) falling within the scope of Employer's Risks, or Early Warnings, or adverse ground conditions, force majeure not leading to Contract termination, or any instruction of the Employer to slow down the progress of works or change in the scope of Works by the Employer requiring additional time for completion of the Works as per the revised scope of Works, may request the Employer to extend the Completion Time reasonably. The Contractor must have to provide complete record of the circumstances on account of which extension of time is being applied along with an up-dated program/schedule in bar chart form for completion of the balance works. The Employer may evaluate the request lodged by the Contractor and extend the Completion Time. The decision of the Director/Head Engineering will be final & binding upon the Contractor. It is being understood and agreed by the Contractor that the sole remedy for delay shall be extension in the time for performance of the Contractor's work, which extension shall not be subject to any valuation.
17	**Insurance to be taken out by the Contractor** From AA rated Insurance Company of PACRA/ JCR. **The Works** Amount of Cover: The sum stated in Letter of Acceptance plus fifteen percent 15%. **Contractor 's equipment** Amount of Cover: Full replacement Cost Injury to Person and Damaged to Property including Third Party Insurance **Amount of Cover:** I) As per workmen compensation act II) Contractor's all Risk including Third party III) damages to the Structure, stores if supplied by the Bank
20.1	**Liquidated Damages** In the event of delay in completion of the Works beyond the Time for Completion, as extended in accordance with the Contract, the Contractor shall pay Liquidated Damages at the rate of [.1%] of the Contract Price per day, subject to a maximum aggregate amount of [10%] of the Contract Price. The Procuring Agency may deduct such Liquidated Damages from any amounts due or becoming due to the Contractor.
20.2	**Correction for Over-Payment** If the Intended Completion Date is extended after Liquidated Damages have been paid, the Procuring Agency shall correct any overpayment of Liquidated Damages by the Contractor by adjusting the next Payment Certificate. No interest shall be payable to the Contractor on the amount of such overpayment.
28	**Terms and Conditions of Payment** Add the following

1.1.1 The Contractor shall submit to the Employer/Engineer, from time to time, a Statement, Bill or Invoice setting out in detail all amounts to which the Contractor considers himself entitled under the Contract, together with all supporting documents and records (if required) to substantiate such amounts, in such form and manner as may be prescribed by the Employer/Engineer from time to time.

1.1.2 The Employer/Engineer shall have the right, by any Bill or Interim Payment Certificate, to make any correction, adjustment or modification to any amount previously certified in any Interim Payment Certificate. Furthermore, if any part of the Works is not being executed to the satisfaction of the Employer/Engineer or is not in accordance with the Contract, the Employer/Engineer shall have the authority to omit, withhold or reduce the value of such work in any Interim Payment Certificate until the Contractor has satisfactorily rectified the relevant deficiencies.

1.1.3 The Contractor shall pay all taxes, duties and fees required to be paid by him under the Contract, and the Contract Price shall not be adjusted for any of this cost except where otherwise expressly provided for in the Contract.

1.1.4 The quantities given in the Bill of Quantities are estimated and provisional and are given to provide a common basis for bidding. 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.

1.1.5 Upon issuance of Final Completion Certificate, the payments pertaining to the Works completed during Defects Liability Period and / or money as Retention Money shall be released as per sub-Clause-28.3 and the accounts for the contract shall be closed. The Employer shall release payments within sixty (60) days.

28.3 Retention Money

10% of the net payable amount from each bill (except Mobilization Advance) of the Contractor will be deducted as retention money. The retention money would be released as follows:

a. 5% on Completion of the whole work,
b. Balance 5% after successful completion of the Defects Liability Period / Warranty Period.

28.4 Advance Payment:

If requested by the Contractor, an interest-free Advance up to 15 % of the Contract Price stated in the Letter of Acceptance shall be paid by the Employer to the Contractor in two equal parts upon submission by the Contractor of an Advance Bank Guarantee for the full amount of the Advance in the specified form from a Scheduled Bank in Pakistan subject to approval of Director/Head Engineering Payments shall be made as per the following criteria;

First part of the Mobilization Advance within twenty (20) days after verification of the approved/ legible Bank Guarantee from the issuing bank.

Second part of the mobilization advance on arrival of required tools & plants and commencement of Works at site to the entire satisfaction of the Employer.

Section VIII – Special Conditions of Contract (SCC) – Part-B

28.5 Payment Terms

28.5.1 Payment for Supply of Material/Equipment:
Up to seventy-five percent (75%) of the supply part of the BOQ items will be paid against delivery of material/equipment on site, and upon production of Factory Test Reports / Warranties / Shipping documents/ Inspection Reports at Manufacturer's Facility (where applicable) and indemnity bond as per approved format.

28.5.2 Payment upon Installation, Testing and Commissioning:
Up to ninety percent (90%) of the supply and installation parts of BOQ items will be paid upon successful Testing & Commissioning.

28.5.3 Payment upon issuance of Taking-Over Certificate:
Ten percent (10%) amount of whole BOQ item i.e. Supply and Installation will be paid upon issuance of Taking-Over Certificate and completion of the Whole Works, including punch list noted at commissioning time.

28.6 Recovery of Advance:

Advance paid to the Contractor shall be recovered from the interim bills of the Contractor @ 15% of total amount of work done at site for the bill being processed till the time that whole of the amount of Mobilization Advance has been recovered

28.7 Secured Advance

The Employer at his sole discretion may provide to Contractor Secured Advance against an indemnity bond acceptable to the Employer of such sum as the Engineer in charge may consider proper in respect of non-perishable materials brought at the Site but not yet incorporated in the permanent Works subject to approval of Director/Head of Engineering, provided that:

(a) The materials are in accordance with the Specifications for the permanent works;
(b) Such materials have been delivered to the Site and are properly stored and protected against loss or damage or deterioration to the satisfaction of the Engineer in charge but at the risk to cost of the Contractor;
(c) The Contractor's records of the requirements, orders, receipts and use of materials are kept in a form approved by the Engineer in charge, and such records shall be available for inspection by the Engineer in charge;
(d) The Contractor shall submit with his monthly statement the estimated value of the materials on Site together with such documents as may be required by the Engineer in charge for the purpose of valuation of materials and providing evidence of ownership and payment therefore;
(e) Ownership of such materials shall be deemed to vest in the Employer and these materials shall not be removed from the Site or otherwise disposed of without written permission of the Employer.
f) 60% of the purchase price of the item/material or 50% of tender price of the item/material whichever is lesser, after measuring the quantity & verification of the quality of materials at site by the Employer may be paid

The amount of Secured Advance against any item(s)/materials shall be recovered from the next three (03) bill of the Contractor in the form of three equal installments. The Employer reserves the right to recover all outstanding amount of the Secured Advance from very 1st bill of the Contractor submitted after release of the Secured Advance.

28.8 Price Adjustment

The amounts payable to the Contractor shall be adjusted in respect of the rise or fall in the cost of labor, materials, and other inputs to the Works, by applying to such amount the formula prescribed in this Sub-Clause. Price Adjustment under this Sub-Clause shall not be applicable on supply parts of the items and Operation & Maintenance Services.

(a) Other Changes in Cost

To the extent that full compensation for any rise or fall in costs to the Contractor is not covered by the provisions of this or other Clauses in the Contract, the unit rates and prices included in the Contract shall be deemed to include amounts to cover the contingency of such other rise or fall of costs.

(b) Adjustment Formula

The adjustment to the monthly statements in respect of changes in cost shall be determined from the following formula:-

$$Pn = A + b\frac{Ln}{Lo} + c\frac{Cn}{Co} + d\frac{Sn}{So} + \cdots$$

Pn is a price adjustment factor to be applied to the amount for the payment of the work carried out in the subject month where any variations and daywork are not otherwise subject to adjustment;

A is a constant, specified in the Annexure-03 to Bid, representing the nonadjustable portion in contractual payments;

b, c, d are weightages or coefficients representing the estimated proportion of each cost element (Labour, Copper, Sheet and High Speed Diesel) in the Works or Sections thereof, net of Provisional Sums and Prime Cost; the sum of A, b, c, d, e shall be one;

Ln, Cn, Sn and Dn are the current cost indices or reference prices of the cost elements for month "n", applicable to each cost element; and:

(c) Sources of Indices and Weightages

The sources of indices shall be those listed in the Annexure-03 to Bid.

(d) Base, Current, and Provisional Indices

The base cost indices or prices shall be those prevailing on the day 28 days prior to the latest date for submission of bids. Current indices or prices shall be those prevailing on the day 28 days prior to the start of the execution month to which a particular monthly statement is related. If at any time the current indices are not available, provisional indices as determined by the Engineer will be used, subject to subsequent correction of the amounts paid to the Contractor when the current indices become available.

(e) Adjustment after Completion

If the Contractor fails to complete the Works within the Time for Completion prescribed under Clause 9.1, adjustment of prices thereafter until the date of completion of the Works shall be made using either the indices or prices relating to the prescribed time for

	completion, or the current indices or prices, whichever is more favorable to the Employer, provided that if an extension of time is granted, the above provision shall apply only to adjustments made after the expiry of such extension of time. (f) Weightages The weightages for each of the factors of cost given in the Annexure-03 to Bid shall be adjusted if, in the opinion of the Engineer, they have been rendered unreasonable, unbalanced, or inapplicable as a result of varied or additional work executed or instructed under Clause 12. Such adjustment(s) shall have to be agreed in the variation order.
29.1	**Quality Control Identifying Defects** Defects Liability Period (DLP) shall be 365 days
30.1	**Correction of Defects, and Lack of Performance Penalty** **Remedying Defects** The Contractor shall for a period of 12 months from the date of issue of the Taking Over Certificate carry out, at no cost to the Employer, repair and rectification work which is necessitated by the earlier execution of poor quality of work or use of below specifications material in the execution of Works and which is so identified by the Employer/Engineer in writing within the said period. Upon expiry of the said period, and subject to the Contractor's faithfully performing his aforesaid obligations, the Employer/Engineer shall issue a Defect Liability Certificate Failure to remedy any such defects or complete outstanding work within a reasonable time shall entitle the Employer to carry out all necessary works at the Contractor's cost. **Uncovering and Testing** The Contractor shall give not less than five days' notice in writing to the Engineer-in-charge of work before covering up or otherwise placing beyond the reach of measurement any work in order that same may be measured, and correct dimensions thereof be taken before same is covered or placed beyond the reach of measurement. The Engineer-in-Charge shall check the Contractor's Work and notify the Contractor of any Defects if found. Such checking shall not affect the Contractor's responsibilities. The Employer may instruct the Contractor to search for a defect and to uncover/ or testing any work that the he considers may have a Defect **Failure to remedying Defects** Failure to remedy any defect(s) or complete the outstanding Works except the defects not attributable to the Contractor, to the entire satisfaction of the Employer within a notified time shall entitle the Employer to extend the defect liability period and / or carry out all necessary works at the Contractor's risk to cost.
31.1	**Settlement of Disputes Amicable Settlement** For Notices Procuring agency/Employer/ Engineer's Authorized representatives name and address: Director / Head Engineering, State Bank of Pakistan
32.1	**Dispute Settlement** The dispute shall, after failure of amicable settlement/mediation, be referred to a sole Arbitrator mutually appointed by the parties. In the event the parties fail to agree upon or appoint the Arbitrator within fourteen (14) days of a written request for arbitration, the

	appointment shall be made in accordance with the Arbitration Act, 1940 and applicable law of Pakistan. The place of arbitration shall be Karachi and the language shall be English.
33	Add the following clauses **Attendance of Meetings** The Contractor shall attend all meetings along with his authorized representative(s) when called by the Employer to discuss the quality and progress of Works, site matters and other matters related to the Contract, without any compensation from the Employer
34	**Progress Report** Monthly progress report in the format acceptable to the Engineer shall be prepared by the contractor and submitted to the Engineer in soft/hard format
35	**Lighting Work at Night** 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 arrangements adopted for such lighting shall be to the satisfaction of the Engineer's Representative.
36	**Right of way and Facilities/utilities** The Contractor shall bear all costs and charges for special and or temporary right of way which may be required for the purposes of the work including those for access to the site The Contractor shall also obtain/arrange at the contractor's risk and cost such facilities /utilities which may be required for the purpose of the work including but not limited to material storage areas, labor accommodation, site offices, temporary access roads, water, electricity etc. All costs, charges, rents, licenses, permissions, utilities and other expenses associated with such facilities shall be borne/obtained by the Contractor.
37	**Health, Safety, Environment and Security (HSE&S)** a. The Contractor shall comply with all statutory and regulatory requirements related to Health, Safety, Environment & Security (HSE&S) as well as Employer's applicable rules, procedures or policies related thereto at no additional cost to the Employer. The costs of supplying and/or doing all such things required for the purpose shall be deemed to be included in the amounts payable under this Agreement to the Contractor. b. The Employer shall periodically audit the Contractor's compliance with its HSE&S policies and conduct safety inspections as and when it deems fit. The Contractor shall ensure that Employer's recommendations in this regard are implemented without any delay. c. The Contractor shall provide the Employer information about its working practices, materials and equipment and shall operate in a manner which does not compromise Employer's security or environment standards and the safety and health of its employees and other people. Contractor shall also provide the Employer with any information which it may have related to a potential or actual security threat to the Employer. d. The Contractor shall certify in writing that its personnel are fully trained to execute the Works safely and shall ensure that they understand all risks and hazards associated with the Works. The Contractor shall keep records of such trainings. e. The Employer reserves the right to terminate this Contract without notice to the Contractor in the event of violation of this Clause by the Contractor and related HSE&S requirements of the Employer communicated to the Contractor from time to time. f. The Contractor shall pay special attention to the following environmental protection measures; 1. Use of clean fuels to minimize air polluting emissions.

Section VIII – Special Conditions of Contract (SCC) – Part-B

	2. Control of other air pollutants. 3. Recovery and recycling of usable materials. 4. Control of vehicle noise. 5. Control of noise from power facilities. 6. Limitation of Vibrations. 7. Preservation of natural land to the extent possible. 8. Preservation of archaeological Sites. 9. Careful handling, storage and utilization of hazardous radioactive materials, toxic chemicals etc.
38	**Site Clearance** Upon completion of the Works, or at such earlier stage as may be directed by the Employer, the Contractor shall remove from the Site all temporary structures, camps, dumpsites, debris, surplus materials, waste and other obstructions arising from the execution of the Works, and shall fill and properly reinstate all trenches, excavations and other areas disturbed by the Contractor. The Contractor shall obtain a Site Clearance Certificate from the Employer and submit the same with each Running Bill or the Final Payment Application, as the case may be. In the event that the Contractor fails or refuses to carry out the required site clearance within the period specified by the Employer, the Employer may, without prejudice to any other rights or remedies available under the Contract, undertake or arrange for such work to be carried out through other sources or contractors. The Employer shall be entitled to recover all costs and expenses so incurred from any amount due or becoming due to the Contractor, including retention money and/or any other sums payable under the Contract. If such amounts are insufficient, the Employer may recover the balance from the Performance Security, subject to the terms and conditions of the Contract. In this regard, the decision of the Director/Head of Engineering shall be final and conclus subject to the dispute resolution provisions of the Contract

Formula for Price Adjustment

PRICE ADJUSTMENT UNDER CLAUSE 28.8
OF CONDITIONS OF CONTRACT

The source of indices and the weightages or coefficients for use in the adjustment formula under Clause **20.1** shall be as follows:

Cost Element	Description	Weightages	Applicable index
1	2	3	4
(i)	Fixed Portion	0.53	
(ii)	Local Labour (Labourer (un-skilled) per day, shall be taken as representative of all types of Labour (skilled/unskilled) deployed at site)	0.12	Government of Pakistan (GP) Federal Bureau of Statistics (FBS) Monthly Statistical Bulletin.
(iii)	Copper (Copper from Cables, LT Panels and Transformers)	0.29	Monthly Bulletin LME Copper Price (in US$ convert to Rupees)
(iv)	High Speed Diesel (HSD) (HSD shall be taken as representative of all kind offuels used in connection with the Contract)	0.06	Federal Bureau of Statistics (FBS) Monthly Statistical Bulletin, OGRA / PSO
	Total	1.000	

Notes:

1) The base date price (or base date index) of any element shall be the price of the element for the month on the day falling 28 days prior to the latest day for submission of bids.
2) The current date price (or current date index) of any element shall be the price of the element for the month falling on the day 28 days prior to the last day of the period to which the particular Payment Certificate relates
3) Any fluctuation in the indices or prices of materials other than those given above shall not be subject to adjustment of the Contract Price.

Appendix-A to Bid

Scope of Works

1. **Major Items of Contract:**

   a. Dismantling/pulling/removal, loading, shifting, unloading and transportation of existing 02x750kVA transformers, MV Switchgears, LV Panels, DBs, HT/LT cables etc. to designated location within premises

   b. Installation, testing and commissioning and Sifting of DG Set to designated location within the premises.

   c. Supply, installation, testing and commissioning of 2x1000kVA oil type transformers along with construction of oil pits.

   d. Supply, Installation, testing and commissioning of MV and LV panels including ATS, PFI panels and distribution boards (DB's)

   e. Supply, Installation, testing and commissioning of MV and LT cables in existing/proposed Cable trays/underground pvc pipes/underground cable trench as per site requirements

   f. Supply, installation, testing and commissioning of light fixtures & Fans including wiring etc.

   g. Civil Works i.e. extension of existing Electrical Room after dismantling of existing walls. Construction of oil pits, excavation for cable trench etc

   h. Earthing works.

   i. Submission of drawings and schematics in hardcopy and softcopy form detailing operating procedure and showing system failure scenarios.

   j. The samples shall be submitted to the Engineer at his office in North Nazimabad as specified in Preamble to Conditions of Contract. The rejected sample(s) shall be recollected by the Contractor and fresh sample(s) shall be submitted. The Engineer shall formally intimate the Employer and the Contractor of the reasons of rejection of sample(s).

   k. The Contractor shall submit one set in form of softcopy and two sets in hard form of shop drawings to the Engineer, under intimation to the Employer. The Engineer shall retain one set of the commented/approved shop drawing for his record and return the other set to the Contractor.

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Technical Specifications

1. Brand Names

Equipment and materials specified with brand names have been provided to establish a standard of performance and do not necessarily indicate a preference for a particular manufacturer or material.

The names of manufacturers given below are to indicate the level of quality and performance anticipated by the Employer / Procuring Agency. Other makes may be accepted provided that the quality and performance of such equipment, in the sole opinion of the Employer / Procuring Agency, are at least equal to or better than the equipment offered by the recommended manufacturer listed hereunder.

2. **List of Manufacturers Recommended**

The acceptance of equipment/ materials offered by these manufacturers will be subject to compliance of offered models/ materials with the specifications, capacity and/or performance requirements.

All other items not included in the list hereunder will be approved by the Employer / Procuring Agency in accordance to their compliance with the specifications, capacity and/ or performance requirements.

Onus lies with the Contractor / supplier for establishing the genuineness of any material/ product.

Following are the specifications of material. Bidder can also offer equivalent products, however, adequate documentation in the form of technical data sheets and type test certificates from independent laboratories stating the standards to which the product complies with shall be furnished in the support of their being equivalent. The Employer/ Consultant reserves the right to ask the bidder of additional documentation in the regard.

LIST OF ELECTRICAL APPROVED MANUFACTURERS

S.#	MANUFACTURERS / VENDORS
1	**Medium Voltage Cables (8.7/15kV)**
	Pakistan Cables
	Newage Cables
	Fast Cables
2	**Low Voltage General Wiring/Power Cables LSZH or PVC (600V/1000V)**
	Pakistan Cables
	Newage Cables

	Fast Cables
S.#	**MANUFACTURERS / VENDORS**
3	**Cable Lugs**
	Sofamel
	BICC/Simpa
	Partex
	Cembre
4	**Cable Glands**
	Cembre
	BICC/Ortac
	CMP
5	**Cable Wiring Connectors & Terminal Blocks (Imported)**
	Cembre
	Wago
	Hellermanntyton
6	**MV Cable Termination Kits**
	3M
	Raychem
	Elcon Megarad
7	**PVC / UPVC Conduits & Accessories**
	Dadex
	Galco
	Jeddah Polymer
8	**Anodized Aluminum EMT Conduits**
	KPS
	Jadeed Engineer
9	**Hot Dip Galvanized (14 SWG) Cable Ladder / GI Cable Tray**
	HMI
	Hussain & Co.
	Ezzi Engineering
10	**G.I Back Boxes / G.I Ceiling Pull Boxes (Local)**
	Hussain & Co.

	Electroline
	Ezzi Engineering
11	**Lighting Fixtures by Brands**
	Signify Pakistan
	NVC / ST Lighting
S.#	**MANUFACTURERS / VENDORS**
	Fast Lights
	Coarts
	Britlite
12	**Distribution Boards**
	Hussain & Co.
	Karimi Electromech
	Taj Engineering
	HRA Switchgear
13	**Earthing Rods, Mesh, Bars & Other Materials**
	Wallis
	Furse
	DEHN
	Kingsmill
14	**Rubber Insulation Mat**
	3M (USA) YSU & Co
	Hilti
15	**Oil Type 11kV / 415V Step Down Transformer (E4,C4,F1)**
	PEL
	Transfopower
	Synergy
16	**Medium Voltage Switchgears (IEC 61439 AND KEMA CERTIFIED)**
	NXAIR, Siemens
	Unigear, ABB
	PIX12, Schneider
17	**Enclosed Bus Assemblies**
	Schneider
	EAE
	Power Duct

	Elsewedy
	ABB
18	**Energy Monitoring System**
	TEB
	Circutor
	Enercon
19	**Synchronization Module**
	COMAP or the module that meets the following criteria: IEC/ISA 62443 Security Level 2-3 design. 1. Single ecosystem for gensets, mains, bus tie, PV 2. Dynamic spinning reserve. 3. Native on-grid and off-grid microgrid control. **Note:** The OEM agent/distributor must have ten years' experience in the field and must have permanent office in Karachi

LIST OF CIVIL APPROVED MANUFACTURERS

Product	Standards	Recommended Manufacturers
Waterproofing membrane / Water Stopper bar / Swell Bar	As per standards and specifications mentioned in technical specifications and the Bill of Quantities (BOQ)	Aquafin FosPak BASF Hygrip Roofline OR approved equivalent
Concrete Admixture / Retarders /Joint sealant		Aquafin Sika FosPak BASF Matrix OR approved equivalent
Epoxy grout / Anchor bar & bolts		Hilti Mungo Sika Fischer BASF OR approved equivalent
Termite Control	As per standards and specifications mentioned in technical specifications and the Bill of Quantities (BOQ)	Biflex Dursbin Tenekil Ali Akbar Fipronil OR approved equivalent

Product	Standards	Recommended Manufacturers
Deck slab		Wheeling Cannam OR approved equivalent
Steel Structure		SAIFY IRON Mughal Steel Arcelor OR approved equivalent

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Construction Schedule/KPIs

Bidder shall provide a program in a bar-chart showing the sequence of work items by which he proposes to complete the Works of the entire Contract. The program should indicate the sequence of work items and the period of time during which he proposes to complete the Works including the activities like designing, schedule of submittal of drawings, ordering and procurement of materials, manufacturing, delivering, construction of civil works, execution of electrical works, erection, testing and commissioning of Works to be supplied under the Contract. The proposed sequence of execution of various sections of the project shall be according to the given Key Performance Indicators (KPIs) as following:

Phases	No. of Months	MONTH																	
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Phase 1: Pre-Execution Preparations (Mobilization, submittals, procurement, etc)	3																		
Phase 2: Civil Works Execution of Sub-station	3																		
Phase 3: Earthing Works	2																		
Phase 4: Electrical Equipment Installation & Cable Laying	5																		
Phase 5: Parallel Activities for Distribution, Utilities, Generator Relocation, etc	8																		
Phase 6: Testing and Commissioning	2																		
Phase 7: Project Handover	1																		

The above Key Performance Indicators should be taken into consideration by the bidder in order to execute the works.

Signatures: Stamp:

The above given timeline is basic and a detailed work schedule plan to be submitted by the bidder upon successful selection, incorporating all the builder / civil works as well.

S-2 FORM
Supplier Bank Account Details

	STATE BANK OF PAKISTAN **BANKING SERVICES CORPORATION** **Supplier Bank Account (IBAN) Details Form**	S-2

1. For Office use:

***Office/Deptt**				***Supplier No.**		**WHT Rate**	
Supplier	**New**		**Update**		***Liability A/C**		
***Supplier Type**					***Prepayment A/C**		

2. Supplier Information

***Supplier Name**				
***Supplier NTN**		**CNIC No.**		
Supplier Address			**Supplier City**	
Contact No.			**Mobile**	
E-mail Address			**Fax No.**	

3. Bank Account Information

***Bank Name**					
***IBAN (24 Characters)**					
***Branch Type**	**Islamic**		**Commercial**		
***Title of Account**					***Supplier Stamp & Signature**

(For Office use only)

Forwarded By	**Verified By**	**Entered By (Supplier Mgt User)**
(Procurement Function)		
	Date	

Field marked with * are mandatory.
Information without complete Bank Account Details (IBAN) & NTN/ CNIC will not be accepted.
Any changes in Supplier's particulars should be conveyed immediately to SBP BSC. SBP BSC will not be responsible for credit into wrong account of supplier due to change in bank account details not conveyed to SBP BSC or delay in settlement of supplier's claims.

PUBLIC PROCUREMENT REGULATORY AUTHORITY (PPRA) EPADS

STATE BANK OF PAKISTAN

NORTH NAZIMABAD

UPGRADATION & IMPROVMENT OF ELECTRICAL SYSTEM

ELECTRICAL & ALLIED WORKS

ISSUED DATE: 10 - 06 - 2026

ARCHITECT:

ELECTRICAL CONSULTANT:

ElekEn Associates

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Karachi, Pakistan
Tel: +9221-34551602, 34552037
email: eleken@eleken.com , elekenassociates@gmail.com

REGIONAL OFFICE
110, FIRST FLOOR
AL-Qadir Heights
New Garden Town, Lahore
Tel: +9221-34551602, 35868817

DRAWINGS REGISTER

PROJECT NAME : STATE BANK OF PAKISTAN

SHEET NO : 01

DAY:	10	10						
MONTH:	04	06						
YEAR:	26	26						

S/NO	DWG. NO.	DRAWING TITLE	SIZE	REVISION					
GENERAL DRAWINGS									
1	EL-00-00	MAIN TITLE	A1		●				
2	EL-00-01	DRAWINGS REGISTER	A1	●	●				
3	EL-00-02	MISCELLANEOUS INSTALLATION DETAILS	A1	●	●				
4	EL-00-03	SINGLE LINE DIAGRAM	A1	●	●				
SUB STATION									
5	EL-01-01	SUB-STATION EQUIPMENT LAYOUT PROPOSED	A1	●	●				
6	EL-01-02	SUB-STATION LIGHTING& FIRE ALARM& CCTV & POWER LAYOUT	A1	●	●				
7	EL-01-03	SUB-STATION EARTHING LAYOUT	A1	●	●				

REV.	DESCRIPTION	DATE
05	TENDER DRAWING	10-06-26
04	DRAFT TENDER DRAWING	10-04-26
03	REVIEW & COMMENT	03-03-26
02	REVIEW & COMMENT	15-02-22
01	REVIEW & COMMENT	02-02-22

PROJECT:

STATE BANK OF PAKISTAN
NORTH NAZIMABAD

ELECTRICAL CONSULTANT:

ElekEn Associates

DRAWING STATUS:

TENDER DRAWINGS
(NOT FOR CONSTRUCTION)

DRAWING TITLE:

DRAWING REGISTER

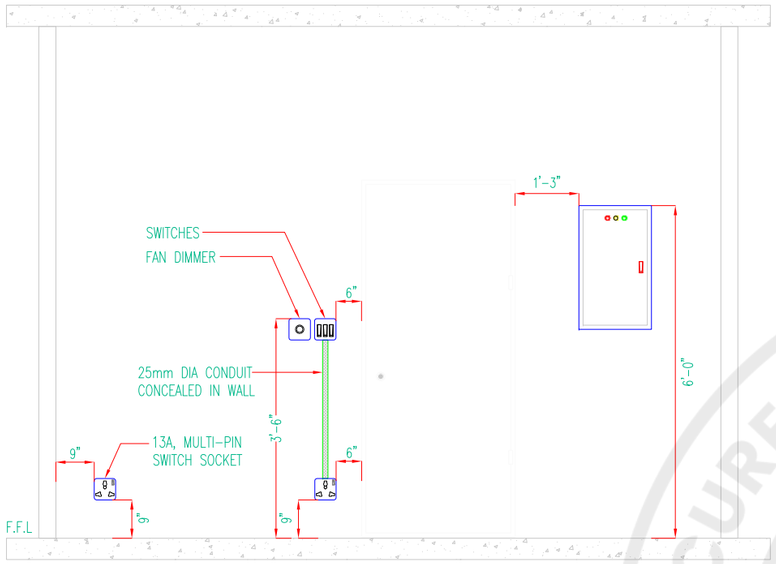
DRAWN BY:	ZAHID	DATE:	JAN-2022
CHECKED BY:	M.J	SCALE:	
PROJ. ENGR:	ARSALAN	JOB NO:	-------

DRAWING NO.

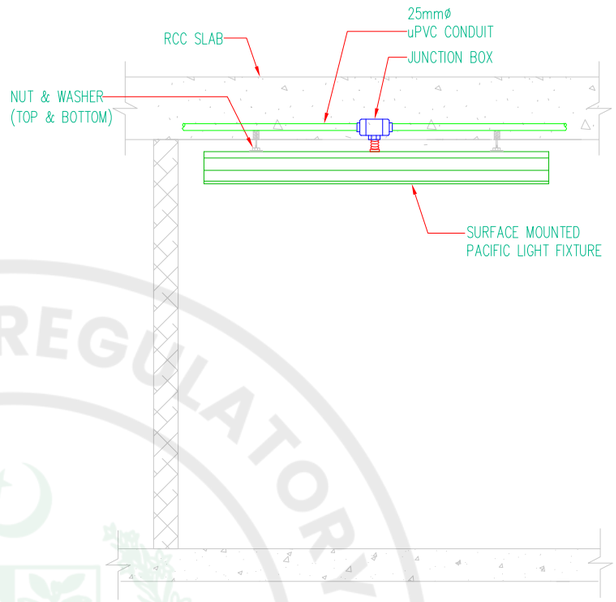
EL-00-01

PUBLIC PROCUREMENT REGULATORY AUTHORITY (PPRA) EPADS

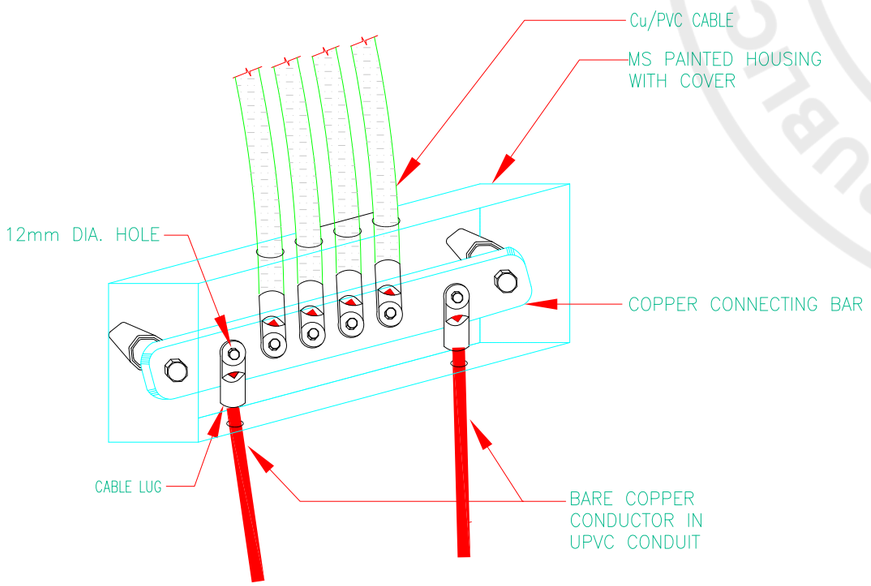
MOUNTING HEIGHT-SWITCH, SOCKET & DISTRIBUTION BOARD.



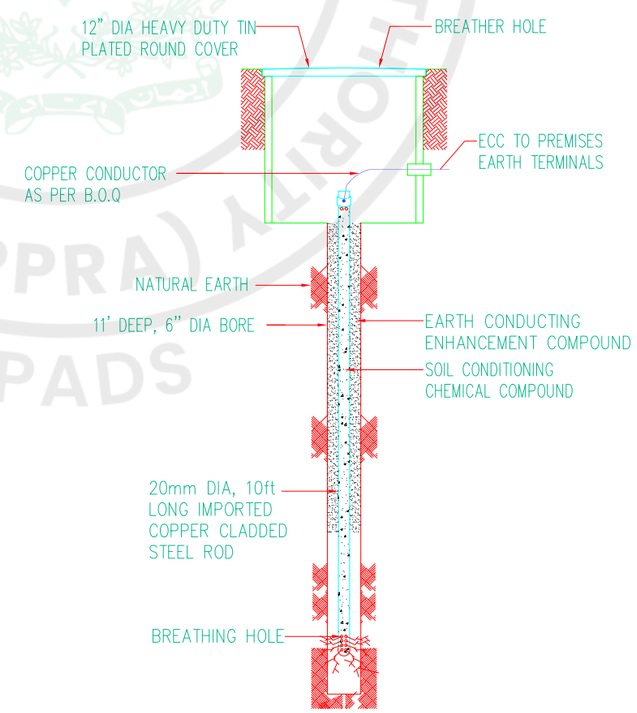
TYPICAL SURFACE MOUNTED LIGHT INSTALLATION DETAILS



EARTH CONNECTING POINT (ECP)



CHEMICALLY ENHANCED EARTHING STATION (CEE)



REV.	DESCRIPTION	DATE
05	TENDER DRAWING	10-06-26
04	DRAFT TENDER DRAWING	10-04-26
03	REVIEW & COMMENT	03-03-26
02	REVIEW & COMMENT	15-02-22
01	REVIEW & COMMENT	02-02-22

PROJECT:

STATE BANK OF PAKISTAN
NORTH NAZIMABAD

ELECTRICAL CONSULTANT:

ElekEn Associates

DRAWING STATUS:

TENDER DRAWINGS
(NOT FOR CONSTRUCTION)

DRAWING TITLE:

MICS .INSTALLATION DETAILS

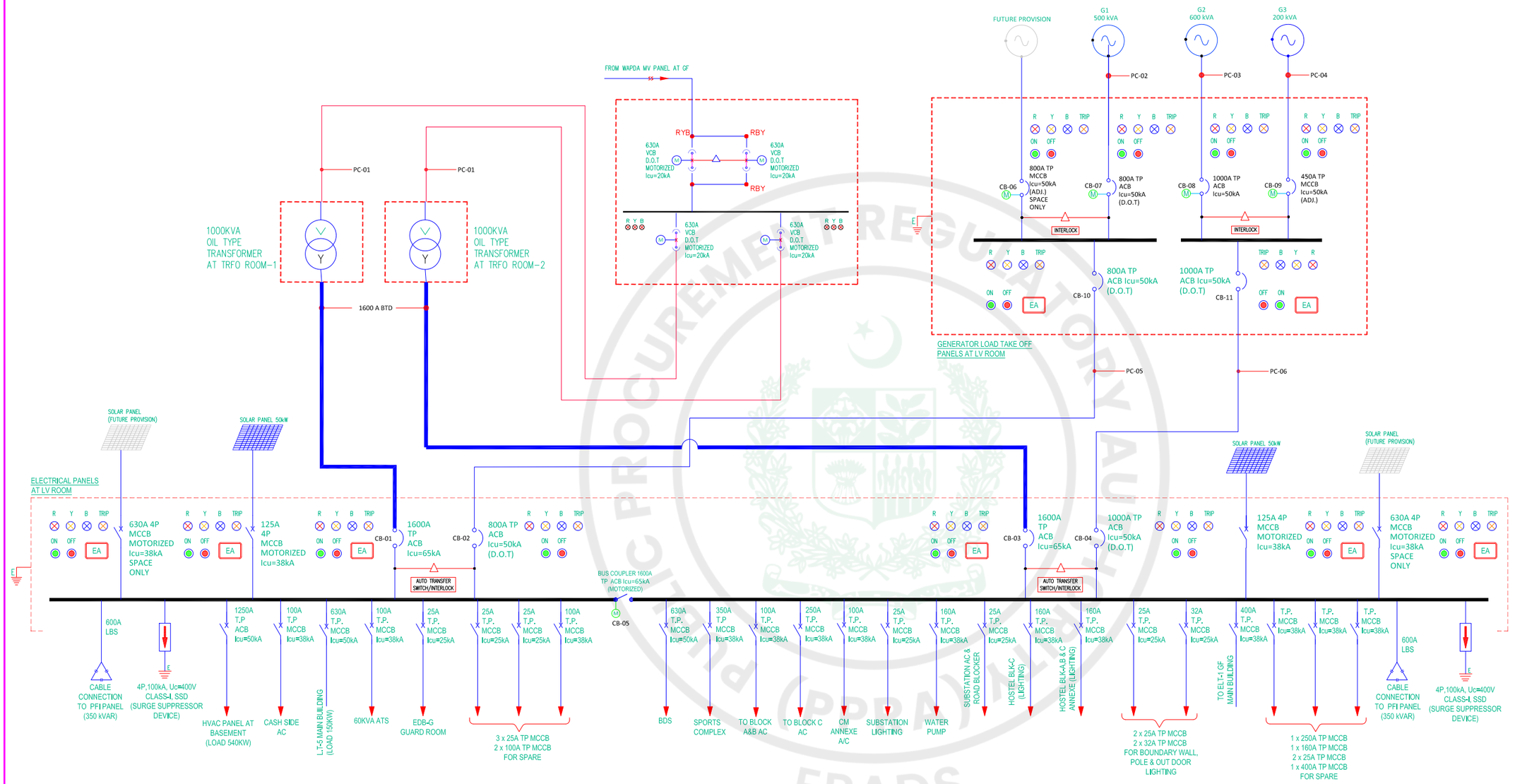
DRAWN BY:	ZAHID	DATE:	JAN-2022
CHECKED BY:	M.J	SCALE:	
PROJ. ENGR:	ARSALAN	JOB NO:	--------

DRAWING NO.

EL-00-02

PUBLIC PROCUREMENT REGULATORY AUTHORITY (PPRA) EPADS

NOTE
1. MAINTAIN 450mm CLEAR SPACE AT BOTTOM OF FLOOR STANDING DBs AND LV PANELS



SCHEDULE OF CABLE SIZE

S/NO	CABLE TAG	CABLE SIZE
1	PC-01	3C-300 Sqmm 8.7/15kV AL/XLPE/PVC
2	PC-02	8 No. 1C-300 Sqmm AL/XLPE/PVC+ ECC 2 No. 1C-95 Sqmm Cu/PVC
3	PC-03	12 No. 1C-240 Sqmm AL/XLPE/PVC+ ECC 2 No. 1C-95 Sqmm Cu/PVC
4	PC-04	04 No. 1C-300 Sqmm AL/XLPE/PVC+ ECC 1 No. 1C-95 Sqmm Cu/PVC
5	PC-05	8 No. 1C-300 Sqmm AL/XLPE/PVC+ ECC 2 No. 1C-95 Sqmm Cu/PVC
6	PC-06	12 No. 1C-240 Sqmm AL/XLPE/PVC+ ECC 2 No. 1C-95 Sqmm Cu/PVC

LOGIC TABLE:

S.NO	CB-01	CB-02	CB-03	CB-04	CB-05	CB-06	CB-07	CB-08	CB-09	CB-10	CB-11	
01	1	0	1	0	0	0	0	0	0	0	0	K.E WITH BOTH TRAFO'S
02	0	0	1	0	1	0	0	0	0	0	0	K.E TRAFO 1 FAILS
03	1	0	0	0	1	0	0	0	0	0	0	K.E TRAFO 2 FAILS
04	0	1	0	1	0	0	1	1	0	1	1	LOAD SHEDDING WITH 100% D.L LOAD
05	0	1	0	0	1	0	1	0	0	1	0	LOAD SHEDDING WITH G1 ONLY
06	0	0	0	1	1	0	0	1	0	0	1	LOAD SHEDDING WITH G2 ONLY
07	0	0	0	1	0	0	0	0	1	0	1	LOAD SHEDDING WITH G3 ONLY

REV.	DESCRIPTION	DATE
05	TENDER DRAWING	10-06-26
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01	REVIEW & COMMENT	02-02-22

PROJECT:
STATE BANK OF PAKISTAN
NORTH NAZIMABAD

ELECTRICAL CONSULTANT:
ElekEn Associates

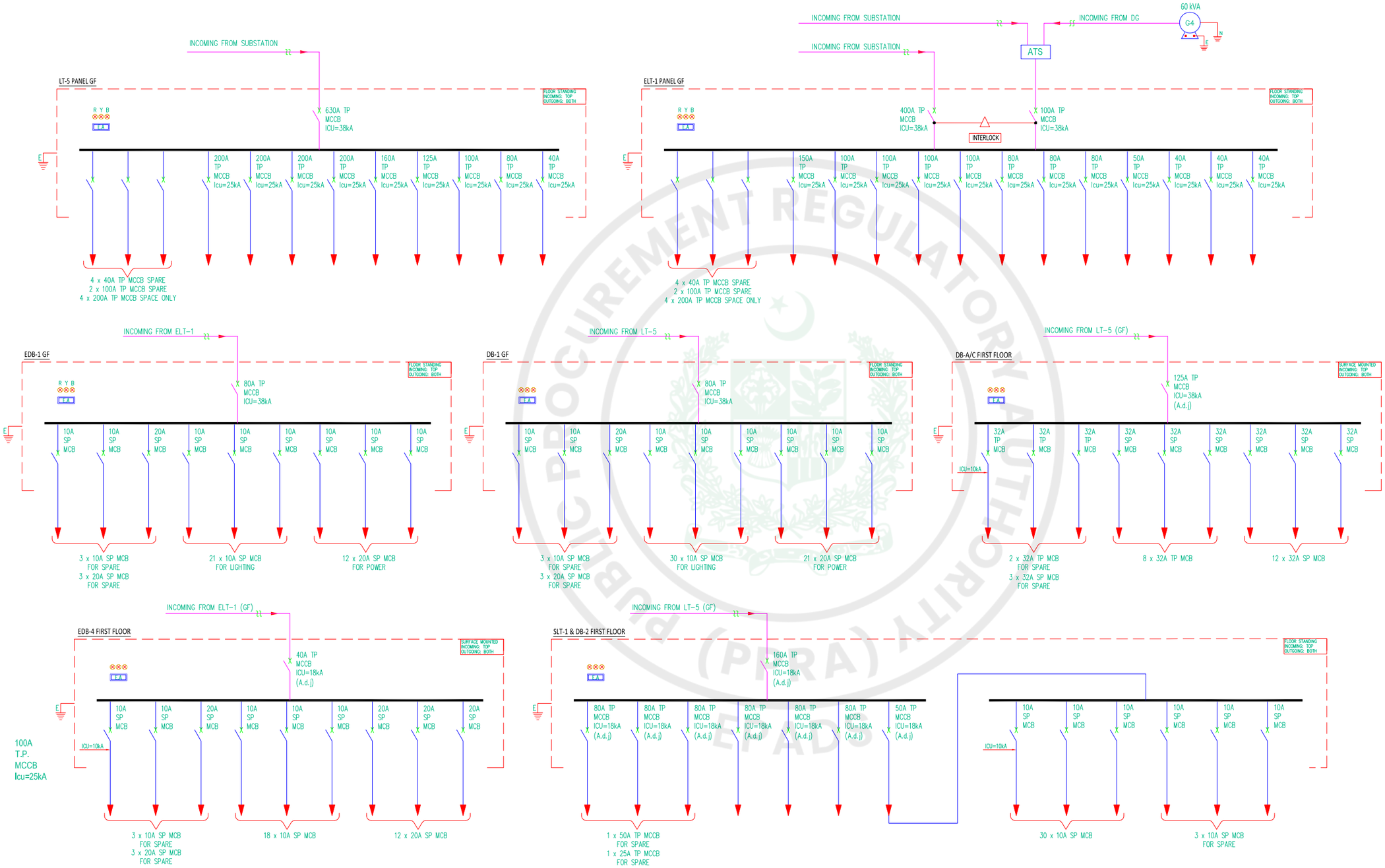
DRAWING STATUS:
TENDER DRAWINGS
(NOT FOR CONSTRUCTION)

DRAWING TITLE:
PROPOSED
POWER DISTRIBUTION

DRAWN BY:	ZAHID	DATE:	JAN-2022
CHECKED BY:	M.J	SCALE:	
PROJ. ENGR:	ARSALAN	JOB NO:	-------

DRAWING NO.
EL-00-03a

PROCUREMENT REGULATORY AUTHORITY (PPRA) EPADS



NOTE

1. MAINTAIN 450mm CLEAR SPACE AT BOTTOM OF FLOOR STANDING DBs AND LV PANELS

REV.	DESCRIPTION	DATE
05	TENDER DRAWING	10-06-26
04	DRAFT TENDER DRAWING	10-04-26
03	REVIEW & COMMENT	03-03-26
02	REVIEW & COMMENT	15-02-22
01	REVIEW & COMMENT	02-02-22

PROJECT:

STATE BANK OF PAKISTAN
NORTH NAZIMABAD

ELECTRICAL CONSULTANT:

ElekEn Associates

DRAWING STATUS:

TENDER DRAWINGS
(NOT FOR CONSTRUCTION)

DRAWING TITLE:

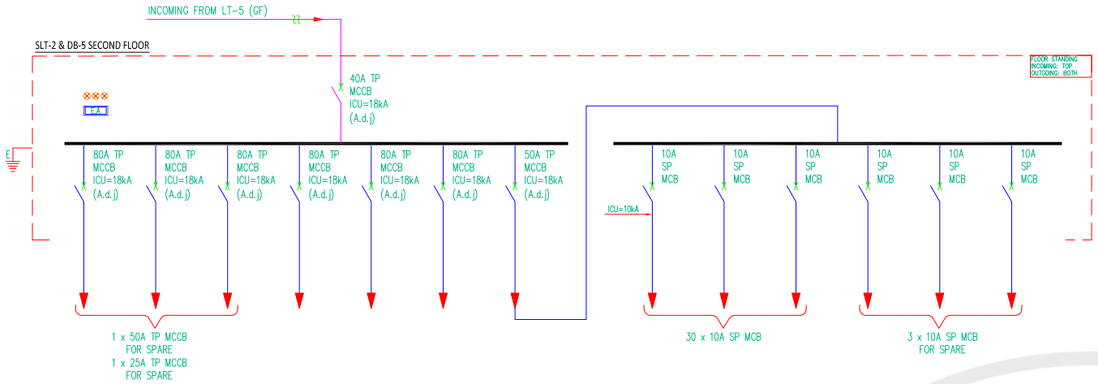
PROPOSED
POWER DISTRIBUTION

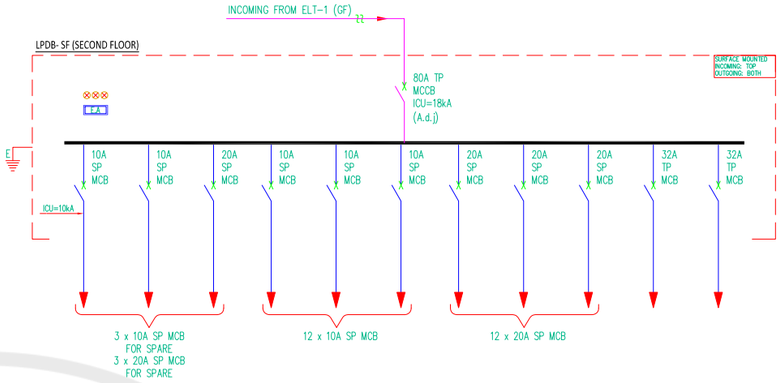
DRAWN BY:	ZAHID	DATE:	JAN-2022
CHECKED BY:	M.J	SCALE:	
PROJ. ENGR:	ARSALAN	JOB NO:	-------

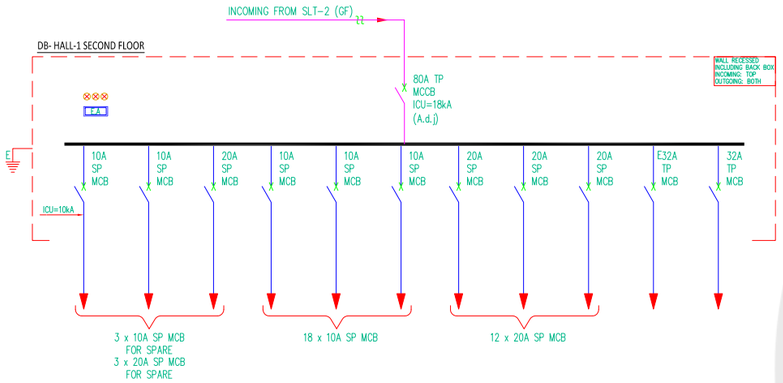
DRAWING NO.

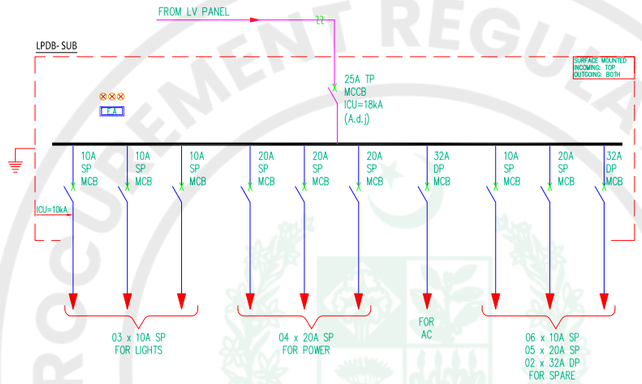
EL-00-03b

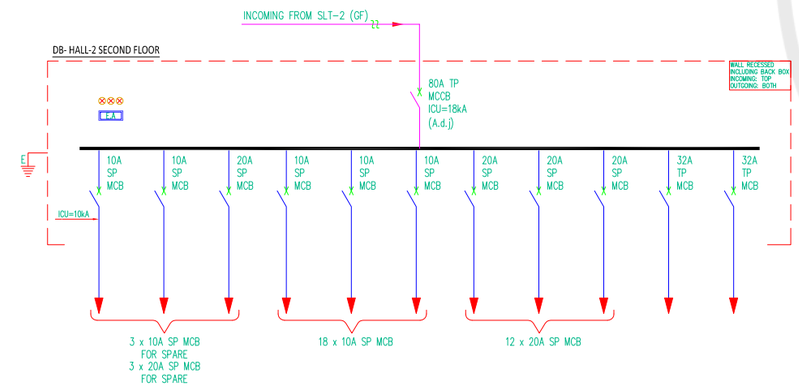
PUBLIC PROCUREMENT REGULATORY AUTHORITY (PPRA) EPADS

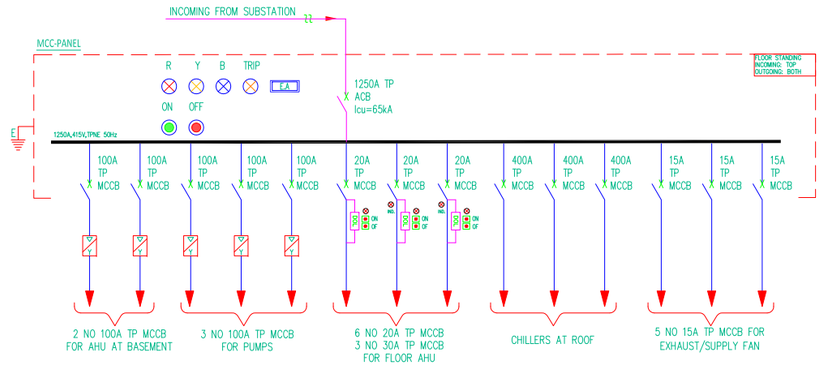












DISTRIBUTION BOARD COMPONENT LIST.

ITEM NO.	ITEM DESCRIPTION	APPROVED BRANDS
1	MCB / MCCB / ELCB	SCHNEIDER / ABB / TERASAKI
2	CARTRIDGE TYPE SURGE SURPRESSOR	DEHN / PHOENIX / SCHENIDER / CITEL
3	MAGNETIC CONTACTOR	SCHNEIDER / ABB / LOVATO
4	MANUAL CHANGE OVER SWITCH	GAVE / TRS / PCE BY CLIPSAL
5	DIGITAL VOLTMETER/ MULTIMETRE / AMMETER	ENTES / INTER / CIRCUTOR
6	PHASE INDICATION LIGHTS	SCHNEIDER / LOVATO / EATON
7	CURRENT TRANSFORMER	SACI / HOBUT / CIRCUTOR / FEDERAL
8	TIMER & RELAYS	FINDER / AUTONICS / PHOENIX
9	EVR	FANOX / PHOENIX / TELE
10	MOA / HOA SWITCH	K & N / PCE BY CLIPSAL / EATON
11	TERMINAL BLOCK	RAAD / KLEMSEN / PHOENIX / WAGO
12	HRC FUSE	DF / ETI / FEDERAL
13	CABLES	PAKISTAN / PIONEER / NEWAGE / FAST
14	COPPER BUS	IMPORTED (LUVATA MALAYSIA) OR APPROVED IMPORTED EQUIVALENT
15	POWDER COATING PAINT	JOTUN OR APPROVED EQUIVALENT R.A.L 7035
16	LOCKS	IMPORTED LOCKABLE LOCKS
17	ILCR (kNX)	MAKEL / HDL / E-ELECTRON

GENERAL NOTES

FOLLOWING GENERAL NOTES NEED TO BE FOLLOWED BY THE DB MANUFACTURER, IN CASE OF ANY DEVIATION THE INSTRUCTION / APPROVAL GIVEN BY THE CONSULTANT SHALL PREVAIL:

1_ LOW VOLTAGE DISTRIBUTION BOARDS SHALL BE FABRICATED WITH 16 SWG SHEET STEEL WITH WELDED GRINDED AND FINISHED FRAME.

2_ DBS SHALL BE ELECTRO STATICALLY COATED WITH POWDER OF COLOR RAL 7032 AND THEN OVEN BAKED. THE THICKNESS OF POWDER COATING SHALL NOT BE LESS THAN 100 MICRONS.

3_ KNOCK-OUTS REQUIRED FOR INCOMING AND OUTGOING CABLES.

4_ IP VALUE FOR INDOOR DBS WILL BE IP--42

5_ DBS WITH ALL COMPONENTS AND ACCESSORIES SHALL BE SUITABLE FOR FRONT OPERATED ONLY.

6_ ALL LIGHTING & SMALL POWER CIRCUITS SHALL BE PROTECTED BY TYPE-C MCBS.

7_ EACH DB TO HAVE SUFFICIENT SPACE ON NEUTRAL AND EARTH BARS TO HAVE PRE DRILLED HOLES FOR CABLE CONNECTIONS.

8_ EACH DB TO HAVE INSIDE POCKET WITH AS-BUILT DRAWING.

9_ EACH DB TO BE TESTED AT MANUFACTURER'S WORK SHOP FOR INSULATION AND FUNCTION OPERATION OF ALL COMPONENTS AND DEVICES.

10_ FLEXIBLE BRAIDED COPPER STRIP SHALL BE PROVIDED FOR EARTHING TO THE DOOR OF DB.

11_ DIMENSIONS/MOUNTING ARRANGEMENTS OF DB AS SHOWN ON THE DRAWING MAY BE TAILORED ACCORDING TO PHYSICAL CONSTRAINTS IN THE INSTALLATION AREA.

12_ ALL DB DOORS SHALL HAVE LOCKABLE LOCKS.

13_ 25% SPACE PROVISION TO BE MADE IN EACH PANEL OTHER THAN THE SPECIFIED PROVISIONS TO CATER THE UNFORESEEN CHANGES.

14_ FOR ALL MCCBs, ICS = 100% ICU

15_ TIN PLATTED (10 MICRONS) COPPER BUS BAR (99.99% PURE) TO BE USED. MAKE AND COUNTRY OF ORIGIN TO BE MENTIONED IN PROPOSAL. BUS BAR SELECTION CRITERIA SHALL NOT BE LESS THAN: 1 MM2 = 1.6 A @ 45'C (AMBIENT TEMPERATURE).

16_ THE DBS TO BE MADE FOR TOP ENTRY AND TOP/BOTTOM EXIT OF CABLES.

17_ ELECTRO STATICALLY POWDER COATED 18 SWG METALLIC FRONT PROTECTIVE SHEETS TO BE USED TO COVER ALL THE LIVE PARTS WITHIN THE DISTRIBUTION BOARD.

18_ THE PROTECTIVE SHEET SHALL BE HINGED FROM ONE END (LEFT SIDE) AND SCREWED AT THE OTHER END (RIGHT SIDE) OR AS PER DOOR SWING DIRECTION.

19_ ALL COMPONENTS SHALL BE AS PER APPROVED MANUFACTURER LIST AS ATTACHED HERE WITH.

20_ INCASE OF ANY VARIANCE, THE CONTRACTOR IS REQUIRED TO TAKE CONSULTANT'S WRITTEN CONSENT/APPROVAL.

NOTE
1. MAINTAIN 450mm CLEAR SPACE AT BOTTOM OF FLOOR STANDING DBs AND LV PANELS

REV.	DESCRIPTION	DATE
05	TENDER DRAWING	10-06-26
04	DRAFT TENDER DRAWING	10-04-26
03	REVIEW & COMMENT	03-03-26
02	REVIEW & COMMENT	15-02-22
01	REVIEW & COMMENT	02-02-22

PROJECT:

STATE BANK OF PAKISTAN
NORTH NAZIMABAD

ELECTRICAL CONSULTANT:

ElekEn Associates

DRAWING STATUS:

TENDER DRAWINGS
(NOT FOR CONSTRUCTION)

DRAWING TITLE:

PROPOSED
POWER DISTRIBUTION

DRAWN BY:	ZAHID	DATE:	JAN-2022
CHECKED BY:	M.J	SCALE:	
PROJ. ENGR:	ARSALAN	JOB NO:	-------

DRAWING NO.

EL-00-03c

PUBLIC PROCUREMENT REGULATORY AUTHORITY (PPRA) EPADS

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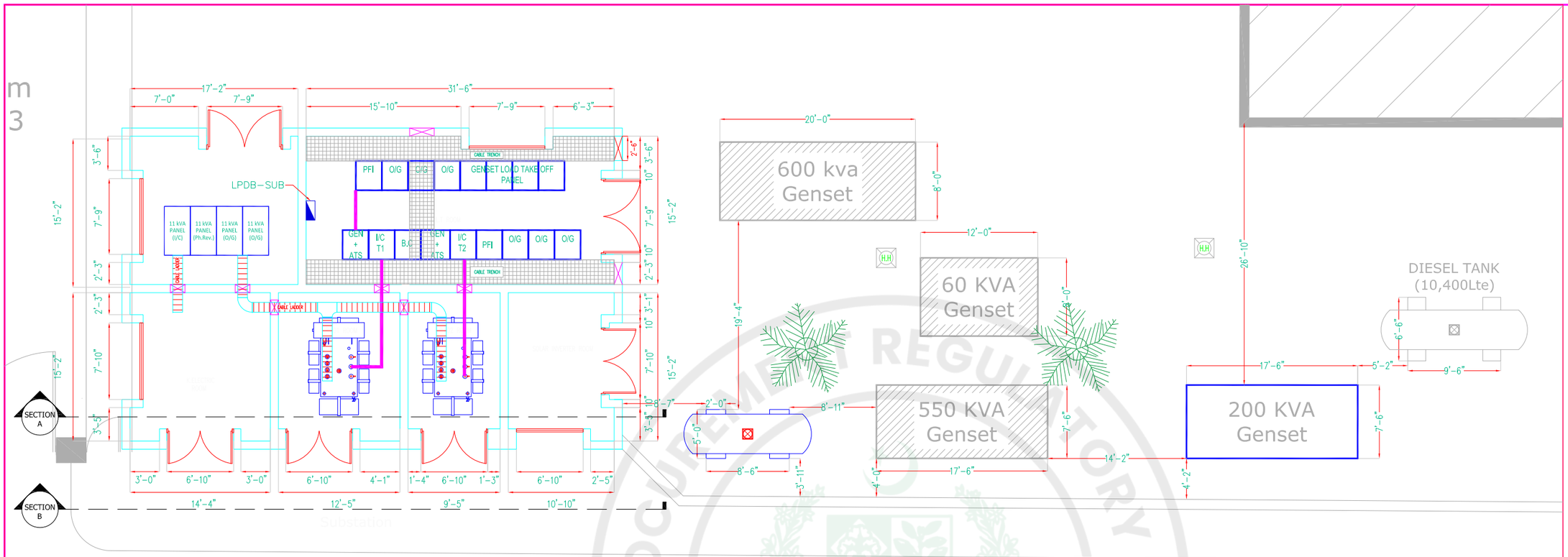
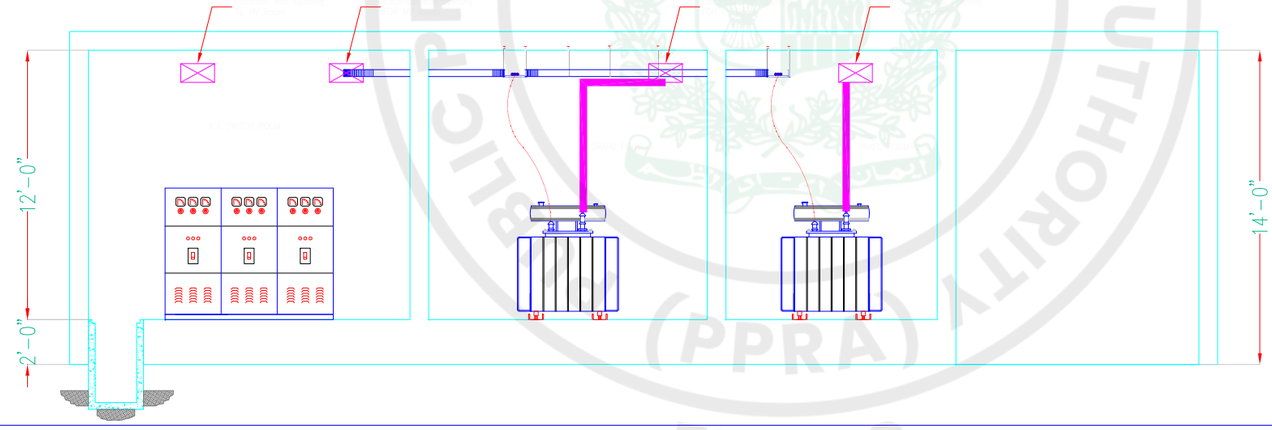
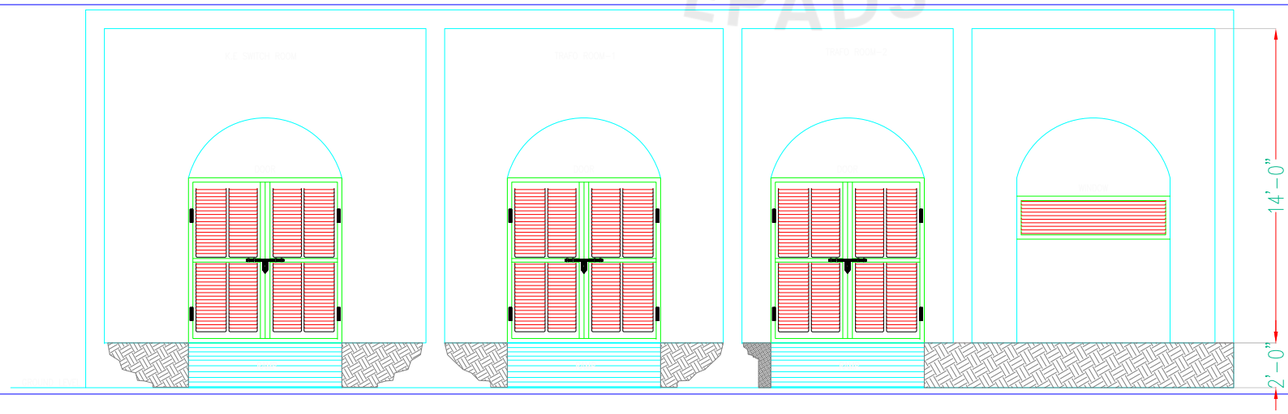
3



PLAN



SECTION-A



SECTION-B

05	TENDER DRAWING	10-06-26
04	DRAFT TENDER DRAWING	10-04-26
03	REVIEW & COMMENT	03-03-26
02	REVIEW & COMMENT	15-02-22
01	REVIEW & COMMENT	02-02-22
REV.	DESCRIPTION	DATE

PROJECT:

STATE BANK OF PAKISTAN
NORTH NAZIMABAD

ELECTRICAL CONSULTANT:

ElekEn Associates

DRAWING STATUS:

TENDER DRAWINGS
(NOT FOR CONSTRUCTION)

DRAWING TITLE:

SUB-STATION LAYOUT

DRAWN BY:	ZAHID	DATE:	JAN-2022
CHECKED BY:	M.J	SCALE:	1/8" = 1'-0"
PROJ. ENGR:	ARSALAN	JOB NO:	-------

DRAWING NO.

EL-01-01

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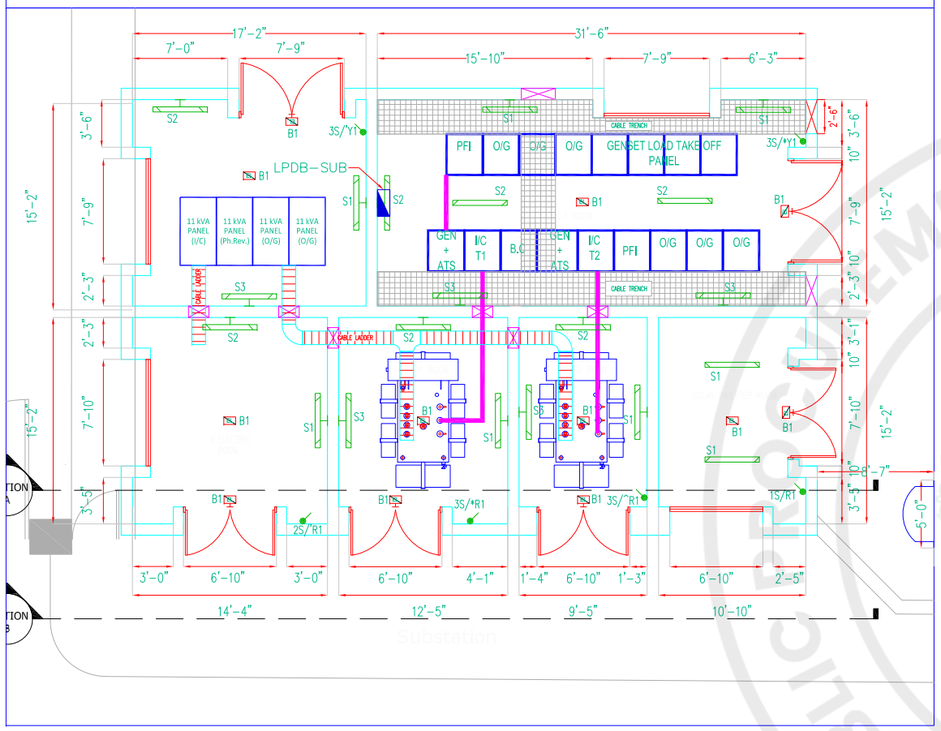
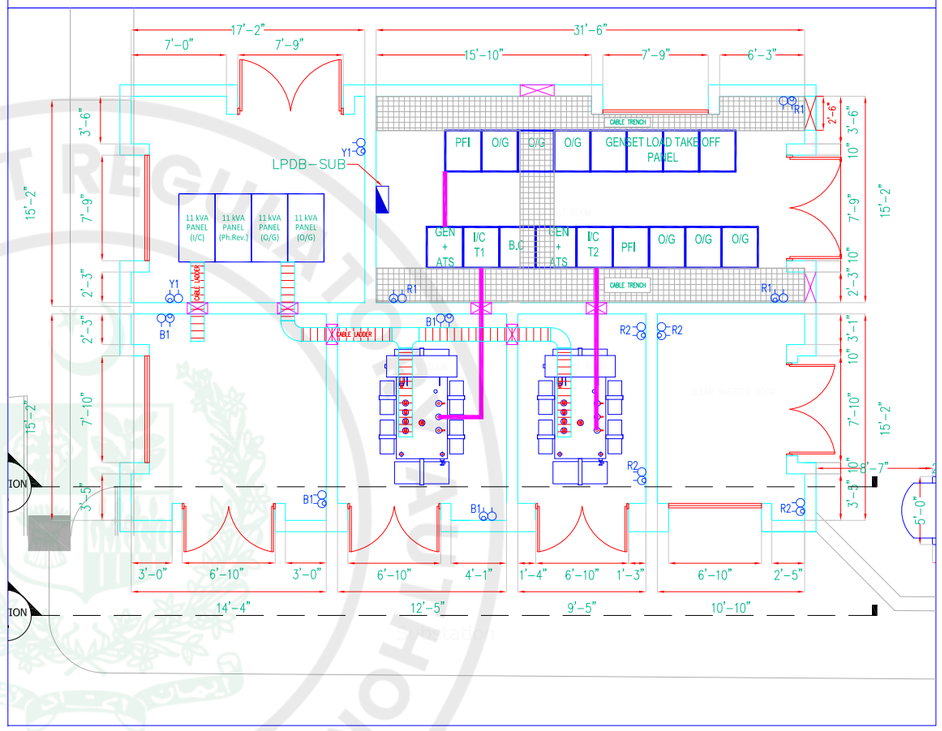
SUB STATION LIGHTING LAYOUT



SUB STATION POWER LAYOUT



ELECTRICAL LEGEND

SYMBOLS	DESCRIPTION	MOUNTING HEIGHT
LIGHTING		
	18W LED BATTEN LIGHT	CEILING MOUNTED
	18W LED BATTEN LIGHT	WALL MOUNTED
	NON- MAINTAINED TYPE EMERGENCY LIGHT	SURFACE / WALL MOUNTED
	10A ONE WAY SWITCH	TOP 3'-6" A.F.F.L

POWER		
	13A INTERNATIONAL SWITCH SOCKET	TOP 1' A.F.F.L
	15A ROND PIN SWITCH SOCKET	TOP 1' A.F.F.L
	DISTRIBUTION BOARD	TOP 6'-0" A.F.F.L

REV.	DESCRIPTION	DATE
05	TENDER DRAWING	10-06-26
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02	REVIEW & COMMENT	15-02-22
01	REVIEW & COMMENT	02-02-22

PROJECT:

STATE BANK OF PAKISTAN
NORTH NAZIMABAD

ELECTRICAL CONSULTANT:

ElekEn Associates

DRAWING STATUS:

TENDER DRAWINGS
(NOT FOR CONSTRUCTION)

DRAWING TITLE:

LIGHTING & POWER LAYOUT PLAN

DRAWN BY:	ZAHID	DATE:	JAN-2022
CHECKED BY:	M.J	SCALE:	1/8" = 1'-0"
PROJ. ENGR:	ARSALAN	JOB NO:	-------

DRAWING NO.

EL-01-02

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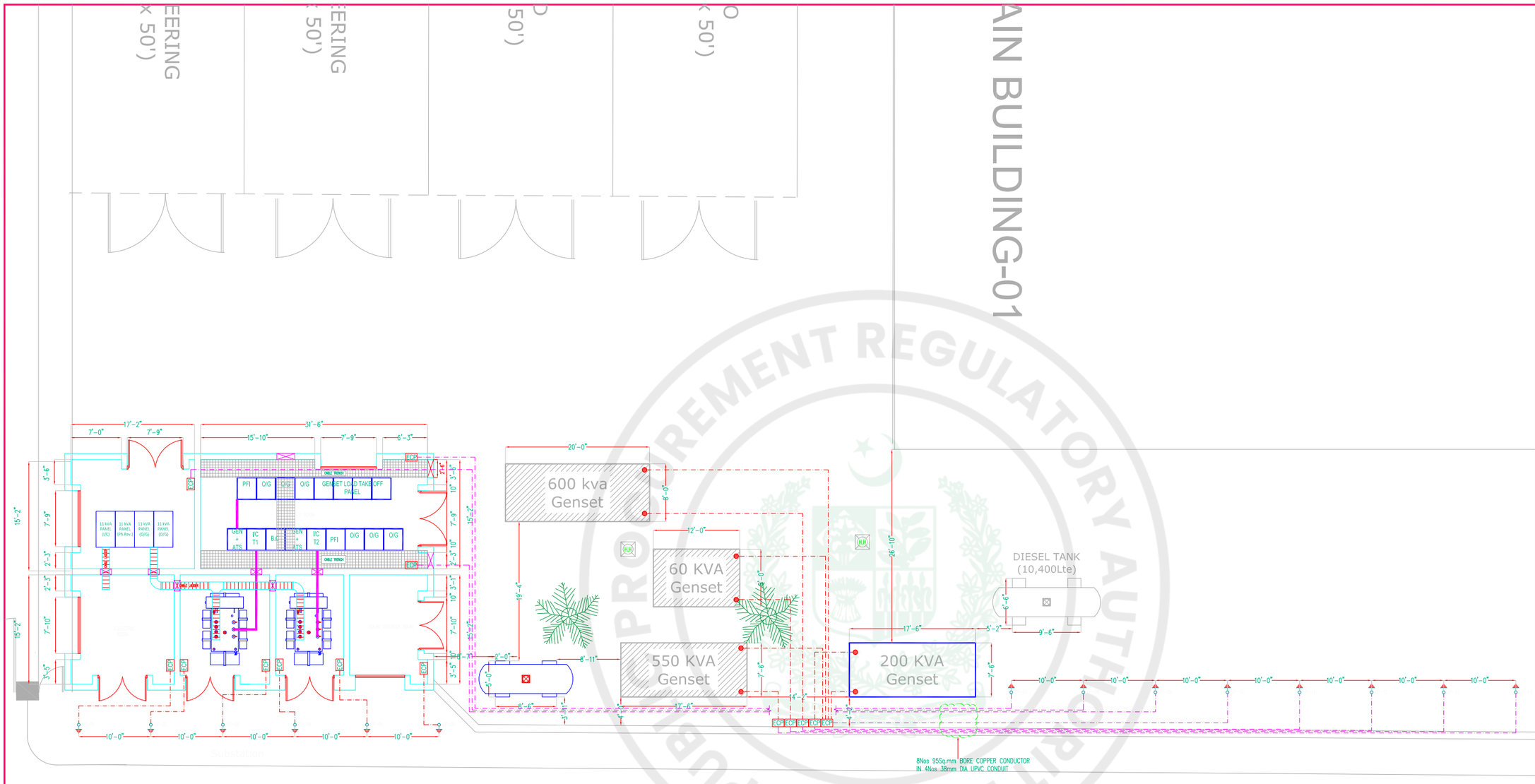

EARTHING PIT IDENTIFICATION LIST.

LABEL	DESCRIPTION
EP-01	K.ELECTRIC – MV PANEL
EP-02	T.R-01 ROOM – NEUTRAL
EP-03	T.R-01 ROOM – BODY
EP-04	T.R-02 ROOM – NEUTRAL
EP-05	T.R-02 ROOM – BODY
EP-06	SOLAR INVERTER ROOM
EP-07	LV PANELS
EP-08	CONSUMER – MV PANEL
EP-09	LV PANELS
EP-10	GENSETS – BODY
EP-11	200 KVA GENSET –NEUTRAL
EP-12	600 KVA GENSET –NEUTRAL
EP-13	60 KVA GENSET –NEUTRAL
EP-14	550 KVA GENSET –NEUTRAL

REV.	DESCRIPTION	DATE
05	TENDER DRAWING	10-06-26
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PROJECT:

STATE BANK OF PAKISTAN
NORTH NAZIMABAD

ELECTRICAL CONSULTANT:

ElekEn Associates

DRAWING STATUS:

TENDER DRAWINGS
(NOT FOR CONSTRUCTION)

DRAWING TITLE:

EARTHING LAYOUT

DRAWN BY:	ZAHID	DATE:	JAN-2022
CHECKED BY:	M.J	SCALE:	3/32" = 1'-0"
PROJ. ENGR:	ARSALAN	JOB NO:	-------

DRAWING NO.

EL-01-03

PUBLIC PROCUREMENT REGULATORY AUTHORITY (PPRA) EPADS

UNDERTAKING

Title: _____
Bidder: _____

1. I/We hereby confirm and declare that I/We has/have not been declared in-eligible or debarred, blacklisted/sanctioned by any Federal or Provincial Government Department, National Counter Terrorism Authority (NACTA), Agency, Organization or Autonomous Body anywhere in Pakistan or fraudulent practices, or no failure to perform with SBP.

2. I/We, understand and agree unconditionally that in case I/We, fail to abide by the above undertaking or any of terms of the Contract, the Client/ SBP BSC shall be at liberty to terminate the Contract without prejudice to any other rights / remedy available in the Contract.

Bidder Sign & Stamp

PUBLIC PROCUREMENT REGULATORY AUTHORITY (PPRA) EPADS

Appendix-B to Bid

Technical Specifications

SECTION V-01
GENERAL ELECTRICAL REQUIREMENTS

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.

1.01 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:

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.

1.02 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 Engineering and Technology (IET), 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.

1.03 STANDARDS

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
- Local Electric / Utility Supply Company standards
- EN Standards for PAVA System
- NFPA 72
- EIA/TIA Standards for ICT System

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.

1.04 INSTALLATION AND SERVICE CONDITIONS:

1.04.1 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 %

1.04.2 Service Conditions:

Equipment shall be designed and built for continuous service with a minimum of supervision and maintenance.

1.05 DOCUMENTS TO BE SUBMITTED:

The contractor shall submit following documents at the time of approval biding or as per instruction of the Engineer:

1. Documents and certificate to be submitted for approval, including:
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

- END OF SECTION -

PUBLIC PROCUREMENT REGULATORY AUTHORITY (PPRA) EPADS

SECTION V-02
COMMON ELECTRICAL WORKS

PART 1 GENERAL

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3.17 Equipment Curbs, Bases and Supports
3.18 Excavation and Backfill
3.19 Concrete
3.20 Cutting and Patching

PART 1 GENERAL

1.1 GENERAL REQUIREMENTS

1. The work of this Division shall be governed by the following documents:
    1. Conditions of Contract
    2. Instructions to Tenderers
    3. Form of Agreement
    4. General and Special Conditions of Contract
    5. Form of Tender
    6. Appendices
    7. Applicable Divisions
2. Comply with requirements of all sections of this Division particularly Section - 26 05 00 Electrical General Provisions.
3. It is the Contractors responsibility to be fully aware of and comply with all of the requirements of the above listed documents.

1.2 SCOPE OF WORK

1. This section is a Basic Materials and Methods section and is to be read as a part of any other section of the specification making reference to conduit, wire, outlets, supports, etc.
2. Provide all necessary materials, labour, equipment, tools, appliances, services, hoisting, scaffolding, supports and supervision to provide complete electrical systems, installed in accordance with the Division 16 specifications.

1.3 QUALITY ASSURANCE

1. Acceptable Manufacturers
    1. Subject to compliance with the requirements of the Contract Documents, acceptable manufacturers are to be firms regularly engaged in manufacture of all material specified in this section of types and sizes required, whose products have been in satisfactory use under similar service conditions for not less than ten years.

1.4 SUBMITTALS

Reference Applicable Divisions - Submittals.

PART 2 PRODUCTS

2.1 CONDUIT

1. Aluminum EMT Conduit factory made bends where site bending is not possible, factory made and threaded fittings with flanges as required, concrete tight where required. Conforming to British Standard BS-4568 Class 4 heavy protection, ASTA certified to British Electrical System Association (B.E.S.A.) Certification Scheme.

2. Rigid PVC conduit complete with site made heat gun bends to 50mm diameter, factory made bends for conduit larger than 50mm, solvent weld joints with socket couplings, and proper connectors and adaptors at terminations. Conforming to British Standards BS-4607 and BS-6099.

3. Aluminum EMT flexible liquid-tight metallic conduit with PVC shielding complete with proper and suitable liquid-tight flexible conduit connectors at terminations shall be used for connections to motorized equipment (minimum length 450mm maximum length 600mm with 180 Deg. loop. Conforming to British Standard BS-4568 similar to Type KEBF by COPEX. All surface conduit shall be EMT.

4. Conduits shall not be less than 25mm diameter size, and shall be complete with all necessary fittings, couplings and connecting devices. Conduits Fire alarm and other systems shall be of minimum 25mm.

5. Conduits and fittings used for electrical installation shall be manufactured especially for electric wiring purposes. When manufactured by a continuous weld process, weld heads both inside and outside the tube shall be completely removed prior to galvanizing, i.e.: Seamless.

6. All conduits and fittings shall be free from rust or other defects on delivery to the site and shall be properly stored in covered racking so that it is protected from mechanical damage and damage by weather and water whilst stored on the site.

7. All conduits shall be coupled to boxes and trunking wire ways using brass male bushes. All such bushes shall be hexagon headed, heavy duty long threaded type.

8. All conduit expansion couplings used shall be fabricated from material equal to that of the conduit with which the coupling is to be used, having factory installed packing ring and pressure ring to prevent entrance of moisture. All expansion couplings shall be equipped with earthing ring or earthing conductor.

9. Where exposed conduits are used (plantrooms, electrical rooms, MDF and above false ceiling) all conduit runs shall be of EMT and shall be fixed using spacer bar pattern saddles giving not less than 6mm clearance between the conduit and the surface to which it is fixed. Saddles shall have finish to match the conduit and saddle clips shall be secured to the bar by means of brass screws.

   Conduits shall be painted to match adjacent finish in line with other sections of the specifications.

2.2 STANDARD OUTLET BOXES AND CONDUIT BOXES

1. Sheet steel outlet boxes conforming to standards set by British Standards BS-1353 and BS-4662l.

2. EMT conduit boxes and fittings conforming to Standards set by British Standard BS-4568.

3. Metallic conduit boxes shall be used throughout all conduit raceway systems, and shall comply with, or be of demonstrated equivalent quality and performance to BS-4568 requirements. All boxes shall be galvanized, zinc plated or equal rust-proofed finish equivalent to conduit finish.

4. For surface exposed conduit installations, circular and/or rectangular boxes shall be used for pull boxes and terminating boxes, according to size and number of conduits connected to box. Boxes shall be either malleable iron or heavy duty steel construction with welded joints and tapped holes to receive metal threaded cover retaining screws. Self tapping screws will not be permitted.

5. All boxes, other than those to which a fitting or accessory is to be directly mounted, shall be fitted with covers screwed to the box by brass screws. Malleable iron covers shall be used with malleable iron boxes and heavy gauge steel covers shall be used with sheet steel boxes.

6. All cover and accessory fixing provisions shall be so positioned that the fixing screws lie completely clear of cables entering the box. All fixing screws shall be brass.

7. All boxes installed in exterior locations use With Terminals Hensel DM 9025 Junction Box IP67, **for plant rooms, janitor's room, ducts etc use MS powder Coated 16-SWG box**.

8. All boxes other than those on which accessories or any item of equipment is to be mounted, or at which flexible connections are to terminate, shall be provided with internal fixed brass earth terminals.

9. Patent box galvanized metal spacers shall be used to interlock both vertically and horizontally between adjacent single gang boxes to achieve correct alignment and spacing between overlapping accessory plates.

10. All boxes provided as junction boxes where cable joints are specified or permitted, shall be provided with fixed terminal blocks. Such boxes shall be of adequate size to contain the terminal block and sufficient cable to allow neat connections to be made. The terminal blocks shall be fixed to the box by brass screws and shall comprise brass conductor connectors, with brass clamping screws enclosed in porcelain or other heat resisting insulation material which will not distort or otherwise have its properties damaged by temperatures below the highest temperature at which the insulation of any cable connected to it is destroyed.

11. Each outlet box must be suitable in all respects for the application, and complete with securing lugs, knockouts, and where necessary, suitable plaster rings, concrete rings, covers and any other required accessory.

12. Outlet boxes for special wiring devices, for special equipment and for special applications, if and where required, are specified hereinafter in this section or on the drawings.

13. Provide blank cover plates for all boxes without wiring devices. Material and cover to the approval of the Consultant.

2.3 PULLBOXES AND JUNCTION BOXES

1. Pull boxes and junction boxes shall be constructed of EMT. Each shall be suitable in all respects for the applications, and complete with screw-on hinged covers with gaskets.

2. The physical size of pull boxes shall be in accordance with the wiring regulations to suit the number and size of conduits and conductors.

3. All motors shall be factory fitted with stud terminals mounted on insulated plate with appropriate terminations for field wiring, all housed in a factory fitted terminal box.

2.4 LOW VOLTAGE (24 VOLT) CONDUCTORS

1. Colour coded imported 2.5mm^2 Fire resistant minimum size insulated wire for 24 volts service, complete with the number of copper conductors required or as specified in drawings and LOAM.

2.5 STANDARD LINE VOLTAGE SOCKET, OUTLETS AND PLATES

1. 13 Amp Socket Outlets:

    1. All socket outlets shall comply with BS-1363 and shall incorporate switches unless specifically indicated otherwise on the drawings or in these specifications.

2. Switched socket interiors shall be mounted to a grid assembly which shall have provision for both lateral and vertical adjustment. The grid shall be of 16 swg mild steel zinc plated or approved equal.

3. Socket outlet tunnel type terminals shall be of adequate capacity to accept three 4mm sq. conductors.

4. Wall mounting socket outlet boxes shall be a minimum of 40mm deep rust-proofed by galvanizing or equal finish and complete with a brass earthing stud secured to the back of the box.

5. Surface pattern outlet boxes shall be either steel or cast iron, supplied with knockouts for drilling on site.

6. Where socket outlets are indicated on the drawings as mounted on desk top they shall be flush type.

7. Socket outlets shall be provided in accordance with the following schedule:

    1. Socket outlet shall be MK make of approved series or as mentioned in Legend Drawings

    2. Socket outlets denoted as weatherproof (WP) or used in mechanical and pump rooms shall be similar to MK Master seal 56482 twin 13 amps switched socket side wired.

    3. Socket outlets mounted in flush floor boxes and in the in floors duct system shall be similar as mentioned in the Drawings.

8. Telephone outlets mounted in skirting or dado trunking, and wall mounted system require back boxes, draw wires, and blanking plates.

9. Data Outlets mounted in skirting or dado trunking, and wall-mounted system require back boxes, draw wires, and blanking plates. Face plates will be installed by the Employer's nominated sub-contractor.

10. For complete details of the under-floor distribution system.

11. Miscellaneous outlets:

1. 13A switched fused connection unit shall be as per List of Approved Manufacturers per List of Approved Manufacturer (LOAM)

2. Emergency stop button, mushroom head complete with actuator, contact block, legend, enclosure and auto-lock key release, equal to "Crabtree" 22509/MR.

3. Dado trunking to be similar to dimensions as stated on drawings.

2.6 HOT DIPPED GALVANISED TRUNKING

All cable trunking shall be hot dip galvanized heavy duty (minimum 2.0 mm thick). Thickness of cover shall be same as the trunking thickness. Same thickness is applicable for all accessories. So site fabrication is acceptable. Supply cable/wire retainer and combs inside trunking. Sizes shall be as shown on drawing.

2.7 SAFETY SWITCHES (ISOLATORS)

1. Safety switches shall conform to IEC 947 – 3 and IEC 609473 and shall be heavy duty type with ampere capacity for AC23 duty type.

2. Each safety switch shall be front operated with a handle suitable for padlocking in the "OFF" position and arranged so that the enclosure cover cannot be opened while the handle is in the "ON" position. Operating mechanisms shall be quick-make, quick-break, positive acting with visible blades and a line terminal shield. Each unit shall also be equipped with solder less lugs and a front cover nameplate identifying the catalogue number and electrical characteristics.

3. Enclosures for safety switches shall be weather proof enclosures, type IP55, made from imported die cast EMT.

4. The ampere rating and number of poles, for safety switches shall be as specified on the drawings, or required by equipment manufacturer whichever is higher.

2.8 BUS BAR CHAMBER

1. Bus bar chamber shall be approved each complete with a formed, primed and painted steel box. Hinged from cover plate, suitable mounting provisions, 5 bus bars, copper construction sized according to load requirements.

2. Bus bar chamber ratings shall be as specified on the drawings.

2.9 SLEEVES

1. In concrete slabs, except as noted below, sleeves shall be EMT with an integral flange to secure the sleeve to formwork construction.

2. In waterproof concrete slabs and in other slabs where waterproof sleeves are required, schedule 40 mild EMT with an integral flange to secure the sleeve to form work construction.

2.10 OTHER REQUIREMENTS

Every accessories or items such as lights, switches, sockets, outlets, speakers, detectors, displays, buttons, cameras, etc. shall be provided with clean facia without any visible screws, rivets, springs , fixing hardware, product logo etc. These accessories and items facia shall be as directed and approved by the Consultant for material, finish and colour. The colour of these accessories or items mounted in the wall shall match colour of wall. If they are mounted in ceiling they shall have same colour as ceiling.

PART 3 EXECUTION

3.1 GENERAL CONDUIT AND CONDUCTOR INSTALLATION REQUIREMENTS

1. Install conduit and conductors concealed in all finished areas, and concealed to the degree made possible by finishes in partially finished and unfinished areas. Conduit may be exposed in unfinished areas such as Electrical rooms, Mechanical rooms and similar rooms unless otherwise noted on the drawings or specified herein. Refer to and examine the architectural drawings and room finish schedules to determine finished, partially finished and unfinished areas of the building. Where conduits are installed exposed, they shall be of EMT painted to the Consultant's approval. Where conduits are installed embedded, they shall be of heavy duty rigid PVC.

2. Where conduit and/or conductors are exposed, arrange same to avoid interference with other work and parallel to the building lines. Where horizontal conduits and/or conductors are exposed, install as high as possible. Do not install conduit and/or conductors within 150mm of "hot" pipes or equipment unless the conduit and/or conductors are associated with the equipment.

3. The drawings do not detail the exact routing of distribution conduits and in the case of branch circuits do not indicate the exact sizes nor routing of conduit. The contractor shall prepare rough-in detail drawings detailing the size and routing of all conduits and shall submit these for the Consultant's approval prior to installation.

4. Be responsible for marking the location of all chases and holes on site. Provide dimensioned drawings to enable a check to be made of all holes and chases in concrete for the Consultant's review.

3.2 INSTALLATION OF CONDUIT

1. Provide conduit for all electric service distribution and branch circuit conductors except where armoured cable and bus duct is specified and for applications where trunking duct, cable tray and similar raceway material is provided.

2. All exposed conduits shall be rigid seamless **18 SWG** galvanized

3. All conduits embedded in walls or floors shall be heavy duty rigid PVC.

4. Provide a separate ground conductor in all EMT conduit and PVC conduit. Size in accordance with local regulations with a minimum size of $2.5mm^2$

5. Generally, distribution conduit is sized on the drawings. Conduit not sized on the drawings shall be sized in accordance with IEE and/or local authorities' regulations with 45% space factor. Note that the sizes of branch circuit conductors scheduled and/or specified on the drawings are minimum sizes and must be increased as required to suit length of run and voltage drop in accordance with local requirements. Where conductor sizes are increased to suit voltage drop requirements, increase the scheduled or specified conduit size to suit.

6. The maximum allowable size of conduit for installation in poured concrete work must be determined in consultation with the Consultant prior to installation. The

placement of reinforcing steel in structural concrete work will take precedence over the placement of conduit. Multiple runs of conduit in poured concrete work must be adequately spaced as directed by the Consultant. Conduits installed in concrete or floor screed shall be sealed watertight. Every circular box shall be provided with extension rings. No offset from conduit to box is acceptable.

7. Do not install horizontal runs of conduit in masonry walls.

8. Support all conduit installed underground on well tamped flat bed of earth, free from rocks or protrusions of any kind.

9. Conduit fittings shall be, unless otherwise noted, constructed of the same material as the conduit and suitable in all respects for the application. Flanged couplers shall be used when conduits are terminated to panels.

10. The Contractor shall be responsible for obtaining from site and checking from drawings the location of structural steelwork and the positions of holes, steelwork and finishes. No steelwork will be drilled without first obtaining written approval from the Consultant.

11. All sets and bends in conduit runs shall be formed on site in bending machines using proper formers, guides, springs, etc.

12. All conduit systems shall be installed so as to enable wiring to be carried out by loop-in system, that is, arranged for the draw-in of cables at the outlet points. Where the Contractor considers the installation of draw-in boxes unavoidable, the proposed conduit routes shall be agreed with the Consultant before work is put in hand.

13. The drawings provided with this specification indicate the approximate position only of outlet points and it shall be the Contractor's responsibility to mark out and centre on site, the final positions and he shall also be responsible for their accuracy.

14. The Contractor's attention is specially drawn to the necessity for keeping all conduit entirely separate from other piping services as direct connections will not be permitted between the conduits and such pipes, except where earthing is required. Conduit runs shall be determined by the Contractor and agreed by the Consultant that cables installed in any particular run are easily with-drawable.

15. Conduit systems shall be mechanically continuous and water-tight after installation. Conduit shall be installed in such a manner as to ensure against the collection of trapped condensation.

16. Runs of conduit between draw-in positions shall not have more than two right angle bends or the equivalent and the length of such runs shall be limited to permit the easy drawing-in of cables. The Contractor shall demonstrate as required by the Consultant that cables installed in any particular run are easily withdraw able.

17. Draw-in boxes shall be provided in all straight conduit runs at intervals not exceeding 9m and in runs containing two right angled bends at intervals not exceeding 7.5m.

18 Where conduits cross expansion joints, the Contractor shall install expansion couplers at the position of the expansion joint and at right angles to it.

19 Where conduit runs terminate in cable trunking, the termination shall be made with flanged couplings as specified for adaptable box entries.

20 Where conduit runs terminate in the boxes, the termination shall be made with flanged couplings as specified for adaptable boxes.

21. Where conduits enter boxes with tapped threads less than 20mm, the termination shall be made with a brass spout nipple.

22. Outlet boxes for wall lighting points shall be flush with the wall surfaces unless indicated on the drawings and twin parallel spout entries provided if necessary for looping purposes. Outdoor outlets shall be provided with grommets, gaskets and rust proof cover plate. Ball type outlets shall be used to connect pendent lights with ceiling outlets through EMT conduits. No plug in ceiling rose is required in electrical-mechanical room and similar rooms.

23. Outlet boxes for luminaries shall be of the loop-in type where the installation is concealed and the Contractor shall allow for terminating arrangement and install any additional draw-in boxes required in accessible locations.

24. For luminaries fed by concealed cables and having boxes fitted flush with the ceilings, the Contractor shall include for all the necessary extension rings or break joint rings. Pattresses shall be fitted where required to outlets on surface runs.

25. Heavy distance saddles shall be used for surface fixings of EMT conduit.

26. Where any surface mounting control gear or other equipment is to be installed in conjunction with concealed conduit work, the conduit shall be terminated at a flush mounted circular or adaptable box. The back of the equipment shall be drilled and bushed for back entry and the equipment mounted so as to conceal the adaptable box.

27. Where conduits are specified in floor screeds, the Contractor must carefully check the proposed screed depths at all positions before installing conduits and shall, wherever possible, arrange to cross conduits where there is ample thickness of screed. If at isolated positions, the crossing of conduits in shallow screeds cannot be avoided, arrangements may be made to set the lower conduit into a shallow chase performed in the slab, subject to the agreement of the Consultant.

28. The Contractor shall provide attendance during the pouring of concrete to ensure that conduits and accessories are not displaced or damaged.

29. No wiring shall be carried out before the particular section of the conduit installation to be wired is complete to the satisfaction of the Consultant.

30. Erection of Metallic Conduits:

    1. The conduit shall be properly and tightly screwed between the various lengths and to the boxes to which it runs and terminates, so that the wiring is continuously and effectively protected throughout its entire length. The entire system shall be electrically and mechanically continuous throughout forming a completely bonded system, the whole being efficiently earthed in the supply point.

    2. Where conduits are connected by means of a socket, the ends of the conduits shall butt together in the centre of the socket and, except in the case of running joints, no exposed threads shall be visible after erection.

    3. Where running joints are used, they shall be thoroughly coated immediately after erection with cold galvanizing primer and then painted. Where the finish of conduit is damaged in erection, it shall be immediately made good with cold galvanised primer and an approved metallic paint.

4. The inside surface and ends of conduits and fittings used in connection therewith, shall be smooth, cut square and free from burrs and all other defects. Reamers shall be used on the ends of all conduits after screw threads have been cut and all grease, enamel, etc. removed.

5. All EMT conduits shall be jointed with solid screwed couplings and flanged couplers at DB's.

6. All conduit shall be clean and free from rust. Approved type lubricant shall be used wherever required.

7. All conduit outlets in malleable EMT boxes and Tucson boxes shall be adequately spaced from the edges of the box to allow correct fitting of nuts. Throats and bushings to be installed at the ends of all conduits.

31. Conduit Supports and Fixings

1. Surface mounted conduits shall be secured (at a maximum interval of 1.2m) by means of space-bar saddles where multiple runs occur. 'Distance' saddles shall be used on individual runs such as down drops to switches and plug points.

2. In no case shall conduits be mounted directly on the surface of walls and ceilings, a minimum space of 6mm to the back of the conduit being required.

3. All fixing shall be by means of screws and/or bolts. Where walls are plugged, special plugs or plugging material shall be used for fixing purposes. Wood plugs are not acceptable.

4. The use of crumpets is restricted to securing of conduits in wall chases pending plastering of other finishes.

5. In ceiling voids and similar spaces where conduits pass across ceiling beams, plain stamped saddles shall be used. Elsewhere, on fair faced brickwork 12mm saddles shall be used, with cast iron saddles on rough concrete and brickwork.

32. Cleaning

1. The conduit outlets when installed and before wiring shall be temporarily closed by means of well fitting wooden plugs, and immediately before cables are drawn in, conduit systems shall be thoroughly swabbed out until they are dry and clean.

33. Erection of Flexible Conduits

1. All conduits must be secured to outlet boxes, junction boxes or cabinets by placing locknuts on outside of box and locknuts and bushings on the inside of box.

2. Conduits connecting recessed fixtures and their adjacent junction boxes must be flexible metallic conduit 20mm (3/4") minimum size and shall be of sufficient length to permit the dropping of the fixture below the ceiling to gain access to the junction box.

3. Conduit to motors shall be terminated in the conduit fittings on the motors, the final connection being made with liquid tight low acid PVC coated metallic tight flexible conduit and suitable liquid tight connectors.

4. A green insulated $4mm^2$ (minimum) tinned copper earth connection shall be made between the solid conduit or cable sheath and the equipment, the copper cable being run inside the flexible conduit. Couplings fitted to removable covers or non-metallic

equipment etc., shall be bonded to the earthing terminal of the equipment etc. Where changes to flexible conduits occur, a watertight outlet box with threaded entries shall be inserted and the earth connection made to an internal terminal. The cover screws shall not be used for earthing connections. Refer to the Contract Documents for sizes of earthing conductors relative to associated circuit protective devices.

34. Draw Wires in Conduits

1. A 2mm galvanized iron draw wire or approved equal shall be left in every conduit which is left by the Contractor for installation of wires and cables. The draw wire shall have a tensile strength not less than 90 kg.

2. No less than 300mm of slack shall be left at each end of the draw wire.

35. Colour Coding for Exposed Conduits, trunking and bottom side of cable trays.

1. Provide colour coding stripes as specified hereinafter. Stripes shall be 20mm wide and 100mm long. Where dual colour coding is indicated, the base colour stripe shall be 75mm long, the secondary colour stripe 25mm long to form a total stripe length of 100mm. Stripes shall be placed at 4m intervals.

2. Colour Coding:

Fire alarm system	- Red
CCTV & Security System	- Blue
Lighting	- Yellow
Small Power	- Green
Telephone	- Grey
Intercom	- Beige
Low Voltage systems	- Purple
BMS	- Orange
Public address systems	- Pink
Emergency/EXIT lighting	- Purple

3.3 INSTALLATION OF OUTLET BOXES

1. Provide an outlet box for each lighting fixture, wiring device, telephone outlet and any other outlet specified herein or shown or specified on the drawings, unless otherwise noted. Provide galvanized metal back box for every items mounted in wall and ceiling slab/false ceiling. IP rating of box as per area of application.

2. Generally, mounting heights and locations for outlets are shown on the drawings and/or specified herein, however, confirm the exact location and arrangement of all outlets with the Consultant prior to roughing-in. Architectural drawings and the Architect's instructions have precedence over electrical drawing diagrammatic layouts and specified mounting heights and locations.

3. Do not install outlet boxes "back-to-back" in walls and partitions. Such outlets must be staggered and sealed against noise transmission. "Thru-Wall" type outlet boxes will not be permitted for any application.

4. Support and secure boxes independent of the conduit or cable connected thereto.

5. All recessed outlet boxes for surface mounted devices or lighting fixtures must be totally concealed by the device or fixture. Face plate final finish of switches, socket outlets, telephone and data outlets shall match surrounding finish unless instructed by the Consultant.

3.4 INSTALLATION OF PULLBOXES AND JUNCTION BOXES

1. Provide pull boxes in conduit systems wherever necessary to facilitate conductor installations. Generally, conduit runs exceeding 30m in length, or with more than two (2) 90 degrees bends shall be equipped with a pull box installed at a convenient and suitable intermediate location.

2. Provide a junction box wherever required and where shown and/or specified on the drawings.

3. All pull boxes and junction boxes must be accessible after the building is completed.

4. Accurately locate and identify all concealed pull boxes and junction boxes on "as-built" record drawings.

5. Support and secure all boxes independent of the conduit or cable connected thereto.

6. Install identification labels indicating system name on all pull boxes and junction boxes.

3.5 INSTALLATION OF LOW CURRENT CONDUCTORS

1. Install all low current wiring in conduit.

2. Any special requirements pertaining to low voltage wiring will be specified hereinafter in this section or on the drawings.

3.6 INSTALLATION OF STANDARD LINE VOLTAGE, SOCKET OUTLETS AND PLATES

1. Provide socket outlets in locations shown and/or specified on the drawings.

2. Equip each socket outlet with a faceplate with an opening or openings suitable for the device it conceals. Secure faceplates to the device frames with metal screws finished to match the faceplate, except for wall installations, where they shall be screw less type.

3. Submit to the Consultant, for approval, a sample of each standard outlet to be utilized on the project.

4. Change locations of outlets at no extra cost or credit providing distance does not exceed 5m and information is given before installation.

5. Final finishes of the faceplates shall match the surrounding finishes unless otherwise instructed by the Consultant.

3.7 INSTALLATION OF FLUSH FLOOR BOXES

1. Install floor boxes and assemblies to manufacturers recommendations.

2. Floor boxes shall be adjusted to be exactly flush with the finished floor surface with lamacoid labels for circuit reference.

3.8 INSTALLATION OF INCANDESCENT DIMMER SWITCHES

1. Install dimmer switches to manufacturers recommendations.

2. When grouping dimmers refer to manufacturers requirements regarding de-rating of dimming switches.

3.9 INSTALLATION OF SAFETY SWITCHES (DISCONNECTS)

1. Provide disconnects:

    1. Wherever shown on required on the contract documents.

    2. Wherever required by starter schedule drawings.

    3. For motorized equipment which cannot be seen from the motor starter location or is more than 10m away from the starter location.

    4. For all "packaged" equipment supplied by other Divisions and fed from a motor starter panel.

    5. Where required by local regulations.

2. Enclosures for safety switches mounted indoors although not exposed to the weather and above false ceiling shall be Type IP54.

3. Enclosures for safety switches mounted outdoors or in locations exposed to the weather shall be weatherproof type IP65.

4. Where safety switches are not within reach of equipment shall be mushroom type lockable pull / push EMERGENCY stop button.

3.10 INSTALLATION OF BUS BAR CHAMBERS

1. Provide bus bar chambers wherever shown, and/or specified on the drawings.

2. Specified bus bar chambers ratings shall be based on 50° ambient temperature.

3. Bus bar chambers mounted outside the building, exposed to the weather or in mechanical rooms and basement corridor service tunnels shall be weatherproof to IP65.

3.11 INSTALLATION OF SLEEVES

1. Where conduits, raceways and conductors pass through structural poured concrete, supply sleeves, unless otherwise noted.

2. Size sleeves, unless otherwise noted, to leave 12mm clearance around the conduit, raceway, etc. Pack and seal the void between the sleeves and the conduit, raceway, conductor etc. for the length of the sleeves as follows:

    Seal all sleeves with a one part in tumescent elastomer, equal to 3m Brand Fire Barrier Caulk CP25. Putty 303, sealing systems 7902 or 7904 series, composite sheet CS-195 or wrap stop FS-195.

3. Interior partition sleeves: 1.5mm thick steel, galvanized.

4. Sleeves in Exterior Walls and Floors: Cast iron complete with pre-manufactured sealing rings and pressure bushings of proper size. Keep pressure bushings accessible for future tightening.

5. Sleeves through Floors: To extend 50mm above finished floors unless otherwise shown. All sleeves for future use shall be capped.

6. Electrical riser closets shaft edge to extend 100mm above the finished floor as an up stand.

7. Sleeves through roofs must be sheet metal flashing with sloping flanges between two layers of roofing material and separate watertight counter flashing on conduit.

8. In poured concrete construction, accurately locates sleeves, and turn these sleeves over to the division performing the concrete work for placement in the concrete formwork.

9. Submit to the concrete reinforcement detailer at the proper times, drawings, indicating all required sleeves, recesses and formed openings in poured concrete work. Such drawings shall be completely and accurately dimensioned and shall relate sleeves, recesses and formed openings to suitable grid lines and elevation datum.

10. "Gang" type sleeving will be permitted only with the Consultant's approval.

11. Terminate sleeves for work which will be exposed so that the sleeve is flush at both ends with the wall, partition or slab surface so that the sleeves may be completely covered by escutcheon plates.

12. Openings for multiple conduit or conductor runs, etc., will be provided by the division responsible for the particular construction in which the opening is required. Carefully co-ordinate the opening locations with the particular division and ensure that openings are suitably sized and located. Seal the space between the opening and the conduit, conductors, etc. for the length of the opening as for sleeves in paragraph .2.1 above.

13. Where a round or formed opening is required, where placement of a sleeve has been missed, or where provision of an opening has not been properly co-ordinate, neatly cut a suitably sized hole or opening using proper tools to the approval of the Consultant. Prior to cutting any such holes or openings, determine whether or not any reinforcing steel or services, are concealed behind the surface where the hole or opening is to be cut and be responsible for all costs incurred for correcting any damage caused to the structure or services due to cutting holes or openings without prior study and approval of the Consultant.

3.12 INSTALLATION OF ESCUTCHEON PLATES

1. Provide escutcheon plates over all exposed conduit & cable trays passing through walls, floors, ceilings, partitions, furrings etc., in exposed finished areas (i.e. without false ceiling.

3.13 INSTALLATION OF INSERTS, BEAM CLAMPS AND FASTENERS FOR CONDUIT, RACEWAY ETC. AND EQUIPMENT HANGERS AND SUPPORTS

1. Provide all inserts, beam clamps, fasteners, and similar hardware required for conduit, duct, raceway, conductor, etc., and equipment hanger and/or support materials unless otherwise noted for casting into concrete in accordance with specification Section – 26 05 00.

2. Accurately and properly set concrete inserts in the concrete framework. Every items in the areas supported from soffit of the slab shall be fixed using inserts or bridge. No drilling in the concrete slab is acceptable for fixing/supporting whatever items in any areas. This is applicable for all divisions of this project.

3. For runs of three (3) or more conduits, raceways, or conductors in concrete formwork, use multiple type inserts used for the smallest conduit in the group.
4. Fasten hangers and support provisions to brick or masonry with expansion shields and machine bolts, or for light loads, use plugs and screws.

5. In cavity walls and/or ceilings use two (2) wing toggles and for heavy loads, provide steel anchor plates with two (2) or more toggles to spread the load.

6. Provide beam clamps for attaching, hanging and/or support provisions to structural steel, or where approved by the Architect, weld the hanging and support provisions to the structural steel.

7. Explosive power actuated fasteners will not be permitted.

8. Use fiber or lead screw anchors for anchoring screws.

3.14 ACCESS DOORS

1. Access doors shall be provided under other divisions of the contract for the particular type of construction in which the access door is to be installed.

2. Prepare detail drawings indicating exact size and location of all access doors required by this division and submit to the Consultant for review. Access doors are required to access trays, pull boxes, junction boxes, VAV's, CAV's, SFD's, smoke detectors and control panels.

3. Indicate access panels on "As built" drawings and note at each location the items that access is being provided for.

4. Provide lamacoid labels (white on black), screwed or riveted in place, for all access doors and access tiles listing items or equipment which access is being provided for unless otherwise directed by the Consultant.

3.15 PAINTING AND FINISHES

1. Painting of exposed electrical work will be done as part of the work covered under Division 9 of the Contract.

2. All exposed electrical fittings, supports, hangers, frames conduit, racks, boxes, raceways and similar material and apparatus within battery / rectifier / UPS rooms and similar rooms without false ceiling shall be galvanized and finished with galvanized corrosion resistant spray ready to accept paint. Take special care when priming work exposed to the elements or in wet areas to prevent rust or corrosion from damaging adjacent surfaces. Final finish colour to be approved by the Consultant.

3. All large switchgear, transformers, distribution centres, panel board, starters, disconnects or similar apparatus shall be factory finished in gloss air dry enamel over corrosion resistant sealer primer. Unless specified to the contrary, this finish shall be RAL 7032.

4. Touch up and/or repaint any factory finished equipment not scheduled to be painted by Section 09900 that has been scratched or otherwise damaged during installation.

3.16 STANDARD IDENTIFICATION

1. Identify electrical work as specified below.

2. For each piece of electrical distribution equipment from the electrical source of supply up to and including panel boards and motor systems, for special control panels and cabinets, and for any other piece of equipment where specified in this section, provide engraved lamacoid identification nameplates. Nameplates shall generally be black-white-black with beveled edges, secured to apparatus with stainless steel screws. Warning signs shall be red with white lettering.

3. Equip large multiple cell or component apparatus such as switchboards and distribution panels with main nameplates identifying the equipment, voltage characteristics and capacity, and with sub-nameplates clearly identifying each cell or component and its service.

4. Panel board nameplates shall identify the panel board references and numbers designated on the drawings, unless otherwise instructed. All nameplates for disconnect switches, control panels, all components of electrical systems, LV systems, fire alarm system, BMS, public address system, MDB's, MCC's, SMDB's, DB's and all cabinets/boards/panels under all divisions shall outline their service in English and Arabic. Size of name plate and front plate shall be approved by the Consultant.

5. Motor starters, magnetic and manual, shall identify the piece of motorized equipment being serviced.

6. Exact nameplate wording and sizes must be approved by and confirmed by the Consultant prior to manufacture.

7. Directories for branch circuit panel boards shall be clearly and neatly typewritten, accurately identifying the type, location and wattage of the connected load for each circuit breaker. Directories shall be secured to the rear of the cabinet door under protective plastic. Incorporate copies of all panel board directories in each copy of operating and instruction manuals.

8. Clearly identify each branch circuit breaker with Z-type markers chevron cut in a permanent manner to correspond with directories. Glued paper identification will not be acceptable.

9. Clearly identify main pull or junction boxes (excluding obvious outlet boxes) by painting the outside of the covers. Schedules of colours shall be as stated before:

10. In addition to painting miscellaneous signal boxes clearly identify the specific system in which the box is installed by means of securely attached lugs on the inside of the cover plate.

11. Colour code empty conduit capped and terminated for future use as specified above and clearly identify its intended use by means of securely attached tags on the inside of the cover plate.

12. Conductors shall be colour coded, throughout to identify phases, neutrals and grounds, by means of coloured conductor insulation. Colours shall be as follows:

1.	Phase R	- Red
2.	Phase Y	- Yellow
3.	Phase B	- Blue
4.	Ground	- Green/Yellow
5.	Neutral	- Black
6.	Control	- A/C Orange/D.C. Grey

13. Control conductors, in addition, shall be numbered with Critchley Markers, or Elect overt Ltd., Z-type markers or equal. Colour code conductors, for special component manufacturer's recommendations.

14. All cables shall be labeled using Critchley markers at both ends of termination.

15. All wires shall be terminated using porcelain barrel type connectors or approved equal. All multistrand wires and cables shall be crimped with lugs before termination. This applies to all types of wires and cables for all divisions in this project for site installations and also any wiring done at manufacture's place.

3.17 EQUIPMENT CURBS, BASES AND SUPPORTS

1. Set all floor-mounted equipment on 100mm high concrete housekeeping pads 100mm wider and longer than the equipment base dimensions unless otherwise directed by the Consultant for technical reasons. Coordinate pad locations and surface treatment.

2. Furnish dimensioned drawings, templates and anchor bolts for proper setting of equipment on bases and pads. Provide all structural steel frames, brackets, etc., for equipment bases and supports unless otherwise noted, and be responsible for all required leveling, alignment and grouting of the equipment.

3. Provide structural steel stands for equipment where indicated or specified. Flange bolt stands to housekeeping pads.

4. Where equipment is suspended above floor level it shall be, unless otherwise noted, supported on a suitable fire treated wooden platform on structural steel angles or channels bracketed to the wall or secured by hanger rods to slab construction, or where loading is excessive, from separate structural steel members carried to either the floor or ceiling, or both as required.

5. Provide structural steel cat walks within void and access panels in auditorium area to access equipment / devices above false ceiling.

3.18 EXCAVATION AND BACKFILL

1. Refer to other Divisions of the Contract and do all excavating, bedding, backfill and related work for the work of Division 16 as specified therein except as varied by this article.

2. For all electrical cables excavation, excavate to 750mm or 1200mm as applicable below and a minimum of 200mm to either side of the cable or duct run. Fill back with a bedding of granular 'A' gravel or sand. Provide necessary cable marker, concrete tiles if cable level is less than 600mm below ground level. Brass cable service identification plates shall be provided every 20m run and on change of direction.

3. Refer to the Contract Documents and to local authorities' requirements for concrete encased duct installation.

4. Where excavation is necessary in proximity to and below the level of any footings, bed with concrete to the level of the highest adjacent footing. Concrete strength shall be as directed by the Consultant. Prior to commencing work approval of all intended work shall be given by the Consultant.

5. Carry out pavement cutting and repair of the Public Property as may be required for excavation and backfill work.

3.19 CONCRETE

1. Refer to other Divisions of the Contract, and do all concrete or related work required for the work of Division 16 therewith, except where specially noted otherwise.

2. Division 16 shall be responsible for all co-ordination to meet local authorities' requirements for ducts, provision of ducts and fittings as specified.

3.20 CUTTING AND PATCHING

1. Inform other trades in time concerning required openings. In work already finished, cutting and patching shall be done by the trades installing the affected work at the expense of the General Contractor. Obtain the approval of the Consultant before commencing with work.

- END OF SECTION -

PUBLIC PROCUREMENT REGULATORY AUTHORITY (PPRA) EPADS

SECTION V-03

OIL TYPE TRANSFORMER

OIL FILLED TRANSFORMER

1.1 SCOPE OF WORK

The scope of work under this section includes the following as specified here in:

A. The contractor shall supply, install, commission & test mineral oil filled transformer complete with connections, terminations and accessories. The transformer shall be designed and manufactured for continuous indoor operation in a tropical climate on a 3-phase distribution system with solidly earthed neutral. It shall be of a short circuit, impulse and moisture-proof design. The transformer shall be designed, manufactured and tested according to the latest edition of International Electro technical Commission (IEC) Standard 60076. It shall be compact and suitable for easy installation on site.

B. The transformer shall be designed to operate without enclosure.

C. The electrical connections to other equipment shall be properly coordinated to form a complete system (s) complying with this specification.

D. Workshop drawings shall be provided for the transformer. These drawings shall include fully dimensioned external and internal general arrangements showing all principle dimensions, weights, foundation/cable/bus bar entry details and the positions of all functional devices, schematic drawings showing all windings, method of connection, terminal markings, and IP rating.

E. Transformers in the context of this specification shall comprise assemblies of a magnetic core, primary and secondary windings, supporting framework and enclosure.

Unless otherwise specified all terse used shall comply with IEC 60076 and DIN/VDE standards

F. The design, manufacture, selection, installation, testing, commissioning and subsequent maintenance of all equipment and materials described in this specification shall comply with the requirements of, the electricity at work regulations and the IEE wiring regulations.

Where more onerous requirements are specified herein, the conditions of this specification shall take precedence.

2.0 DESIGN REQUIREMENTS:

2.1 WINDINGS

Electrolytic copper of high conductivity and insulation material of class A (IEC) shall be used for the windings and other energized parts. All MV and LV windings shall be fully insulated compositions likely to soften, or shrink during service. None of the materials used shall shrink, disintegrate, carbonize or become brittle under the action of hot oil at any load condition.

The windings shall have the following insulation strength according to IEC 60076.

a)	Rated system voltage	11 kV
b)	Impulse withstand voltage (crest value)	75 kV
c)	One minute power frequency	28 KV

withstand test voltage (r.m.s)

d) System highest voltage (r.m.s) 12 kV

Power frequency withstand voltage of the neutrals being 65% of the respective line withstand voltage in accordance with IEC 60076.

2.2 BUSHINGS

Bushings shall be free from defects and thoroughly verified. The glaze shall not form a dependence factor for insulation and shall be of uniform shade of brown covering completely all exposed parts of the insulator.

The terminals shall be suitable for cable or bus bar connections on the LV side and cable on the MV side, respectively. The connections shall be provided with suitable clamps to absorb shocks due to vibration of the connecting jumpers.

Stresses due to expansion and contraction in any part of the bushing shall not develop bulges. hair-line cracks or other defects.

Protective spark gaps shall be provided on MV bushing to protect the transformer from surges.

2.3 MAGNETIC CORE

The core and its clamping plates shall form a rigid unit structure which shall maintain its form and position under the severe stresses encountered during shipment, installation and short circuits. Care shall be taken to secure evenly distributed mechanical pressure over the whole lamination to prevent setting of the core and to eliminate noise and vibrations when the transformer is in operation. The core construction should be such that removal and replacement of windings shall require removing of core lamination to a minimum extent.

Core lamination shall be made of cold rolled grain oriented, high permeability mineral steel, free from burrs. Each lamination shall be insulated with a material that will not deteriorate due to pressure and the action of hot oil.

The maximum flux density shall not exceed 1.9 Tesla at feeder voltage 1.05 times the rated voltage and on condition that higher harmonics are suppressed to the maximum possible extent.

2.4 TRANSFORMER TANK

The tank shall be constructed of heavy mild steel plates and shall withstand filling with oil at vacuum without permanent distortion. All seams or joints other than those which may have to be broken shall be welded both inside and outside to assure strong leak-proof joints.

Heavy structural steel members shall be welded to the bottom of the tank to from a rigid under-supporting base.

In order to prevent tank deformations during operation, a pressure relief device of sufficient size shall be provided at the transformers for rapid release of any pressure that might be generated within the tank, and which might result in damage to the equipment. The device shall operate at a static pressure of less than the hydraulic test pressure of the tank. Means shall be provided to prevent the ingress of rain or dust. Exhausting oil shall be directed downwards into transformer oil collecting pit. A drain at the lowest point of the transformer tank shall be provided.

The following moving and handling facilities shall be provided for each transformer.

a) Four (4) jacking pads to enable to raise or lower the transformer completely filled with oil by means of hydraulic jacks.

b) Lugs for lifting the complete transformer.

c) Pulling eyes for moving the transformer in any direction.

d) Wheels suitable for locking the transformer shall be mounted on four bi-directional flanged wheels for running of rails. The bi-directional flanged wheels shall be capable of rolling in the directions parallel to both the shorter axes of the transformer. The bi-directional movement shall be obtained by means of a swivel arrangement, capable of being locked in any of the two positions. Necessary jack and other allied tools for use when altering the wheel positions shall be supplied. Suitable means shall be provided to enable the wheels to block firmly to the rails when the transformer is in service.

The tank cover shall be provided with suitable flanges or other approved means for connection of bus ducts (LV side) or cable end boxes (MV and LV side)

2.5 TRANSFORMER OIL

The Transformer oil shall be mineral oil complying with IES standards.
The tender shall state full details of the insulation to be supplied.

2.6 OIL CONSERVATOR

A conservator vessel complete with the sump and drain valve shall be provided for each transformer in such a position as not to obstruct the electrical connections to the transformer and shall have sufficient capacity to allow oil expansion from 0°C to + 100°C. The conservator vessel shall be designed in such a way that it could be completely drained by means of drain valve mounted when serviced. A rod type oil level gauge showing the full oil level range shall be provided. The conservator shall be fitted with one breather in which silica gel shall be filled as a dehydrating agent. The Breather shall be provided with a separate isolating wall.

2.7 EARTHING

Two earthing terminals of adequate size shall be provided and installed diagonally at the bottom of the transformer tank.

2.8 INTERTURN INSULATION

High and low voltage coils shall be provided with very high integrity inter turn insulation to Class A, to withstand the thermal and mechanical stresses under the specified operating conditions.

2.9 INSULATION CLASS

The HV and L.V windings shall be of insulation class A in respect of mechanical and electrical strength (Partial Discharge Test). The maximum continuous operation temperature shall be within the limit of the maximum system temperature according to IEC. The maximum temperature rise shall be limited to 90K at 50°C ambient. The transformer shall operate at higher ambient temperature with reduced load without getting damaged.

2.10 DEGREE OF PROTECTION

When specified, the transformer shall be designed to suit the location and anticipated environmental conditions and shall comply with the Electricity at work Regulations.

3.0 PERFORMANCE

A. GENERAL

The transformers shall comply with the requirements of IEC 60076 in respect of partial discharge, impulse withstand short circuit strength.

B. RATED VOLTAGE

Unless otherwise specified the rated voltage class of the primary windings shall be 11kV and secondary windings 0.4 kV, at a frequency of 50Hz. The windings shall be connected for vector group Dyn 11.

C. THERMAL RATING

Transformers shall be designed and manufactured to operate continuously at the nameplate rating, in an ambient temperature not exceeding 50°C and RH not exceeding 100%, unless otherwise specified.

The manufacturer shall confirm any de-rating necessary, should the transformers be required to operate in conditions exceeding those specified.

D. LOSSES

Losses at no-load and loaded conditions shall be the lowest achievable for the transformer type specified. These losses shall be stated in the schedule(s) which accompany this Specification.

E. NOISE LEVELS

The manufacturer shall confirm the guaranteed noise levels, Measurement of sound levels shall comply with IEC 60076-10. The transformer shall be provided with noise reduction support blocks in order to reduce noise level.

4.0 HANDLING FACILITIES

A. LIFTING

Transformers shall be provided with permanently fitted lifting lugs or eye bolts to facilitate handling by crane or hoist.

Transformers shall be equipped with jacking points to facilitate the removal and or insulation pads.

The bottom supporting steel work shall be fitted with holes or have lugs attached for the attachment of hauling apparatus.

B. FRAME WHEELS

Transformers shall be designed for floor mounting and be provided with removable bi-directional or steerable rollers.

The rollers shall be lockable or means provided to prevent movement of the transformers after Installation.

5.0 CONNECTION FACILITIES

A. CONNECTION METHODS

Connection methods shall comply with IEC 60076 Provision shall be made by the manufacturer for the mounting and connection of cable boxes and/or bus bars as specified for the HV and LV conductor connections.

Where HV and LV cable boxes and/or bus bars are specified these shall generally be arranged on opposite sides of the transformer. However exact positions shall suit the specified requirements of each individual situation.

LV cable terminations shall be kept separate from the HV cable connections and insulated to the specified voltage and able to withstand the specified short circuit currents.

All HV coil interconnections shall be insulated for the specified voltage, and able to withstand the specified short circuit currents.

An earthing terminal shall be provided at a convenient point on the supporting steel work. All steel work shall be bonded to the earthing terminal if it is not electrically continuous. Provision shall be made for making an earth connection to the neutral of the LV windings, should this be required.

B. TERMINAL MARKINGS

HV and LV winding terminals shall be clearly marked with characters in accordance with IEC 60076.
The characters shall be stamped or engraved on securely fixed, durable and non-corrodible plates.

6.0 TAP CHANGING FACILITIES

A. TAP CONNECTIONS AND LINKS

Each transformer shall be provided with tapping on the HV winding to cater for supply voltage variations in the range ±2.5%, - 5% and -7.5% in compliance with IEC 60076.

Tap changing shall be effected by off-circuit tapping links.

A visible warning notice shall be fixed adjacent to the tapping links and worded as follows:

" WARNING - OFF LOAD TAP CHANGING LINKS – ISOLATE HV AND LV SUPPLIES TO TRANSFORMER BEFORE OPERATION"

7.0 THERMAL PROTECTION

Each transformer shall be provided with a system of thermal protection and temperature monitoring.

Temperature sensing thermistors shall be mounted in each LV coil as close as practicable to its hot spot. The thermistors shall be wired back to an electronic controller fitted on the transformer.

The thermistors shall be used to indicate winding temperature, and provide alarm and trip indications, and to operate forced cooling fans and trip HV circuit breakers where specified. Volt- free contacts shall be provided for relaying signals to remote equipment.

Wiring from the thermistors to the temperature controller shall be carried out with single core copper cables to DIN/VDE standards with LEF insulation. Cables shall be contained in galvanized steel conduit supported from the transformer steel work.

8.0 RATING PLATES

Rating plates shall be fitted complying with IEC 60076

9.0 TESTING INSPECTION AND COMMISSIONING

The tests to be carried out in accordance to IEC 60076.Test report shall be provided and shall include but not necessarily be limited to :

A. Visual and Mechanical Inspection

1. Inspect physical and mechanical condition including evidence of moisture and corona.
2. Inspect anchorage, alignment, and grounding.
3. Prior to cleaning the unit, perform as-found tests, if required.
4. Verify that control and alarm settings on temperature indicators are as specified.
5. Inspect bolted electrical connections for high resistance using one of the following methods:
   - Use of low-resistance ohmmeter
   - Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method.
6. Perform specific inspections and mechanical tests as recommended by manufacturer.
7. Verify that as-left tap connections are as specified.

B. Electrical Tests

1. Perform resistance measurements through bolted connections with a low-resistance ohmmeter.
2. Perform insulation-resistance tests winding and each winding ground with test voltage. Calculate polarization index.
3. Perform turns-ratio tests at the designated tap position.
4. Perform an excitation-current test on each phase.
5. Measure the resistance of each winding at the designated position.
6. Measure core insulation-resistance at 500 volts dc if core is insulated and if the core ground strap is removable.
7. Verify correct secondary voltage phase and phase neutral after energization and prior to loading.

C. Test Values

1. Compare bolted connection resistances to values of similar connections.

2. Bolt-torque levels should be in accordance with the manufacturers recommended values.

3. Micro ohm or mV drop values shall not exceed the high levels of the normal range as indicated in the manufacturer's published data. If manufacturer's data is not available, investigate any values which deviate from similar connections by more than 50 percent of the lowest value.

4. Insulation-resistance test values at one minute should be in accordance with Table 10.5.

5. The polarization index shall be compared to previously obtained results and should not be less than 1.0.

6. Turns-ratio test results should not deviate more than one half percent from either the adjacent coils or the calculated ratio.

7. Temperature corrected winding-resistance test results should compare within one percent of previously obtained results.

8. Core insulation-resistance values should be comparable to previously obtained results but not less than one mega ohm at 500 volts dc.

D. SITE TESTS

All site tests shall be carried out in accordance with this Specification.

After delivery to site the transformer shall be inspected in the presence of the Owner's consultant, prior to installation.

After installation on properly prepared foundations the transformer shall be tested and inspected in the presence of the Owner's consultant.

The HV and LV winding connections shall be demonstrated as providing the specified polarity and phase rotation and tap connections.

The HV and LV windings shall be tested for continuity and insulation resistance using a 1000V insulation tester. The insulation resistance between adjacent windings shall not be less than 100 M ohm.

After the HV windings are energized, it shall be demonstrated that the voltage and phase rotation at the LV terminals are as specified.

10.0 PARTICULAR REQUIREMENT – ACCESS

The specified transformer is located as indicated on the drawings.

This places restrictions on the transformers' physical dimensions in case it is necessary to remove/replace a transformer once the installation is handed over and in use.

The Contractor shall demonstrate to the Owner's consultant that the manufacturer's transformer type selected could be removed/replaced (without incurring builders work) with access through the proposed location.

If required by the Owner's consultant, detailed dimensioned drawings proving removal/replacement is practical shall be provided.

11.0 SUMMARIZED TECHNICAL REQUIREMENTS

HV Supply System	11000V	
. Number of phases	3 phase	
. System neutral	not applicable	
. Fault level (nominal design)	350 MVA	
LV Supply System	400V	
. No-load voltage	3 phase	
. Number of phases	4 wire	
. Rating	1000 kVA	
Parallel / Synchronized Operation	No	
Supply Frequency (HZ)	50 HZ	
HV winding connection	Delta	
LV winding connection	Star	
Vector group reference	Dyn 11	
Impedance at 75° C	6%	
HV Tapping (% of no-loads volts)	± 2.5%, ± 5% and - 7.5%	
Method of cooling	ONAN	
Secondary voltage at:		
. Full load	400 V	
. No load	415 V	
Rated Voltage	11000 V	400/230V
HV Insulation Level	12 kV	1.1 kV
. Impulse kV Peak	95 BIL	-
. Power Frequency (kV RMS)	28 kV	3 kV
Paint finish color	Manufacturer Standard	
HV conductor and type	Top entry - Cables	
LV conductor and type	Top entry - Cables	
Indoor or outdoor	Indoor – refer to layout	
Installation/space limitations	drawing	
Coil material (HV)	Copper	
Coil material (LV)	Copper	

.- END OF SECTION -

SECTION V-04

MEDIUM VOLTAGE SWITCHGEAR

SECTION 26 13 00_ MEDIUM VOLTAGE SWITCHGEAR

PART 1 - GENERAL

1.1 WORK INCLUDED

A. This section supplements the main contract conditions and forms part of every section of Division 26 Electrical trade and shall be read in conjunction with all sections of the specification.

B. Provide all labour, materials, products, equipment and services to supply and install the main MV switchboard system as indicated on the drawings and specified in these specifications.

C. From here on in, the refence 'medium voltage' or 'MV' shall mean a voltage of 11,000 volts / 11kV.

1.2 REFERENCE STANDARDS

A. In addition to the requirements indicated on the Design Drawings and the MEPF Scope of Works, the Work shall be in accordance with the following standards, codes and relevant statutory requirements.

1. American Society for Testing and Materials, ASTM International Standards.
2. British Standards Institution (BSI) Group, including but not limited to,
   a. BS 7671 (IET Wiring Regulations).
3. International Electrotechnical Commission IEC.

IEC 62271-1	High-voltage switchgear and control gear Part 1: Common specifications
IEC 62271-200	High-voltage switchgear and control gear Part 200: AC metal-enclosed switchgear and control gear for rated voltages above 1 kV and up to and including 52 kV
IEC 62271-100	High-voltage switchgear and control gear Part 100: Alternating-current circuit-breakers
IEC 62271-102	High-voltage switchgear and control gear Part 102: Alternating current disconnectors and earthing switches
IEC 62271-105	High-voltage switchgear and control gear Part 105: Alternating current switch-fuse combinations for rated voltages above 1 kV up to and including 52 kV
IEC 61243-5	Voltage detecting systems (VDS)
IEC 60282-1	HV HRC fuses – Part 1: current limiting fuses
IEC 60099	Surge arresters
IEC 60529	Degrees of protection (IP code)

IEC 62262	Degrees of protection (IK code)
IEC 60071	Insulation co-ordination – Part 1: Definitions, principles and rules
IEC 61869-1	Instrument transformers Part 1: General requirements
IEC 61869-2	Instrument transformers – Part 2: Additional requirements for current transformers
IEC 61869-3	Instrument transformers – Part 3: Additional requirements for inductive voltage transformers
IEC 61936-1	Power installations exceeding 1 kV AC. Part 1: Common rules
IEC 60376	Specification of technical grade sulfur hexafluoride (SF6) for use in electrical equipment

4. Direct acting indicating analogue electrical IEC 60051 measuring instruments and their Accessories

a. Definitions and general requirements Part 1
b. Special requirements for Ammeters & Voltmeters Part 2
c. Special requirements for Watt meters & VAR meters Part 3
d. Special requirements for frequency meters Part 4
e. Special requirements for phase meters, Part 5 power factor meters & synchro scope
f. Special requirements for accessories Part 8
g. Recommended test methods Part 9
h. High-voltage alternating current IEC 62271-100 circuit breakers
i. Standard current ratings IEC 60059
j. Alternating current disconnectors IEC 60129 and earthing switches
k. Instrument transformers 60044
l. Current transformers Part 1
m. Inductive voltage transformers Part 2
n. Combined transformers Part 3
o. Requirement for protective current Part 6 transformers for transient performance
p. Voltage transformers IEC 60044-2
q. High-voltage switches for rated voltages IEC 60265 above 1 kV and less than 52 kV
r. High-voltage fuses IEC 60282
s. Current limiting fuses Part 1
t. Expulsion fuses Part 2
u. Determination of S.C. power factor for Part 3 testing current limiting or expulsion type fuses
v. A.C. metal-enclosed switchgear and IEC 62271-200 control gear for rated voltages above 1kV and up to and including 52 kV
w. High-voltage alternating current IEC 60420 fuse-switch combinations
x. Identification of insulated and bare IEC 60446 conductors by colours or numericals
y. High voltage alternating current contactors IEC 60470
z. Class 0.5, 1 and 2 alternating-current I EC 60521 watt-hour meters

aa. Classification of degrees of protection IEC 60529 provided by enclosures

bb. Graphical symbols for diagrams IEC 60617

B. When different standards, namely BS or VDE, are specified on the data sheets and/or accompanying documents, then MV switchboards shall conform to the latest edition of the specified standards or alternative in IEC.

C. Further to the international standards, MV Switchgear shall also conform to the local standards and / or regulations published by the authority having jurisdiction, when these are higher, more stringent or of a special nature.

D. General design, material, manufacturing techniques, testing and packing used shall generally conform to relevant documents in the latest Regulations published by the local authority having jurisdiction in relation to technical Specifications for electrical works.

1.3 REFERENCE STANDARDS – LOCAL AUTHOIRTIES WITH JURSIDICTION

A. In addition to the requirements indicated on the Design Drawings, or specified in Division 01 General Requirements, the Particular Specifications and the MEPF Scope of Works, the Work shall be in accordance with the relevant statutory authority requirements published by the local authorities having jurisdiction.

- Karachi Electricity Supply Company (KARACHI ELECTRIC)
- Pakistan Electricity Rules 1937
- Building Energy Code of Pakistan
- Building Code of Pakistan- Fire Safety Provisions
- Any other local authority Guideline applicable for this project

1.4 DESCRIPTION OF WORK

A. The work detailed herein covers the items of works listed below. The Contractor's attention is drawn, however, to the fact that although these items are required to be priced in the appropriate Bill of Quantities section as an integral part of the Scope of Works

1. The MV Distribution: Supply and install all MV Switchgear complete with all metering and instruments as detailed.

2. Supply all cables and connect between all MV distribution switchgear and between Main MV Switchgear, transformers & generators making connections to MV Switchgear described above and on drawings.

3. The Contractor shall pay all applicable connection charges imposed by the authority having Jurisdiction

4. Facilitating main MV cable incomer from KARACHI ELECTRIC to MV metering panel by providing sleeve on the retaining wall, cable ladder arrangement etc.

5. Main MV incoming cable from KARACHI ELECTRIC substation until MV metering panel including termination will be done by KARACHI ELECTRIC approved contractor.

1.5 COORDINATION

A. Coordinate the main low voltage switch boards with the following:

1. Busbar manufacturer for flange connections onto the switchboard

2. Construction of switch board enclosure to ensure switchgear fits in the space provided.

3. Division 23 – Mechanical trade for supplies to plant and equipment.

4. Generator manufacturer/supplier for start/stop of the engine/alternator and changeover of supplies to back-up power

5. Power factor correction equipment vendor

6. BMS vendor for status monitoring of all main breakers

7. Local supply authority for provision of incoming power

1.6 QUALITY ASSURANCE

A. Acceptable Manufacturers

1. Acceptable manufacturers are to be firms regularly engaged in manufacture of all materials specified in this section of types and sizes required, whose products have been in satisfactory use under similar service conditions for not less than ten years. The manufacturer shall have Quality System in compliance with ISO 9001-2000. Certificate of compliance issued by an independent agency shall be submitted.

2. Manufacturer and product must be approved by the authority having jurisdiction. The MV switchgear shall be designed manufactured tested and installed in accordance with the latest editions and amendments of regulations and requirements published by the authority having jurisdiction. In case of conflict between the specification and authority requirements, the latter shall take precedence.

B. Manufacturers must demonstrate that they can provide the following back-up service

1. The manufacturer/supplier must have a 24 hour emergency service, with competent staff to work on the supplied equipment that can respond and be on site within 1 hour of a trouble call.

2. The manufacturer/supplier must be able to enter into a 24 hour, 7 days a week, long term service and maintenance agreement with the Employer.

3. The manufacturer and/or his agent shall provide evidence of availability of spare parts in his local stock for proper operation and maintenance of the medium voltage system

1.7 CODES AND STANDARDS

1.8 SUBMITTALS

A. Manufacturers Technical Data

1. During the time of the contract and before substantial completion of the electrical installation, submit to the Engineer three (3) copies of descriptive literature, technical data, maintenance recommendations (from the equipment manufacturer), catalogues, etc

B. Test Reports

1. Provide test reports prepared in accordance with requirements of the authority having jurisdiction to the Engineer. Provide other tests reports necessary to establish the adequacy, quality, safety, completed status, and suitable operation of each system.

C. Installation Instructions

1. Submit the complete manufacturers installation instructions of all the products used

D. Calculations

1. Forward the following calculations and data:
   a. Calculations and charts proving that discrimination in the breaker characteristics are achieved.

   b. Detailed short circuit level calculation to select the short circuit rating of the various switchgears.

   c. Bus bar sizing calculation for each switchgear or provide short circuit withstand current type test report.

   d. Calculation for temperature rise inside switchgears or provide temperature rise test report.

   e. Load analysis report for each substation and logic design for monitoring and control through PLC (if applicable)

E. Shop drawings

1. The Contractor shall furnish the following drawings and documents along this submittal for Approval

   a. Dimensioned drawing showing outline of the switchgears 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 switchgear.
   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

F. Test data to be submitted

G. All technical schedules shall be duly filled-in and signed. Following details shall be submitted:

1. General arrangement of the switchgear showing all dimensions

2. Details of circuit breakers

3. Details of relays

4. Single line diagram of the switchgear

5. Details of current transformer and voltage transformer

6. Catalogues for all major components of the switchgear

7. Interlocking diagram

8. Detailed technical specification

9. Civil layout plan indicating power cable and control cable entry

10. Minimum clearances around the assemblies for ventilation and safety

H. Accessories

1. All accessories required for the operation and maintenance of the switchgear shall be supplied.

1.9 FACTORY TESTING

A. Refer to Section 26 00 00

B. Notify the Engineer 4 weeks in advance of final factory tests of the MV Switchgear The Employer and the Engineer shall be entitled to witness all or any of the factory tests. Contractor to bear all costs for testing, traveling, boarding/lodging for four representatives witnessing the tests.

C. Submit copies of certified test results.

PUBLIC PROCUREMENT REGULATORY AUTHORITY (PPRA) EPADS

PART 2 – PRODUCTS

2.1 GENERAL

A. MV switchboard shall be certified for the category of duty specified. In particular, the busbar system shall be type-tested and certified by a recognized international testing authority for its performance during the anticipated short circuit condition.

B. The manufacturer of the switchgear assembly shall supply the documentation of the latest status of the type test documentation summary including the cover sheets as part of the project specific gas air-insulated medium voltage switchgear Type Test Certificates in accordance with sub-clause 6 of IEC 62271-200 as listed:

1. sub-clause 6.2: Dielectric tests
2. sub-clause 6.5: Temperature-rise tests
3. sub-clause 6.4: Measurement of the resistance of circuits
4. sub-clause 6.6: Short-time withstand current and peak withstand current tests
5. sub-clause 6.101: Verification of making and breaking capacities
6. sub-clause 6.102: Mechanical operation tests
7. sub-clause 6.7: Verification of the degree of protection (IP coding)
8. sub-clause 6.103: Pressure withstand test of gas-filled compartments
9. sub-clause 6.8: Tightness tests
10. sub-clause 6.106: Internal arcing tests for classification IAC
11. sub-clause 6.9: Electromagnetic compatibility tests (EMC)

C. The electrical components to be used in the construction and assembly shall be identical to those used in the type tests. The type of devices and method statement of testing shall be clearly stated

2.2 GENERAL DESIGN AND CONSTRUCTION REQUIREMENTS

A. General

1. The design of the electrical system and equipment shall ensure that all operating and maintenance activities can be performed safely and conveniently. Even under extreme conditions of major short circuit or mal operation there shall be no danger to persons in the vicinity of the assembly.

2. The breaker shall be of VCB incomer and outgoing VCB with the facility to replace the vacuum interrupter. All 11kV live parts shall be covered with an epoxy resin insulation layer. The switchgear panel shall be equipped with current transformers, voltage transformers, low voltage compartment with measuring, control & communication compatible protection equipment's of numerical type relay. The switchgear shall have a uniform panel design with only one panel width up to 750mm for up to 1000A/1250A feeders and one panel depth for all cable feeders regardless of the rated current.

B. Expected service life of the vaccum switchgear shall be at least 30 years and above

C. Ratings

1. The normal continuous rating of the complete switchgear in site conditions of Karachi (40 degrees ambient temperature) shall be as specified. The switchgear shall have following ratings:

   a. Rated voltage: 12kV
   b. Service voltage: 11kV
   c. Rated frequency: 50Hz

d. Rated short time current: 20kA for 3 sec.
e. Power frequency withstand voltage: 28kV
f. Impulse withstand voltage: 75kV

2. Switchboards shall be rated on the basis of voltage, current, frequency and the symmetrical breaking capacity of incorporated MV automatic switching devices as defined in appropriate IEC publication 62271-100 or as specified on drawings.

3. For standard voltages, frequencies and currents reference is made to IEC 60038, 60196 and 60059 respectively. Medium voltage, current-carrying components, shall furthermore be capable of carrying their rated current continuously at rated voltage and under specified service conditions without exceeding the permissible temperature limits when mounted in the completely assembled switchboards. Selected standard ratings for switchboards are those listed in IEC publication 62271-100.

4. The switchgear must conform to the classifications according to IEC 62271-200.

Partition class:	PM (metallic partition)
Loss of service continuity category:	LSC2B (metallic partition, i.e. partitioned into separate busbar, switching-device and connection compartments)
Internal arc classification:	IAC A FLR 20 kA 3s

Class and number of operating cycles

M2	10000 times mechanically without maintenance
E2	10000 times rated normal current without maintenance
C2	very low probability of restrikes

D. System Variation

1. All equipment and components of the MV boards shall be capable of continuous operation at their full current and voltage ratings and without detriment or malfunction at system continuous deviation of up to and including the following percentages of the normal values

a. Voltage ± 10%
b. Frequency ± 5%
c. Absolute total voltage and frequency variations 10%

E. Performance Requirements

All components shall be capable of withstanding the dynamic, thermal and dielectric stresses resulting from the test duties specified in IEC publication 62271-100

F. Temperature Rise

1. The temperature rise of the MV distribution and motor control centre shall not exceed temperatures indicated in IEC 62271-100.

G. Construction Requirements

1. Internal Arrangement

a. The switchboard shall be comprised of a busbar system and consist of one or more sections, each having one incoming feeder panel placed as indicated on the data sheets or single line diagrams of the electrical load. Each section shall be equipped with a busbar connected voltage transformer for metering supply, preferably to be mounted in the incoming feeder panel or in a separate measuring panel.

b. The entire switchgear is to be designed safe-to-operate. The switchgear is to be conceived in such a way that it shall be extendable on both sides or panel replacement throughout the entire service life of the switchgear. The individual panels shall be interconnected by bolted sections and securely insulated.

c. The medium voltage part of the switchgear must be maintenance-free and independent of environmental influences. The vacuum circuit-breaker as well as the switch-disconnector or disconnector designed as three-position switch for "CLOSE" - "OPEN" - "READY-TO-EARTH / EARTHING" must be maintenance-free with reference to contact elements including operating mechanism based on an indoor environment to IEC 62271-1.

d. Capacitive voltage taps (capacitive voltage dividers) in the bushings to the cable feeder shall enable the verification of safe isolation from supply without danger at the panel front.

e. In case the total load for metering and control exceeds the standard rating, a second busbar connected voltage transformer shall be provided for supply control only. Battery shall be provided for DC loads. The current rating of the incoming feeders and the busbars shall in general be of equal value for each part of a combined panel or as indicated on drawings.

f. All incoming switches and bus couplers shall be equipped with facilities for padlocking both in the "in" and in the "out" position. The layout of the operational front and the location of the components of the assembly shall be arranged in a logical and systematic sequence and standardized throughout. Alphanumeric notation, generally in accordance with IEC 60445, shall be used for identification and marking of phases, conductors and terminals.

g. The system of construction for the MV distribution shall be a factory built assembly of a standard, well tested design of withdrawable as specified in equipment schedules. Interchangeable standardized components shall be used where feasible. It is preferred that spare compartments can be equipped to the maximum rating of the unit.

h. In the Main MV Switchgear, all incomers, bus couplers and outgoing feeders shall be operated through three positions i.e. In-Out-Test. In all three positions, limit switches and indications shall be available for each position.

2. Housing / Enclosure

a. The MV main and distribution switchgear shall be of the floor mounting cubicle type, metal enclosed with sufficient mechanical strength and be equipped with lifting facilities (eyebolts). The materials of construction shall be properly prepared and treated against rust or corrosion. The switchgear and control gear shall be self-supporting and suitable only for front entry and operation. In case of cable cellar, adequate bottom plates shall be provided which at least prevent access by rodents.

b. All switchgear panels to be designed with following functional assemblies:

1) Busbar compartment with insulation and plug-in/bolted busbar
2) Switchgear with vacuum circuit-breakers and three-position switches
3) Cable compartment with pressure-resistant floor cover
4) Rear pressure relief duct upwards with integrated absorbers (if applicable)
5) Low voltage compartment
6) Panel enclosure

c. The degree of protection shall be in accordance with IEC publication 60529 and shall be minimum as follows

1) Degree of protection for switchgear enclosure: IP 42

d. Any further IP requirements allowable as per IEC or equivalent standards shall be specified on the data sheets.

e. All components requiring periodical maintenance shall be easily accessible

3. Interchangeability

a. Electrically identical components shall be of one type and make

4. Anti-Condensation Precautions

a. Effective precautions shall be taken to prevent the formation of harmful condensation inside the enclosure, under both operating or non-operating conditions and service conditions. 250V - 1 phase space heaters shall be provided. The space heaters shall be controlled by a thermostatic switch and shall be wired to outgoing terminals. The heating device shall be of sufficient capacity to raise the internal temperature by 5oC above the ambient temperature. The heater shall be covered safely to avoid accidental contacts and heater terminals shall be adequately shrouded

5. Arcing Faults

a. Measures shall be taken to prevent the occurrence of internal arcing faults in accordance with the IEC requirements. The design and construction of the MV distribution shall be such as to provide the highest possible degree of personnel protection against radiation, overpressure and hot gases

b. The switchgear has to be resistant to internal arcs according to IEC 62271-200 for short-circuit currents up to a maximum of 25 kA, 1 s. The resistance to internal arc faults to protect the operating personnel has to be proven for all accessible sides of the switchgear according IEC 62271-200. The IAC-classification shall be IAC A FLR. Ducts, required if any

6. Insulation

a. A Solid-Air-Solid insulation system where failure of one solid layer does not lead to voltage breakdown shall be preferred

7. Busbar Systems

a. Busbars shall be of Imported tinned 99.9% pure copper high conductivity electrolytic copper with joints by means of noncorrosive high tensile steel bolts, nuts and washers, and secured against loosening. Insulated busbars are

preferred. Busbars shall be suitable for extension to the left or to the right as required. Busbars shall be accessible for maintenance purposes, etc.

b. The busbars can be accessed by removing steel sheets. Thus, the busbar compartment is a "tool-based" accessible compartment according to IEC 62271-200

8. Compartments and Partitions etc

a. Adequate compartments and partitions shall be provided to allow easy maintenance operation, e.g. fuse replacement, etc. Main circuit compartments shall always have individual overpressure reliefs.

b. The entire medium voltage switchgear has to be designed safe-to-operate

2.3 MV SWITCHING DEVICES

A. General

1. MV switching devices shall be of withdrawable for the main MV Switchgear as specified on drawings, tested and certified by an official authority to meet the requirements of the national / local regulations.

B. Type

1. Switching devices shall be maintenance-free Vacuum circuit breakers as indicated on drawings or in the equipment schedule.

2. The circuit-breakers must be designed for 10,000 mechanical operating cycles at rated normal current. Electrical endurance of vacuum circuit-breakers shall be 50 breaking operations at rated short-circuit breaking current

C. Mechanical interlocks shall be provided on all boards to prevent connecting or disconnecting the circuit breaker while closed and to prevent the closing of the circuit breaker unless the separable contact is in full contact or separated by a safe distance. The type of switching device and its operating mechanism shall be selected in accordance with its duty and the number of load operations.

The following standard interlocks must be implemented within the switchgear:

1. Three-position disconnector against circuit-breaker (mechanically)
2. Three-position disconnector against three-position earthing switch (mechanically)
3. Locking device at the circuit-breaker
4. Locking device at the three-position switch
5. Interlock between three-position switch and vacuum contactor (electrically)
6. Release of circuit-breaker locking device only with "feeder earthed"
7. Blocking of undervoltage release at the circuit-breaker

The following interlocking conditions according to IEC 62271-200 must be fulfilled

- Feeder earthing switch can only be operated with VCB in OPEN position
- VCB can only be racked on the movable part with the associated switching device in OPEN position and with feeder earthing switch OPEN
- VCB can only be operated in interlocked disconnected or service position
- VCB can only be closed in interlocked service position with the low-voltage connector plugged in. Beyond the specifications of the standards:
- Withdrawable part can only be racked-in or racked-out with closed medium-voltage door

- Coding prevents insertion of VCB with a lower rated normal current into panels with a higher rated normal current

The safety of operating personnel must be guaranteed by the above-mentioned interlocks and operations. The circuit-breaker and make-proof earthing switch must be type-tested in the panel according to IEC 62271-200

D. The following switching devices shall be provided as a minimum:

1. ON-OFF indicators
2. Motorized spring charging
3. Anti-pumping
4. Emergency 'OFF' pushbutton
5. Closing / trip coil suitable for control voltage
6. Blocking for manual switch 'ON' facility
7. Breaker carriage earthing
8. Earth switch interlock
9. Padlock arrangement

E. Control Mechanism

1. Rated voltages for closing, tripping, control and auxiliary circuits shall be selected from IEC 62271-100. Control mechanism of switching devices may be of the following types:

   a. Electromagnetically operated with DC control supply.
   b. Spring-operated hand charged in case of local control only.
   c. Spring-operated power charged

2. All switching devices shall open automatically, be trip-free and have their energy for the opening operation stored prior to the completion of the closing operation. Furthermore, they shall be provided with a local manual-operated tripping feature protected against inadvertent tripping. Power charged spring-operated mechanism shall not require more than 10 seconds for spring charging. Power charged spring-operated mechanism of remote-controlled switching devices shall be charged when the switching device is in its normal service position. Switching devices for motor panels shall be protected against "pumping". All electrical charging and electromagnetic mechanisms as well as the closing control components shall be capable of operating when the auxiliary or control supply is between 85% and 105% of its rated value. Each switching device shall be provided with visual mechanical indicators, one marking the closed position with "I" and/or a red flag and the open position with "O" and/or a green flag, and in case of a stored energy closing mechanism one marking whether the operating mechanism is charged or discharged. These indicating devices shall be directly driven by the switching mechanism. The switchboard vendor shall ensure that all required information is available to him before preparation of his detailed logic / control scheme drawings.

F. Disconnectors

1. Disconnectors (isolators) are not permitted, even with safety interlocks, except when used for the separation of fixed and moving parts.

G. Earthing Devices

1. In combination with the circuit-breaker, the three-position disconnector is used for make-proof feeder earthing. The operating mechanism of the three-position disconnector shall be operated manually. It has to be possible to provide motor control keeping the mechanical interlock here, too. The operating mechanism shall be maintenance-free for life

2. Three-phase earthing facilities at the cable sides and for the busbar system of each section are required. For this purpose portable or integrally mounted three-phase earthing switching devices shall be provided for each type of MV switching device. These devices shall be capable of making and carrying the prospective short-circuit current at the point of earthing. The earthing devices shall be suitable for local, manual operation only. If portable earthing devices are provided, a minimum of two of each type is required. Depending on the design, padlock facilities for locking in the open and closed position shall be provided.

3. Earth switches shall be provided with mechanical interlock with the respective breakers in such a way that it should not be possible to close the earth switch when the breaker is in closed position.

4. When earthing devices are to be applied in a compartment it shall not be possible:

   a. To insert a portable earthing device in the closed position.
   b. To close a fixed-type switching device in the compartment concerned.
   c. Generally, circuits shall not be earthed automatically, i.e. when withdrawing the switching device the earthing device has to be inserted deliberately.
   d. Clear instructions, preferably pictorial, shall be submitted showing the proper methods of how and where to fit the earthing devices

H. Current Chopping

1. Switching devices shall not cause switching surge voltages which exceed the insulation level of the connected equipment. Vacuum switching devices shall be equipped with ZnO overvoltage protection devices.

I. Auxiliary Contacts

1. Each switching device shall be provided with at least 2 make and 2 break auxiliary contacts directly driven by the switching mechanism. These contacts shall be completely wired up to terminal blocks in the secondary terminal compartment

2. The rated making and thermal-breaking capacities of these contacts shall be

Making capacities	**Thermal-breaking capacities**
> 16A at 500V AC and power factor 0.3	> 1A at 500V AC and power factor 0.3
> 1.7A at 110V DC inductive	> 1A at 110V DC inductive
> 4A at < 60V DC inductive	> 2A at < 60V DC inductive

2.4 TERMINALS

A. General

1. Each panel shall be provided with appropriate facilities for the independent terminals to connect the MV main cable and the LV auxiliary cables. The terminal compartments for MV and LV connections shall be effectively segregated in accordance with IEC 60298. The terminals shall be so arranged that all connections can be made safely, even when the assembly is energized. Suitable terminating facilities of adequate dimensions and thermal rating shall be provided for each conductor. Inside the compartments separate terminals or bolts, one for each cable, are required for earthing purposes. Efficient means to prevent strain on the actual conductors and cable connection shall be provided

B. Terminals for MV Cables

1. Three-core cables

   a. Cable termination shall be suitable for the specified cable.
   b. For PVC or XLPE type cables dry type cable termination is required. When two or more cables are required, a suitable marshalling box may be required to obtain uncluttered straight terminal connections.

   c. To maintain the totally insulated design concept of the Switchgear, only fully insulated plug-in type terminations with direct solid dielectric-to-gas insulation shall be used

2. Single-core cables:

   a. The terminal box and its cable entries on a relevant panel shall be suitable for the specified cable. Single conductor entries shall be mounted in non-magnetic plates. The end sleeves or glands shall also be of non-magnetic material

C. Terminations for Auxiliary LV Cables

1. Terminal blocks fitted with tubular type contacts with non-loosening screws shall be provided for termination of auxiliary LV cables including that required for wiring between cubicles or panel sections. Crimped termination is required to terminal blocks to ensure sound contact. Clamping terminals are not allowed. Within the panel compartments suitable clamping devices shall be provided for securing of the cables. Terminals in current measuring circuits shall be special purpose with suitable bridging links and measuring facilities.

2. Specified auxiliary contacts for remote circuits shall be wired and connected to an accessible terminal block in the vicinity of the cable entries. Termination compartments for auxiliary and control cables shall have adequate dimensions, with ample accommodation for the required number of terminals.

D. Two or more conductor terminations on one terminal are not acceptable unless the terminals are designed for more than one conductor. Metal cable glands suitable for the cables specified shall be included in the supply of the assembly.

2.5 ISOLATING FACILITIES

A. Isolation of Main Circuits

1. Switch panels shall be provided with safe means of isolating the circuit side from the busbar side.

B. Interlocks (applicable for withdrawable switchgear)

1. Interlocks in accordance with IEC 62271-200 shall be provided to prevent unsafe operation of the switchboard and shall comprise at least the following features:

2. They shall permit operating the switching device only when:

   a. The isolating device is in fully operating position.

   b. The switching device is in a specifically provided test position with the isolating device in the closed position and the control and auxiliary circuits operative but with panel control facilities only.

c. They shall mechanically interlock the isolating device in its closed position when the switching device is closed.

3. Alternatively, they shall cause tripping of the switching device upon attempted operation of the isolating device.

C. Safety Shutter Devices (applicable for withdrawable switchgear)

1. The panel shall be fitted with a set of shutters to cover each 3-phase group of stationary isolating contacts, i.e. both on the busbar and on the circuit side. The shutters shall open or close automatically by a mechanical drive from the switching device when the latter is being racked in or out. Each set of shutters shall be equipped with padlocking facilities in its closed position. When padlocked, the shutters shall prevent access to the stationary isolating contacts.

D. Shutters on the busbar side shall be painted red and shall be clearly labeled "BUSBARS" in large white letters. Shutters on the circuit side shall be painted yellow and shall not be lettered.

E. Isolating Contacts for Secondary Circuits

1. The connection in the secondary circuits between the fixed and the moving parts of panels shall be by means of self-aligning contact. These connections shall be maintained when the moving portion of the equipment is in the test position

2.6 PROTECTIVE DEVICES

A. Fuses

1. Application requires correct correlation with other protective devices in the assembly. The fuse rating of circuit protection device shall be readily visible without the need to move a covering. Fused switch circuit protection devices shall be heavy duty type. Door shall be interlocked with handle and have pad-locking provision in OFF position

B. MV circuits

1. For metering / control circuits High-rupturing-capacity, short-circuit current-limiting fuses, shall be used exclusively and be in accordance with IEC 60282-1. Application of two or more parallel fuses per phase shall be subject to approval by the Engineer

C. LV circuits

1. Miniature circuit breakers shall be used for control, measuring and auxiliary circuits

D. Breakers with Relays

1. General Requirements

a. Selection of relays shall be in accordance with the relevant circuit requirements.

b. All protection relays shall be of numerical type and from a manufacture approved by the authority having jurisdiction. Means shall be provided for secondary injection testing of relays without disconnecting wiring. Protective relays shall have hand-reset facilities and operational signals such as light-emitting diodes.

c. Non-tripping relays have only hand-reset facilities. Special precautions shall be taken in order that relays will not actuate accidentally owing to vibrations or shocks, e.g. by opening or closing of doors and switching devices. Preference shall be given to dustproof flush-mounted relays of the removable type, provided with calibrating and testing facilities. Current-carrying terminals of the relays shall be automatically short circuited at withdrawal of the relays.

d. MV motor protection shall be through comprehensive motor protection relay with provision for protection against negative phase sequence, earth fault, overload, stalling, RTD protection for alarms and trip to be incorporated

2. Over-current and Earth-fault Relays

a. Over-current and earth-fault relays, not being motor protective relays, shall have a rated current of 1A and shall be of the induction-pattern, inverse time-lag, and definite minimum time type with the following characteristics

1) Over-current elements shall have nominal current settings continuous variable from 50% to 200% of rated current;

2) The earth-fault elements shall have nominal current settings variable from 10% to 40%;

3) For both over-current and earth fault elements the setting of the characteristics shall be variable.

b. All relay elements shall have hand reset and a mechanical flag indicator or digital display.

3. Under-voltage Relays

a. Where motor panels are incorporated, each busbar section shall be provided with an instantaneous under-voltage relay. The drop-out value shall be adjustable between 50% and 65% and the pickup value shall always be less than 85%. The under-voltage relay activates a time-delayed tripping relay for each motor. This tripping relay shall be self-resetting and be equipped with one set of normally open position and be adjustable from 1 to 5 seconds.

4. Motor Protection Relays

a. Each relay combination shall be equipped with two auxiliary relays with light-emitting diodes indicators, i.e. one hand-resetting relay, indicating instantaneous tripping on short-circuits or earth faults, and one hand-resetting relay, indicating delayed tripping on overloads or single phasing.

b. Numerical types of relays are preferred with the following features

1) Compact design and modular construction.
2) Comprehensive self, monitoring and self-diagnostic.
3) Thermal overload protection.
4) Thermal pre-alarm.
5) Start authorization by detection of thermal state.

6) Under current protection.
7) Voltage protection.
8) Negative phase sequence protection.
9) Earth fault protection.
10) Locked rotor protection.
11) Starting time supervision.
12) Protection against successive starts.
13) Serial communication interface for on-line and off-line transmission of relay operation data, parameter setting, sequential events, fault recording, remote setting, etc.
14) Facility to hook up a remote PC for the data analysis.
15) Each relay shall be equipped with auxiliary relay, having indicators and hand reset button.

5. Earth-fault Relays

a. For earth-fault protection of motors a single-element, hand-reset, flag-indicating or digital displayed, instantaneous earth-fault relay shall be provided. This relay shall have a nominal current of 1A and current settings variable from 10% to 40%.

6. Differential Relays

a. Differential protection shall be provided for large motors, transformers etc. where specified in data sheets or drawings. Transformers with rating above 2MVA shall have differential protection.

7. Restarting Relays

a. These relays shall be of the plug-in type.
b. Restarting relay (RR)
c. This relay shall have the following characteristics:

1) Voltage-dip detection level: 65% Un
2) Voltage-restoration detection level: 89% Un
3) Memory: 4.5s
4) Immediate restart after voltage dips: < 0.2s
5) Delayed restart, adjustable between 0.1s and 30s, after voltage dips between 0.2s and 4s inclusive.

8. Timing Relay (TMR)

a. This relay shall be of the slow-operating type, adjustable from 0.1s to 30s. Elements with multiple functions such as tripping, and alarm duties shall have separate operating contacts for each function and be brought out to separate terminals

9. Metering

a. All voltage and current transformers shall be cast resin type

10. Voltage Transformers

a. Voltage transformers shall be in accordance with IEC 60044-2.

11. Rating and type

a. Rated primary voltage depends on system data, which will be stated on the data sheets. The preferred secondary voltage of measuring and protection transformers shall be 110V. Rated output capacity of the transformers shall be matched to cover the burden required by the equipment connected, and preferably be selected from the range of standard values.

12. Class of accuracy

a. Generally, measuring voltage transformers are Class 1 and this will be stated on the data sheets.

b. Protective voltage transformers shall be of Class 3P.

c. The winding connection is depending on the metering and protection system connection.

E. Protection

1. At MV side:

a. Depending on manufacturer's practice and, whenever necessary, high-rupturing capacity, short-circuit current-limiting fuses shall be in accordance with IEC 60282-1; Fuses, if installed, shall be readily accessible and suitable precautions shall be taken to enable safe removal and replacement of fuses

2. At LV side:

a. Miniature circuit breakers will be used.

b. All breakers shall be capable of handling the inrush currents for all service conditions, without abnormal ageing or deterioration.

c. Voltage transformers for automatic voltage regulators shall have no fuses at all but shall be connected within the protective zone of the differential protection of the generator.

F. Location

1. Depending on the requirements, the following general rules may serve as a guide to establishing the correct location of voltage transformers on the assembly.

a. For voltage detection, etc. a measuring transformer shall be connected to the bus bar of each section.

b. In addition, however, measuring voltage transformers for incoming units, e.g. generator and main intake feeders, shall be connected on the supply side.

c. For the control supply of the switching devices of a section, preference is given to a voltage transformer connected to the busbar side of the section concerned.

2. Current Transformers

a. Current transformers shall be in accordance with IEC 60044-1.

3. Rating and type

a. Rated output capacity of the transformers shall be matched to cover the burden required by the equipment connected, and preferably be selected from the range of standard values.

b. Rated primary current shall preferably be selected from the range of standard values. Where required, the current ratio will be stated on the data sheets.

c. Rated secondary current shall be either 5A or 1A; for remote metering only 1A is acceptable.

d. Short-time thermal current rating of the transformers shall be 1s.

e. When the electrical system value requires a time duration of 3s, the current transformers shall be rated accordingly.

4. Class of accuracy

a. Generally, measuring current transformers shall be Class 1 and this will be stated on the data sheets.

b. The over current factor "n" shall be less than 5 in order to prevent damage of instruments at maximum fault current.

c. Protective current transformers are to be Class 5 P; however, Class 10 P is acceptable

d. The over current factor shall be greater than 10 in order to ensure the proper working of the protective devices and shall be indicated as follows: Class 5 P 10 or 10 P 10.

5. Terminals and connections

a. Secondary terminals of current transformers shall be wired up to a terminal block with short-circuiting links, located at an accessible place. One side of the secondary winding of each current transformer shall be connected at this terminal block to the earth bar.

6. Ammeters

a. Ammeters shall be flush-mounted, square type (96 x 96 mm). They shall have an element rated at 1 or 5 amperes.

b. Ammeters in the motor circuit shall have an overload scale of 5 x In.

7. Voltmeters

a. Voltmeters shall be flush-mounted, square type (96 x 96 mm).

b. They shall have the following full-scale readings:

c. For MV: 0 - 15,000V

8. Watt-hour Meters

a. Watt-hour meters shall have cyclometric registers. Watt-hour meters for motors may be of the single-element, balanced-load type.

9. kW Meters

a. kW meters shall be flush-mounted, square type and approved by the authority having jurisdiction.

10. Power Factor Meters

a. Power factor meters measure in the number of phases as indicated on the data sheets. Power factor meters shall have a scale 0,5-1-0,5.

11. Counters

a. Each switching device shall be provided with an operation counter.

G. Accuracy

1. Ammeters and voltmeters shall be of Class 1.5 and watt-hour meters shall be of Class 2.5 as specified in IEC publication 51 and 521. Power factor meters shall be class 1.5.

H. Auxiliary Circuits

1. Auxiliary circuits shall be clearly grouped and be adequately protected. All current wires shall be at least 2.5 mm^2 others 1.5 mm^2 of the PVC type and be able to withstand 2500V impulse test. All wires shall be connected to terminals individually and clearly identified at both ends by ferrules of isolating material or plastic code markers in accordance with the wiring diagram(s).

2. Connections shall be of non-loosening type.

3. Colour coding of secondary wiring shall be in accordance with IEC 60446. Wiring between two terminals shall be continuous; joints or interconnections are not allowed.

4. To accommodate and support the secondary wiring, covered plastic channels, insulated tubes or plastic strips shall be used.

5. Secondary wiring shall never be mounted direct to metal. The filling factor for channels shall not exceed 70%. Where supporting of a wire is not feasible the wire or part of it shall be as short as possible.

I. Protection of Control and Auxiliary Circuits

1. All circuits shall be protected by miniature circuit-breakers of the airbreak-type or cartridge type fuses.

J. Indication and Alarms

1. Contacts for remote alarm shall be normally closed.

2. Protective devices shall have protective action indication.

K. Mimic Diagram

1. The front of the MV boards shall be provided with a plastic or equivalent line mimic diagram illustrating the main circuit and its components.

L. Emergency Stop

1. Each motor shall be provided with an emergency stop facility which shall comprise of a red colored mushroom headed stay-put-twist to release push button. The emergency stop device shall be located adjacent to the motor

2.7 EARTHING

A. Earthing shall be in accordance with IEC 62271-200, colour coding of protective conductors shall be in accordance with IEC 60446.

B. Main Earth Bar

1. A main earth bar shall be fitted along the whole length of the switchboard. This shall be made from hard-drawn, high-conductivity copper and be capable of carrying the short-circuit rating of the board but have a cross section of at least 125mm^2. The earth bar shall be bolted to switchboard frame and equipped with convenient facilities for connecting of all parts of the switchboard which require earthing. Joints in the main earth bar shall be bare copper and bolted with galvanized steel bolts, nuts and washers, secured against loosening. For direct connection to the station earthing grid, earthing bolts (M12) with nuts and spring washers shall be provided at both ends of the main earth bar.

C. Earthing Connections

1. In addition to ensure adequate electrical continuity between all metal parts of the switchboard and its cables and the main earth bar particular care shall be taken to ensure that:

2. Housings of withdrawable switching devices shall be positively earthed in the service position by appropriate earthing connections;

3. Band joints of compound-filled busbar chambers shall be suitably earthed to the frame of the switchboard;

4. The earth connections of voltage transformers and current transformers shall be made directly from the terminal board to the earth bar.

5. Means shall be provided of ensuring that the earthing connection of each withdrawable switching device and voltage transformer to the main earth bar is made prior to its primary connections.

2.8 BATTERY CHARGING SYSTEM (WITH DUAL CHARGERS)

A. Battery and Chargers

1. MV switchgear shall be provided with a dc battery and charger.

2. The dc supply shall be rated for 48 VDC. The voltage at load terminal shall not drop below 90% nor exceed 110% of nominal value during a battery discharge or with the charger operating in float/boost mode.

3. The dc supply system shall be built in to a panel, which shall consist of battery bank, battery charger, voltage control unit for regulating the voltage, an earth fault detector, and MCB's.

4. Voltage control unit shall be rated for 150% of the entire switchgear load and it shall be independent from the circuits of the charger. Protection against over discharge of the battery shall be provided.

5. The battery bank shall be minimum 100AH. Batteries shall be of Nickel – Cadmium type. The charger shall be rated for 150% of the entire switchgear load plus the boost charge current of the battery bank. The batteries shall be recharged in less than 24 hours after a discharge. The ac supply rating shall be 230V AC, 50 c/s single phase and the output shall be 48 VDC.

6. The charger shall have ac input ON lamp, dc output voltmeter and ammeter, a lamp for indicating boost/float charge. A lamp for indication of charger defective shall also be provided. The charger shall have a voltage regulation of + 2% of set value or better and have an output ripple content of less than 2%. Automatically switch into the boost charging mode when battery is discharged beyond value and return back to float charge mode after recharging. The charger shall have built in over voltage protection and should have a soft start feature.

7. The panels shall be free standing and made of steel. The panels shall be suitably painted with anti-corrosive paint to protect against the climate of Karachi.

8. The system shall be designed such that during normal mode, the charger shall be operating either in float charge or boost charge mode.

9. At this time, the battery shall be charged as well as fed via voltage control unit to the connected load.

10. When one charger module is failed, the charger shall continue to feed the connected load. While the charger is in service, it shall be possible to remove and replace the defective module by a new one without affecting the system operation.

11. Only reputed makes of battery and charger shall be supplied by the Contractor.

12. The battery charger shall be monitored on the BMS/PCMS system for fault conditions.

13. Each battery charger cubicle shall be provided with a dedicated single phase 230V circuit from an appropriate emergency backed local distribution board.

2.9 TECHNICAL PARTICULARS MV SWITCHGEARS

S. No	Description	Specified	Proposed
General			
1	Manufacturer	Siemens / Schneider / ABB	
2	Country of origin	As per Manufacturing ranges	
3	Type of switchgear	VCB shall be cassette type Withdrawable	
4	Standards	IEC 62271-200	
5	Rated voltage (kV RMS)	11	
6	Max. system voltage	12	
7	Number of phases	3	
8	Rated frequency	50Hz	
9	Power frequency withstand voltage	28kV	

10	Impulse withstand voltage	75kV	
11	Rated normal current	1000A/1250A	
12	Rated short circuit current	20kA	
13	Rated short time current	20kA for 3 sec	
14	Rated peak withstand current	63kA	
15	Rated voltage of auxiliary circuits	110 VDC	
16	Approximate dimensions mm	Refer Layout	

S. No	Description	Specified	Proposed
Circuit breaker			
1	Type and Make	Siemens / Schneider / ABB	
2	Interrupting medium	Vacuum	
3	Rated voltage	11kV	
4	Max. System voltage	12kV	
5	Power frequency withstand voltage	28kV	
6	Impulse withstand voltage	75kV	
7	Rated normal current	630-1250A	
8	Rated frequency	50 Hz	
9	Short time withstand current	20kA for 3 sec	
10	Rated voltage of auxiliary circuits	110 VDC	
11	Number of operations (Mechanical)	10,000	
12	Standards	IEC 62271-100	

S. No	Description	Specified	Proposed
Earth switch			
1	High speed earthing switch	Yes	
2	Rated short circuit current	20kA for 3 sec	
3	Rated peak withstand current	63kA	
4	Rated frequency	50 Hz	
5	Number of phases	3	

S. No	Description	Specified	Proposed
Relay (Dual Powered)			

1	Type and Make	Siemens / Schneider / ABB	
2	Numerical protection offered	Yes	
3	Metering function provided	Yes	
4	Rated voltage of auxiliary circuits	110 VDC	
5	Standards	IEC 255	

S. No	Description	Specified	Proposed
Current transformer			
1	Make	Siemens / Schneider / ABB	
2	Type	Cast epoxy	
3	Rated primary voltage	11kV	
4	Ratio		
5	Burden		
6	Short time withstand current	20kA for 3 sec	
7	Maximum voltage	12kV	
8	Power frequency withstand voltage	28kV	
9	Impulse withstand voltage	75kV	
10	Standards	IEC 60185	

1. Each Panel shall include the following items:

   a. One three phase cable earth switch
   b. One three phase cast epoxy resin current transformers of required ratio
   c. One three phase voltage transformers with HRC fuses
   d. One numerical microprocessor-based metering, protection and control unit for Incomer
   e. One Trip-Neutral-Close control switch
   f. Additional Auxiliary contacts, ports, relays etc. for remote BMS and PLC control and monitoring as specified within Division 25.

2.10 RATING PLATES AND NAMEPLATES

A. Switchgear shall have a rating plate permanently fixed in the front of the equipment giving at least the following information

1. Rated voltage and frequency.
2. Rated SC capacity and current capacity of busbars.
3. Standard to which equipment conforms.
4. Year of manufacture.
5. Manufacturer's name, type and serial number.
6. Weight.

B. All components (switching devices, contactors protection relays, instruments etc.) shall be fitted with a rating plate in accordance with the relevant IEC requirements. All functional units

shall be clearly labeled to identify the service. All relays, meters, switches etc. shall be labeled in accordance with the wiring diagrams. All labels shall be made of corrosive resistant material with indelible characters in the language of the local country. Rating plates shall be made of corrosion-resistant metallic material and have indelible inscriptions in the language specified in the requisition. Enameled plates are not acceptable.

C. Each panel shall be provided with nameplates, mounted on the front of a non-removable part. The labels shall be of black non-deteriorating material (e.g. Resopal or Traffolite) and shall permit inscriptions with characters in white in the language, specified in the requisition.

2.11 FINISHING

A. The painting shall be suitable for the specified service conditions. Unless specified otherwise painting shall be as per manufacturer's standard. Manufacturer to provide particulars of procedures paint and finish colour.

2.12 ERECTION

A. Assemblies shipped in transport units shall have these units clearly marked to facilitate assembly and erection at site. Each transport unit shall be provided with hoisting facilities. Foundation and erection drawings, in the language as specified, bolts, foundation clamps, small material, etc., required for erection at site shall be packed inside the transport unit.

2.13 INSTALLATION OF MEDIUM VOLTAGE PANELS

A. Install switchboards as noted on the Design Drawings. Ensure sufficient access for servicing and maintenance. Switchboard shall be provided at the base with 100mm reinforced plinth.

B. Contractor to provide 5mm thick rubber matt with electrostatic flooring inside the complete MV switchgear room at ground floor and basement-01 floor.

2.14 TOOLS AND TESTING EQUIPMENT

A. Special tools and equipment required for erection, commissioning, maintenance and testing shall form part of the order and be shipped together with the assembly. Voltage detection and phasing sequencing equipment shall be offered in the quotation. A suitable wall-mounting cabinet shall be provided for all such portable tools and equipment. Testing equipment for motor starting units shall be provided with local-on control facility.

B. Minimum 3 Trolleys’ shall be provided with the switchgear panels for ease of operation and maintenance.

2.15 SPARE PARTS

A. Spare parts shall be adequate for start-up procedures and for two years of operation. Spare parts shall be adequately identified and packed.

PART 3 – EXECUTION

3.1 ELECTRIC SERVICE

A. Electric service at 11kV, 3 Phase, 3 wire, 50Hz A.C. will be rendered from switching stations.

B. Work by this section for the Electric Service:

1. Note that it is understood that the authority having jurisdiction will provide MV incoming feeders to the site from existing local authority substation. This shall be confirmed by the contractor.

2. Provide all MV Switchboards except the main MV metering panel which will be supplied by KARACHI ELECTRIC with all specified control gear and accessories.

3. Provide MV interconnecting cabling between MV Switchboards and from MV Switchboards to the transformers.

4. Provide the sleeves through the exterior wall to accommodate the incoming primary service cables (MV) to the MV metering panel.

C. Be responsible for ensuring that the Engineer and the local authorities having jurisdiction are informed 48 hours prior to their inspections of the sub-station construction. The schedule for inspection shall be as follows:

1. Before the floor or ceiling has been poured and with duct entry to the sub-station in position.
2. Upon completion of the ducts in sub-station including ventilation, drains and doors, etc.
3. Upon completion of MV switchgear installation and prior to commissioning.
4. During and up to successful completion of commissioning and putting equipment in service.

D. Requirements

1. All work performed as part of this section for the electrical services shall conform to all requirements of local authority having jurisdiction.

2. Make all required arrangements with the authorities, perform all required work, obtain and pay for all required permits and certificates required by the Utility in order to ensure that the electric service is installed and put into operation at the proper time.

3.2 INSTALLATION OF SWITCHBOARDS

A. Install MV switchboards as noted on the drawings.

B. Equip panel boards with suitable lugs or provisions to accommodate the main and branch conductors scheduled.

C. Turn over to the Employer upon acceptance of the project, 2 keys for every panel board mounted in a key cabinet.

3.3 INSPECTION AND TESTING

A. Type Tests

1. Type tests shall be carried out in accordance with IEC 62271-200 provided that additional requirements specified (e.g., bus bar insulation) are taken into consideration.

2. Certificates shall be available at the quotation stage. Certificates issued by independent internationally recognized testing laboratories are required.

B. Routine Test

1. Before leaving the works the Contractor shall carry out the routine tests using the Specialist Manufacturer Testing Engineers and Technicians in accordance with the IEC 62271-200 on the total assembly or parts thereof when delivered with time intervals, and the results shall be recorded in a test report.

2. The Engineer and authorized representative of the authority having jurisdiction, shall witness the final routine testing. Notification shall reach the Engineer and the authority having jurisdiction at least ten working days before the testing takes place.

3. Inspection and tests shall be carried out on the complete assembled switchgear. Transportable units can be wired together instead of completing bus bar joints.

4. The following checks and test shall at least be carried out.

5. Switchgear shall be visually inspected on technical execution and conformity with the latest issue of the approved drawings and with the order. Spot checks shall be made to verify:

   a. The degree of protection of the enclosure,
   b. The degree of protection within the compartments,
   c. The effectiveness and reliability of safety shutters, partitions and shrouds,
   d. The effectiveness and reliability of operating mechanisms, locks and interlock systems,
   e. The insulation of the bus bar system,
   f. The creepage distances and clearances,
   g. The proper mounting of components,
   h. The internal wiring and cabling system,
   i. The correct wiring of main and auxiliary circuits,
   j. The suitability of clamping, earthing and terminating arrangements,
   k. The correct labeling of functional units,
   l. The completeness of the data on the nameplate,
   m. The availability of the earthing system throughout the switchgear,
   n. The interchangeability of electrically identical components,
   o. The non-interchangeability of mechanically identical but electrically different components.

6. Insulation resistance test, between each phase against earth, with the two remaining phases connected to earth.

7. The insulation resistance tests shall be carried out with all manually operated and latched type switching devices in the service and closed position and all main fuses installed.

8. Dielectric test shall be carried out in accordance IEC

9. Testing of the mechanical and electrical operation of a number of functional units on random basis, including their control and protective devices.

C. The Engineer reserves the right to request an Engineering and inspection testing for the entire MV installations to be carried out by an independent Engineering testing company specializing in this type of work.

3.4 CO-ORDINATION STUDY

A. The protective system devices have been selected such that protection is adequate and good coordination is possible; however, since differences do exist between manufacturers, some changes in trip ratings or relay settings may be necessary and shall be carried out at no additional charge to the Employer.

B. Carry out the following:

1. Immediately upon award of the Contract and prior to the manufacturing of the switchboards, prepare a set of co-ordination curves and forward eight copies to the Engineer for his review. Make any changes as directed by the Engineer and / or authorities having jurisdiction at no additional charge to the Employer. Obtain all necessary and required information from local authorities having jurisdiction to support this study.

2. The time-current characteristic curves for the following shall be plotted:

   a. The relays and breakers protecting the incoming service.
   b. Main and feeder protective devices.

3. Testing procedures shall be in accordance with the following Regulatory Authorities, British Standards Institution and International Electro-technical Commission IEC.

3.5 EQUIPMENT GUARANTEE

a. Standard Warranty after testing commissioning after handing over to the client.

END OF SECTION

PUBLIC PROCUREMENT REGULATORY AUTHORITY (PPRA) EPADS

SECTION V-05
LOW VOLTAGE SWITCHGEAR

SECTION 26 23 00_ LOW VOLTAGE SWITCHGEAR

PART 1 - GENERAL

1.1 WORK INCLUDED

A. This section supplements the main contract conditions and forms part of every section of Division 26 Electrical trade and shall be read in conjunction with all sections of the specification.

B. Provide all labour, materials, products, equipment and services to supply and install the main LV switchboard system as indicated on the drawings and specified in these specifications.

1.2 REFERENCE STANDARDS

A. All electrical installations shall be carried out in accordance with the latest editions of International Standards and Codes of Practice specifically with the current issue of the IET Wiring Regulations (BS 7671) and the requirements of the local supply authority.

B. The complete installation shall be installed and tested in accordance with the relevant British and International Standards and requirements of the local supply authority.

1. National Fire Protection Association (NFPA) Standards

2. British Standards Institution (BSI) Group, including but not limited to,

a. BS EN 61869-2 Instrument Transformers. Additional requirements for current transformers.

b. BS EN 60051 Direct acting indicating analog electrical measuring instruments and their accessories Part 1: Definitions and general requirements common to all parts.

c. BS EN 61439 Low-voltage switchgear and control gear assemblies.

d. BS EN 60670 Boxes and enclosures for electrical accessories for household and similar fixed electrical installations.

e. BS EN 60947 Low-voltage switchgear and control gear.

f. BS EN 61095 Electromechanical contactors for household and similar purposes.

g. BS EN 61131 Programmable Controllers.

h. BS EN 61158 Industrial communication networks.

i. BS EN 61800 Adjustable speed electrical power drive systems.

j. BS EN 61810 Electromechanical elementary relays.

k. BS EN 62053 Electricity metering equipment (a.c.).

l. BS EN 62208 Empty enclosures for low-voltage switchgear and control gear assemblies. General requirements.

m. BS HD 60269, BS 88 Low-voltage fuses.

n. BS 842 Specification for A.C. voltage-operated earth-leakage circuit breakers.

o. BS 3693 Recommendations for design of scales and indexes on analog indicating instruments.

p. BS 4662 +A1 Boxes for flush mounting of electrical accessories.

q. BS 5424-3 Specification for control gear for voltages up to and including 1000 V a.c. and 1200 V d.c.

r. BS 5685 Electricity meters.

s. BS 7671 Requirements for electrical installations, IET Wiring Regulations.

t. BS 7856 Code of practice for design of alternating current, watthour meters for active energy (classes 1 and 2).

u. BS 5733 General requirements for electrical accessories. Specification.

v. Degree of ingress protection shall be in accordance BS EN 60529- IP 54.

3. National Electrical Manufacturers Association, NEMA Standards

1.3 REFERENCE STANDARDS – LOCAL AUTHOIRTIES WITH JURSIDICTION

A. In addition to the requirements indicated on the Design Drawings, or specified in Division 01 General Requirements, the Particular Specifications and the MEPF Scope of Works, the Work shall be in accordance with the relevant statutory authority requirements published by the local authorities having jurisdiction.

- Lahore Electric Supply Corporation
- Pakistan Electricity Rules 1937
- Building Energy Code of Pakistan
- Building Code of Pakistan- Fire Safety Provisions
- Any other local authority Guideline applicable for this project

1.4 GENERAL REQUIREMENTS

A. Furnishing, installation and termination of Low Voltage Switchboards.

B. Equipment and installation shall meet or exceed latest regulations published by the local authority having jurisdiction.

C. Connection to Central energy monitoring system & Building Management System (BMS), including interface elements such as relays, transducers, etc. as detailed in other Sections, BMS schedules and /or shown on the Drawings. Provide network interface card (NIC) to allow remote monitoring of all available data parameters (objects) by a third-party central energy monitoring system and Integrated Building

Management System (BMS). NIC shall provide standard protocols of either Modbus/RTU or BACnet MS/TP over an EIA-485 network, or Modbus/TCP or BACnet/IP over an Ethernet TCP/ IP network. A NIC may be provided integral to each device or may act as gateway to multiple devices physically located within the same room. Provide all necessary network wiring internal to the equipment and the NIC. Provide a complete register mapping of all available data objects for each device. Provide full documentation of protocol parameters (baud rate, parity), device addressing and data object registers for each NIC to BMS contractor.

1.5 DESCRIPTION OF WORK

A. Supply, install and connect all main, sub-main and final distribution equipment and make the utility service connections all as described hereinafter and in accordance with the requirements of the Contract Documents.

B. The main (LV) switchboards shall comprise of main breakers, indicating instruments and outgoing breakers to provide a complete service and distribution system for the whole project.

C. Generally, the sub-distribution shall be carried out by means of:

1. X multi-core cables to the various locations terminating at distribution panel boards, MCC panels and items of electrical equipment.

2. Where electrical loads are large and voltage drops are high due to lengthy runs, a copper bus duct shall be installed to provide adequate distribution.

3. Distribution from final panelboards shall be generally in conduit and single copper conductors drawn into the conduit all as specified in other sections of the specification.

D. The Scope of works includes the supply and installation of the following low voltage equipment, but not limited to:

1. Main Low Voltage (LV) Panels
2. Sub Main Distribution Boards (SMDB)
3. Final Distribution Boards (DB)
4. Disconnect Switches (Isolators)
5. Motor Starters
6. Air Circuit Breakers
7. Moulded Case Circuit Breakers
8. Metering
9. Current Transformers
10. Voltage Transformers
11. Contactors

1.6 SUBMITTALS

A. General: Comply with the requirements of Division 01 General Requirements and MEPF Scope of Works procedures and submit the following.

B. Post Contract Submittals

1. Product data shall have the following information:

a. Compliance with Local Authority requirements.

b. Service voltage, number of phases, and frequency

c. Main bus-bars capacity (Ampere Rating) and short circuit rating

d. Overcurrent protective device types with short circuit, frame, and trip ratings, features, and characteristics.

e. Metering equipment types and functions

f. Time-current coordination curves for each circuit breaker.

2. Shop drawings shall have the following information:

a. Overall dimensions and weight of enclosures (including kN/m2)

b. Front and side views of enclosures

c. Top and bottom plans showing space available for conduits, cables, busways, etc.

d. Nameplate legends. 3-line diagram

e. Size and number of bars per phase and neutral in each bus run including main, section and branch buses plus equipment ground buses.

f. Electrical characteristics of equipment, including ampere ratings of buses, temperature rise, and maximum short circuit withstand ratings and control voltages.

g. Features, characteristics, and ratings of overcurrent protective devices.

h. Internal wiring diagrams.

i. Schematic and wiring diagrams of control circuits.

3. Supplementary Product Literature: Include a statement from the manufacturer for the design life of the system.

4. Method of setting of protective devices for overload short circuit and earth fault currents as coordinated with upstream and downstream systems based on specific coordination curves of protective devices used and specific calculated prospective short circuit currents at various point.

5. List of tests included.

6. Certified test data.

7. Outline technical specifications reflecting proposed materials and systems.

8. A list of proposed suppliers and Subcontractors intended to be used.

9. Preliminary Method Statement.

10. Preliminary Quality Plan.

11. Summary of deviations from the Specification.

12. Point-wise compliance statement to the specifications, duly signed by the manufacturer/ manufacturer's authorized representative and the Contractor.

1.7 CLOSEOUT SUBMITTALS

A. General: Comply with the requirements of Division 01 General Requirements and MEPF Scope of Works, and submit the following:

1. Standard Warranty after testing commissioning after handing over to the client.

1. Project Record Documents.

B. Spare Parts

1. Provide spare parts that are identical to, and interchangeable with, similar parts installed.

1.8 QUALITY ASSURANCE

A. The Quality Control/Assurance duties shall be performed by the Contractor.

B. The system of quality control verification shall be in accordance with ISO 9000 standards of Quality Control/Assurance.

C. Product selection for restricted space: Drawings indicate maximum dimensions for the equipment, including clearance between the equipment and adjacent surfaces and items. Switchgear having equal performance characteristics and complying with indicated maximum dimensions may be considered.

D. The main switchboard manufacturer, assembler and supplier shall be independently certified to BS EN ISO9001 Quality standard. A copy of this certification shall be submitted to the Consultant for approval.

E. All mains and sub-main panel boards shall undergo the following routine factory tests before dispatching and a test certificate shall be forwarded for the same.

1. Primary injection test for all circuit breakers and meters.
2. Secondary test for all protective relays.
3. Milli-volt drop test.
4. Insulation test.
5. Function test.
6. All such tests shall be witnessed by the Consultant.
7. 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.

F. ASTA or KEMA Total Type Test Certificate shall be submitted to prove the assembly performance and design all switchgear and panel boards as mentioned.

G. The components and cables design, material and performance shall conform except where otherwise indicated, with the latest issues and amendments of the following codes and standards.

1. IEC 60947 Low voltage switchgear and control gear.

2. IEC 60898 Circuit breakers.
3. IEC 60947-3 Switches, disconnectors, switch-disconnectors and fuse-combination units.
4. IEC 61869 Instrument transformers.
5. IEC 61439-1 and 2 Switchgear.
6. IEC 61869-5 Instrument transformers Part 5: Additional requirements for capacitor voltage transformers.
7. IEC 60051, IEC 61010 Measuring instruments.
8. IEC 60947-1,IEC 60947-4 Contactors and motor starters.
9. IEC 60947-5-1 Control circuit devices and switching elements - Electromechanical control circuit devices.
10. IEC 60529 Degrees of Protection Provided by Enclosures (IP Code).
11. IEC 60068-2-30, IEC 60068-2-1, IEC 60068-2-11 Environmental testing.
12. IEC 60947-6-1 Multiple function equipment - Transfer switching equipment.
13. BS EN 60051/ IEC 60051 Direct acting indicating analog electrical measuring instruments and their accessories.
14. BS EN 60079/ IEC 60079 Electrical apparatus for explosive gas atmospheres.
15. IEC 60112 Method for the determination of the proof and the comparative tracking indices of solid insulating materials.
16. BS HD 60269, BS 88/ IEC 60269 Low voltage fuses.
17. BS 5685/ IEC 62052, IEC 62053 Class 0.5, 1 and 2 alternating current watt-hour meters.
18. IEC 60664 Insulation coordination for equipment within low voltage systems.
19. IEC 60688 Electrical measuring transducers for converting A.C. and D.C. electrical quantities to analogue or digital signals.
20. BS EN 61008 and BS EN 61009 Earth leakage circuit breakers.
21. IEC 61641 Guide for testing under conditions of arcing due to internal fault.
22. Where conflicts exist between the requirements of this Specification and other drawings, standards, codes and specifications, the most stringent shall be applied.
23. ASTA or KEMA Total Type Test Certificate shall be submitted to prove the assembly performance and design.

1.9 DELIVERY AND HANDLING

A. Delivery: Handle equipment carefully to prevent damage.
B. Shipping splits: Modules shall be not wider than 1 vertical section or as per the manufacturer recommendation, maximum 2400mm, individually wrapped and mounted on shipping skids.
C. Storage: Store equipment in clean, dry place. Protect from weather, dirt, construction debris and physical damage.

1.10 FACTORY TESTING

A. Refer to MEPF General Requirements and Scope of Works.
B. Notify the Consultant 4 weeks in advance of final factory tests of the switchboards. The Employer and the Consultant shall be entitled to witness all or any of the factory tests. Contractor to bear all costs for testing, traveling, boarding/lodging for four representatives witnessing the tests.
C. Submit copies of certified test results.

1.11 COORDINATION

A. Coordinate the main low voltage switch boards with the following:
   1. Busbar manufacturer for flange connections onto the switchboard

2. Construction of switch board enclosure to ensure switchgear fits in the space provided.
3. Division 23 – Mechanical trade for supplies to plant and equipment.
4. Generator manufacturer/supplier for start/stop of the engine/alternator and changeover of supplies to back-up power
5. Power factor correction equipment vendor
6. BMS vendor for status monitoring of all main breakers
7. Local supply authority for provision of incoming power

PUBLIC PROCUREMENT REGULATORY AUTHORITY (PPRA) EPADS

PART 2 - PRODUCTS

2.1 GENERAL

A. Supply all materials, labour, equipment, working plans, etc. and installation to provide a complete low voltage equipment as described herein and indicated on the Design Drawings including, but not limited to the following:

1. Main Low Voltage (LV) Panels
2. Sub Main Distribution Boards (SMDB)
3. Distribution Boards (Final Distribution Boards) (DB)
4. Disconnect Switches (Isolators).
5. Air Circuit Breakers (ACB)
6. Molded Case Circuit Breakers (MCCB)
7. Metering.
8. Current Transformers (CT)
9. Voltage Transformers.
10. Contactors.

B. All materials shall be suitably selected and installed for use in Seismic Zone IIA.

C. Manufacturers:

1. Provide systems and products from one of the listed manufacturers within the approved manufacturer list.

2. All panels should be provided by the authorized local panel builder.

D. All products should be tested as per international standards and local authority regulations in the accredited laboratory certified by the governing body with authorization.

E. All products should be subject to the required tests following a standard sample format or procedure as per the operational performance requirements.

F. All life safety related systems and products should be approved by the Civil Defense

G. All Products' warranties shall be as per client's requirements.

2.2 DESIGN CRITERIA

A. Related Work specified in other Work Sections.

B. Supply, install and connect all main, sub-main and final distribution equipment and make the utility service connections all as described hereinafter and in accordance with the requirements of the Contract Documents.

C. The service provided by step down transformers at 415/ 230 volts 50Hz shall be connected to free standing cubicle main switchboards, sized in accordance with the capacity of the step-down transformers.

D. The main LV switchboards shall comprise of main breakers, indicating instruments and outgoing breakers to provide a complete service and distribution system for the whole project.

E. Generally, the sub-distribution shall be carried out by means of:

1. Busbar and XLPE/ SWA/ PVC multi-core armored cables to the various locations terminating at distribution panel boards, MCC panels and items of electrical equipment

2. Distribution from final panel boards shall be generally in conduit and single copper conductors drawn into the conduit all as indicated in other sections of the Specification.

2.3 MAIN LOW VOLTAGE SWITCH BOARDS (LV PANEL IMPORTED LOCALLY ASSEMBLED)

A. General

1. The specification hereunder shall be applied to all switch boards referred on the Design Drawings (power layout, single line diagrams as Main Low Voltage Panel (LV Panel).

2. The switch boards shall be in accordance with BS EN 60439, Multi-cubicle type FBA, Form 3B **Type-02** minimum Construction.

3. The switchboards shall be rated 415V 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 85 kA RMS symmetrical or as mentioned in Power Schematic riser diagram.

4. The switchboard shall be tested for internal arc withstand as per AS 3439/ 1.

5. Refer to the single line diagram and short circuit calculations for the kA ratings.

6. The switchboard shall conform to fully type tested (TTA) design having passed all 7 tests in accordance with the latest editions of BS EN 60439.

7. The Contractor shall submit valid test certificates such as ASTA or KEMA to the Consultant for acceptance.

8. Refer to the single line diagrams for rating and type of feeder required.

9. Provide meters and CTs as indicated on the single line diagram. Meters shall be mounted in separate compartment in each section.

10. Provide permanent lifting means on top of shipping sections.

11. Include an integral roll-along lifting device for any switchgear equipped with draw out devices. Mount lifting device on top of switchgear.

12. Electrical characteristics

    a. Rated operating voltage: 415V.
    b. Rated insulation voltage: 1000V.
    c. Rated current: Refer to Power schematics.
    d. Rated short circuits withstand current: 85kA, 1 Sec.

13. Special Tools

    a. The Contractor shall provide a complete set of all special tools and devices necessary for the operation and maintenance of the complete assembly.

b. The Contractor shall provide a wall mounted panel to accommodate these tools and devices.

14. The switchgear assembler shall have a valid BS EN ISO 9001 certification.

15. The switchgear system and devices shall originate from single reputed manufacturer. Refer to supplementary list of acceptable manufacturers.

16. In case of local assembly the authorized/ approved assembler shall strictly follow the guidelines and standards laid down by the manufacturer and the Type Test Certificate which is issued by ASTA or KEMA for the authorized assembler for supplied product.

17. The Contractor shall provide fault level calculations to substantiate Proper selection of all devices.

18. The Contractor shall carry out routine tests at their work with the valid testing equipment calibrated by a reputed laboratory.

19. The assemblies shall be of the front or rear access arrangement, comprising of cubicles 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 and be capable of being withdrawn. Withdrawable compartments or breakers shall be indicated clearly in the Design Drawings and single line diagram. The switchgear shall be completely compartmentalized, and metal enclosed in accordance with Form 3B **Type-02 minimum** separation described in IEC 60439-1. Assemblies shall be freestanding.

20. All air circuit breakers shall be withdrawable 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. All circuit breakers within main switch boards shall be of the withdrawable type.

21. All equipment and materials shall be new.

22. 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 shall be required to make such extensions.

23. The switchgear shall be painted inside and out. Unpainted galvanized coating of internal metal work shall not be acceptable.

24. A space of 100mm shall be provided at the bottom of each panel.

25. A vertical cable alley covering the entire height shall be provided. The cable alley shall be minimum 200mm wide.

26. The panel shall be of uniform height of not more than 2200mm.

B. Construction

1. The degree of protection, according to IEC 60529, shall be IP 42 with fixed front frame plus overall plain door and gasket.

2. The switchboard shall be built-up of individual freestanding cubicles to allow easy installation on Site. The cubicles shall be made of electro-zinc coated sheet metal of 2mm thickness. 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 color shall be to RAL 7032/ 9002 and to the Consultant 's acceptance.

3. 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 or top 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 and base frame, removable covers at doors.

   e. Provided with bus bar running at the top all along the Switchgear in a separate sheet steel enclosure.

4. Operating devices shall be incorporated only in the front of the switchgear with a hinged door.

   a. 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 other equipment pertaining to a circuit shall be mounted on the withdrawable chassis. All cutouts shall be provided with gaskets for the purpose of dust proofing.

5. Current transformers shall not be directly mounted on the buses. Current transformers shall be mounted on the fixed portion of the compartment using removable CT link for easy access and maintenance.

6. 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.

7. 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.

8. The withdrawable chassis shall move on suitable guides and on stainless steel rollers or balls to facilitate easy withdrawal.

9. Cable alleys shall be provided with suitable hinged doors. The cable termination shall be completely shrouded. It shall be possible to safely carry out maintenance work on cable connections to any one circuit with the bus bars and adjacent circuits live. Adequate number of slotted cable support arms shall be provided for cleating the cables.

10. 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.

11. Each vertical section shall be equipped with thermostatically controlled space heaters, which may be located in the cable alley and with internal light (230V).

12. Open metal sheet shall be provided between 2 No. 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.

13. 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.

14. All doors shall be provided with concealed type hinges and captive screws.

15. All withdrawable chassis housing circuit breakers shall be of the fully draw out type.

16. It shall be possible to draw out the withdrawable chassis without having to unscrew or unbolt any connections to the equipment mounted on the withdrawable chassis. The power and control draw out type connections shall be of the slab-in or sliding type. All draw out contacts including for auxiliary and control wiring shall be of self-aligning type.

17. All identical equipment and corresponding parts including chassis of draw out modules of the same size shall be fully interchangeable, without having to carry out modifications. For trouble free interchangeability, the draw out arrangement shall be designed such that normal dimensional variations are taken care of by self-aligning feature of the modules.

18. 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.

19. The cable connection shall be made in a separate compartment. The access shall be possible through hinged covers.

20. The cubicle shall be divided into modules with a minimum of 20% of empty modules for extension.

21. All incoming cable entries shall be from top or bottom. Outgoing cable entries shall be from bottom or top as per the requirement.

22. Compartments for future breakers shall be complete with bus connections, plug-in base and mounting plates, ready for the insertion of a breaker.

23. ACBs shall be draw-out with ratings, breaking capacity, etc. as mentioned elsewhere in this Specification and contract drawings.

24. No cast iron or cast aluminum shall be used in any part of the assembly, which is subjected to mechanical stress.

25. All incoming and outgoing switching devices shall have provision for locking in the 'off position.

26. 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.

27. Degree of Protection

    a. The degree of protection for units mounted indoors shall be a minimum of IP 42. This 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.

28. Incoming and sectionalizing units

    a. Incoming and sectionalizing units shall be air circuit breakers and shall be mounted in separate panels.

    b. 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.

    c. A dedicated compartment shall be included for metering on the incomers.

    d. Supplier shall supply details for incoming units and bus-bar standard earthing arrangements.

29. Outgoing units

    a. They shall be ACB or MCCB with type and ratings as indicated on the contract drawings and as indicated in the relevant section of this Specification.

b. Suppliers shall provide a minimum 300mm space between the base of the switchgear and the underside of the lowest outgoing units.

c. All incoming and outgoing circuit breakers shall be provided with short circuit and overload release to trip the breaker, instantaneously if closed onto a fault.

d. All compartments shall occupy the full cubicle width; a semi module compartment or vertical division between compartments is not acceptable.

e. 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.

30. Cable and Wire Terminations and Terminals

a. 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.

b. Formal blocks shall be arranged and positioned to afford easy access for carrying out external cabling, testing, inspection and maintenance.

c. Cable Glands shall be of the double sealed compression type with position armour bond suitable for XLPE and PVC insulated cables.

31. Mechanical Indications

a. 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.

32. Safety Shutters

a. 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.

b. 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.

c. They shall be capable of being padlocked in the closed position.

33. Interlocks

a. 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.

b. 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:

1) 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.

2) The unit being withdrawn from or inserted into the feeder spouts or isolating device when it is in the closed position.

3) The unit being moved to any position other than that selected by means of the mechanical selector.

4) The unit being withdrawn or inserted into the fixed part unless it is in the correct state for withdrawal or insertion.

5) The unit being closed in the service position unless all auxiliary circuits between fixed and removable parts have been completed.

6) Means shall be provided to prevent opening of cubicle doors or covers before disconnection of supply to exposed live parts within.

34. Interlocks and Transfer Functions

a. 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 acceptance.

b. The main switch board incoming transformer feeders and the bus section circuit breakers shall be provided with the required electromechanical interlock for auto transfer in case of failure of incoming supply facilities, for automatic and or manual transfer.

c. The various interlocking schemes shall generally be as indicated on the Design Drawings and to the Consultant acceptance.

35. Nameplates shall be engraved on traffolite sheet, with white letters on black background. Nameplates for main breaker, tie breaker, section and outgoing modules identification and for the entire switchboard shall have letters not smaller than 13mm high. Nameplates for branch breakers, switches, push buttons, control devices, pilot lights and metering shall have letters not less than 3mm high. All nameplates shall be mechanically fixed with non-ferrous metal screws.

36. Warning signs on doors and access panels shall be engraved traffolite with white letters on red background.

37. Control contacts, auxiliary contacts, relays and small or light mechanisms shall be enclosed and protected and shall be accessible for repair or adjustment.

38. Engraved trafolite/ 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.

39. Anti-condensation heaters shall be provided within the assembly and shall be controlled by a panel-mounted hygrostat with a 50% to 100% setting range.

C. Busbars

1. The bus bars shall be TPN+E (100% sized neutral and 100% sized earth, when compared with the phase conductors). Earth bar shall run through the entire length of the switchboard. The metal frames and all components shall be connected to the earth bar. Bus bars current density shall not be less than 1000A/ in^2.

2. All the bus bars used in the panel shall be high grade electrolytic tinned Imported copper of 99.9% conductivity. The bus bars shall be epoxy powder coated throughout the length or at the ends, colored for phase identification.

3. Bus bars shall be provided with at least the minimum clearances in air as per applicable standards for a 415V, 3-phase system.

4. The complete bus-bar system shall be certified by ASTA or KEMA for a fault level as indicated on the Design Drawings, certificate for a typical bus-bar system assembled by the switchgear assembler shall be submitted to the Consultant for acceptance. Components provided by Contractor shall comply with Coordination and Fault study, unless drawings indicate larger value.

5. 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.

6. Horizontal and predrilled vertical bus bar make modification and extension very easy in addition to the above characteristics.

7. The vertical bus bars shall be accessible through hinged doors.

8. Bus bar sizing shall also be in accordance with the local authority regulations and the configuration and size of bus bars used should have been type tested by the original manufacturer. Bus bar supports shall be supplied by the original manufacturer of enclosure and components and provided at the distances as recommended by the original manufacturer.

9. The sub-bus-bar/ vertical dropper of main bus bar system shall be designed same as the main bus bar system. If the bus bar sizes of sub-bus bar/ vertical droppers are reduced then it shall be designed to carry1.5 times the total current of the feeders connected to them.

D. Dual Source Digital Multifunction Metering System

1. A Dual Source digital multifunction metering system (to monitor K.E power & generator power) complete with all CTs and PTs for customer's use shall be installed and factory wired in locations in each switchboard as indicated herein. The same shall be a latest model with trend analysis. All PT secondaries shall be for 230V and all CT secondaries shall be 5A. The system shall be an integrated micro-processor-based multifunction metering package, capable of displaying:

   a. Line and phase volts (V).
   b. Line Current (A).
   c. Power factor (Cos F).

d. Frequency (Hz).
e. Kilovolt amperes (KVA).
f. Kilovolt amperes reactive (KVAR).
g. Kilowatt hours (KWH).
h. Neutral current (A).

2. A standard banana jack test block shall allow testing of the meter by injecting 230V and 5A while the phase display indicates T. 3 set point dry contacts for load shedding or alarm shall be provided, each being field programmable to suit the Employer/Owner requirements. The meter shall be designed to include provisions for communication with external monitoring devices via an RS 232C port.

3. The dual source digital metering system and associated software shall be supplied by the switchboard manufacturer.

4. The Contractor shall include for all hardware and software as required and recommended by the digital meter manufacturer for remote monitoring at the Centralized Energy Monitoring System (CEMS).

2.4 SUB-MAIN DISTRIBUTION BOARDS (SMDB-FREE STANDING LOCALLY FABRICATED)

A. Description

1. The free-standing sub-distribution boards shall be of the multi-tier type incorporating 3 phase, neutral and earth insulated tinned copper bus bars, all necessary CTs and the like as required.

2. Each cubicle shall be equipped with thermostatically controlled heaters, which shall be 'on' all the time and ventilation means.

3. Switchboards shall be designed to operate on a 415/ 230V 3 phase and neutral 50HZ supply and shall have a minimum short circuit rating of 40KA for 1 second up to 1200A **rating or as mentioned in drawings** and 40kA for 1 sec for the ratings above **or as mentioned in drawings.**

4. Switchboards shall be constructed in accordance with BS EN 60439 multi-cubicle type FBA FORM **3B Type-02**.

5. Sub-Main Distribution panel(s) shall be equipped with all necessary circuit breakers and components with enough spare outgoing for any future use.

6. The switchboard shall conform to fully type tested (TTA) design having passed all 7 tests in accordance with the latest editions of BS EN 60439. The Contractor shall submit valid test certificates such as ASTA or KEMA to the Consultant for acceptance.

B. Bus bars

1. All the bus bars used in the panel shall be high grade electrolytic tinned Imported copper of 99.9% conductivity. The bus bars shall be epoxy powder coated throughout the length or at the ends, colored for phase identification. The main bus bar rating shall be the same throughout the entire length of the switchboard and a provision shall be made in the bus bars system to allow for expansion and contraction caused by temperature variation.

2. The bus bar shall be sized taking into consideration the ambient temperature and the specified temperature rise.

3. The neutral bus bar shall be the same size of the phase conductor and the earth bar shall be the same size as the phase bus bars.

C. Breakers

1. Breakers shall have the ratings and rated services breaking capacities (Ics) as per IEC 60947-2 as indicated in the Design Drawings (however the minimum Ics breaking capacities for all MCCB's will be Icu=Ics=25KA **or as mentioned in drawings.** The breaker shall be current limiting type with adjustable short circuit and overload releases.

2. MCCBs of all ratings shall be equipped with thermal magnetic or electronic trip units, which are fully interchangeable. The breakers shall be equipped with electronic trip units, which shall remain operational for ambient temperature up to 50°C. Electronic trip unit shall be in accordance with IEC 60947-2 standard. It shall be possible to fit lead seals to prevent unauthorized access to the settings of the electronic trip units.

3. The cubicle shall be front operated with a mechanical ON/ OFF position indicator and shall be designed and tested in accordance with relevant standards.

4. 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

1. The switchboard shall be constructed of a minimum 2mm thick electro-galvanized steel coated with high solid enamel polyester electrostatic spray and oven baked. There shall be adequate channel frames, drilled or slotted for ease of assembly, to support cable tails, clamps and terminations within the cubicles.

   a. The bus bars shall run in a separate compartment with the partition shall be made of sheet steel. 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.

2. The degree of protection of the Switch Board enclosure shall be IP 42.

3. 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°C at the operating ambient temperature of 50°C.

2.5 SUB MAIN DISTRIBUTION BOARDS (SMDB-WALL MOUNTED LOCALLY FABRICATED)

A. General

1. MCCB distribution boards shall be in accordance with IEC 60439-1 and IEC 61439-1 and 2 Form **3B Type-02**.

2. The manufacturer of the Sub-main distribution boards shall be the same of the Main Switchboard and molded case circuit breakers to ensure consistency and discrimination.

3. Enclosures:

   a. MCCB distribution boards shall be totally enclosed.

   b. The degree of protection according to IEC 60529 shall be IP 42 minimum for indoor installation.

   c. The enclosure shall be manufactured from minimum 1.5mm thick electro-zinc coated sheet steel with Epoxy polyester powder finish.

   d. Color to be RAL7032 as standard unless otherwise agreed in writing by the Consultant.

   e. 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.

   f. Ample-wiring space shall be provided. Detachable blank gland plates shall be provided at the top and bottom.

4. Pan Assembly

   a. The pan assembly shall be completely independent unit that can be taken out of the enclosure for maintenance purpose.

   b. All components are mounted on a strong chassis consisting of 2mm thick electrozinc coated folded sheet steel.

   c. Bus bars shall run in separate compartment fully shrouded by 2 No. layers of high impact polypropylene materials isolating the main bus bar from branch bus bars with IP20 minimum degree of protection and shall be made of hard drawn high conductivity tinned copper, air insulated c/ w earth and neutral bars sized the same as the phase bars.

5. Breakers

   a. Incoming and out-going breakers shall be MCCBs of fixed type with adjustable short circuit and overload releases.

   b. 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.

   c. Short circuit calculations shall be submitted to the Consultant for acceptance.

   d. Breaker selection shall be made to achieve maximum discrimination between the upstream and downstream breakers.

6. Electrical Characteristics

   a. Rated insulation voltage: 690V-1000V (AC).

   b. Maximum rated current of busbars: up to 800 A.

c. Rated short time withstand current of bus bars shall be as indicated on the single line diagram.

d. The short circuit capacity of the distribution boards shall be 40KA for 1 sec or as mentioned in drawing 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, Fabrication shall done locally as per Form 3B type-02 procedure, no KEMA, ASTA certification is required

7. Auxiliaries and Accessories:

a. In addition, the incomer shall be provided with ammeter and voltmeter and selector switches.

2.6 DISTRIBUTION BOARDS (2B Type-01 LOCALLY FABRICATED)

A. Description

1. The specification hereunder shall be applied to all panel boards referenced on the Design Drawings/ load schedules as DBs. The distribution board shall be flush/ surface mounted split bus bar type and shall be provided with standard extension box to allow cable glanding if required.

2. The distribution board shall be surface mounted when installed within the electrical room/ service rooms.

3. Total assemblies to be type tested with type test certificate by ASTA or KEMA submitted to the Consultant for acceptance.

4. 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 or RCBOs for each power circuit as indicated on schedules.

5. As a standard item, all MCB boards shall be provided with permanent circuit identification charts to the acceptance of the Consultant.

6. MCBs shall be in accordance with IEC 898 and RCBOs shall be in accordance with BS EN 61009. ELCBs shall be in accordance with BS EN 61008.

7. DBs inside electrical rooms shall be surface mounted type fixed onto a U channel support.

8. ELCBs in each DB shall be provided as per requirements of K. Electric without any variation.

9. The distribution boards and its breakers shall be from the same manufacturer of the Main Switchboard.

B. Enclosures

1. The enclosure shall be of folded and bolted construction fabricated out of minimum 1.2mm electro galvanized steel sheet and epoxy powder coated to form a cubicle. Hinged door shall be provided for access to the operational knobs of the circuit breaker. Closed knock out type opening shall be provided at top, bottom and at the sides for cable glands and conduits.

2. Surface wall mounted DBs shall be fixed on U channel support and not direct to the wall.

C. Bus bar

1. The MCBs shall be mounted on either 3 phase or single phase or split bus bars as appropriate. All spaces, which are not provided with breakers, shall be covered with blank plates.

2. 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.

3. Bus bars shall be of Imported 99.9% hard drawn tinned plated copper, fully shrouded by 2 No. layers of high impact polypropylene materials isolating the main bus bar from branch bus bars with IP20 minimum degree of protection and rated at 125A as required by the schedules or on the Design Drawings. The minimum withstand short circuit shall be not less than (9 or 10kA) for 1 sec. Rated insulation voltage shall be not less than 690V (AC).

D. Breakers

1. Miniature circuit breakers, RCBOs and earth leakage circuit breaker and shall be provided as indicated on the load schedules.

2. The short circuit rating for the MCBs and RCBOs shall be (9 or 10KA) for DB's.

3. All circuit breakers shall be factory calibrated to ambient temperature of 50°C.

2.7 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 aluminum 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 aluminum with double wall construction.

H. Sample and catalogues with installation details shall be submitted for acceptance by the Consultant, prior to ordering.

I. Provide a disconnect switch ahead of all motors, starters and electrical equipment where indicated on the Design Drawings and where required to meet Code regulations and jurisdictional authorities, whether the equipment is supplied or installed under the Division 26 Electrical Work Sections or any other Division of the Specification.

J. All disconnect switches shall be provided with tag to the Consultant acceptance to indicate equipment connected to the switch. The feeding circuit reference and the related distribution board number.

2.8 AIR CIRCUIT BREAKERS

A. General

1. The circuit breakers shall be in accordance with IEC 947-2, 3pole or 4pole as mentioned in the single line diagram. However, the incomer and bus coupler ACBs shall be of 4 poles. The breaker should be occupied with LSIG protection.

2. The breaking capacity performance certificates shall be available for category B to the abovementioned standards. The test shall be carried out with a breaking performance during operation (Ics) equal to the ultimate breaking capacity (Icu).

3. All circuit breakers can be reverse fed without reduction in performance.

4. 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.

5. Breaker trips shall be completely self-powered with no external control power source required. If external control power is required, 110V D.C. batteries and charger shall be provided. Batteries to be Ni-cad type.

6. Breakers shall be provided with adjustable releases for overload, short circuit and earth fault protection and have the following functions:

   a. Adjustable long-time delay trip.
   b. Adjustable short time delay trip.
   c. Instantaneous trip.
   d. Ground fault trip.

7. Breakers shall be suitable for operating at 50°C ambient temperature and shall be tropicalized.

B. Construction

1. The air circuit breaker ratings shall be as indicated on the single line diagram.

2. 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

1. The operating mechanism shall be the O-C-O stored energy spring type motor/manually operated as indicated on Design Drawings with a closing time of less than or equal 80msec.

2. Each breaker shall be provided with 3 nos. normally open and 3 nos. normally closed potential free spare auxiliary contacts rated 10A at 230V AC.

D. Arc Chutes

1. Arc chutes shall be common on the whole range and removable on Site to allow inspection of arc chutes and main contacts.

E. Electrical Auxiliaries

1. All electrical auxiliaries including the motor spring charging mechanism shall be field adaptable without adjustment or the necessity for any tool (except a screwdriver).

2. Breaker Mounted Trip Unit

a. Each air circuit breaker shall be equipped with a solid-state tripping system consisting of 3 No. current sensors, microprocessor-based trip device and low energy trip actuator.

b. Current sensors shall provide operation and signal function. The trip unit shall use microprocessor-based technology to provide the basic adjustable time-current protection functions. True RMS sensing circuit protection shall be achieved by analyzing the secondary current signals received from the circuit breaker current sensors and initiating a trip signal to the circuit breaker trip actuator when predetermined trip levels and time delay settings are reached. Interchangeable Current Sensors with its associated Rating Plug shall establish the continuous trip rating of each circuit breaker.

c. The Bus Coupler ACB shall be equipped with dummy trip unit and shall not have any trip functions.

d. The trip unit shall have an information system that provides LED's to indicate mode of trip following an automatic trip operation. The indication of the mode of trip shall be retained after an automatic trip.

e. A reset button shall be provided to turn off the flashing LED indication after an automatic trip.

f. The Trip Unit shall be provided with a display panel, including a representation of the Time/Current curve of the trip unit that indicates the protection function settings. The unit shall be continuously self-checking and provide a visual indication that the internal circuit is being monitored and is fully operational.

g. Complete system selective coordination shall be provided by the addition of the following individually adjustable Time/ Current curve shaping solid state elements:

1) All breakers shall have adjustments for long delay pickup and time.

2) Main Incoming and Feeders ACBs shall have individual adjustments for short delay pick-up and time and include I2t settings.

3) Main Incoming and Feeders ACBs shall have an adjustable instantaneous pickup.

4) When indicated on the drawing circuit breakers shall have individually adjustable earth.

5) Fault current pick-up and time and include I2t settings and earth fault alarm only.

h. The Trip Unit shall be provided with a making-current release circuit. The circuit shall be armed for approximately 8 No. cycles after

breaker closing and shall operate for all fault levels above 15 times the ampere value of the current sensor.

i. Trip Units shall have selectable thermal memory for enhanced circuit protection.
j. There shall be an optional display. This display shall show phase, neutral and earth sensors and high phase current. The accuracy of these readings shall be + 2% of full scale.
k. A time delay shall be provided to avoid nuisance alarms.
l. The microprocessor-based trip unit shall have both powered and un-powered thermal memory to provide protection against cumulative overheating should a number of overload conditions occur in quick succession.
m. The Trip Unit shall provide zone interlocking for the short time delay and earth fault delay trip functions for improved system coordination.
n. The zone interlocking system shall restrain the tripping of the upstream breaker and allow the breaker closest to the fault to trip with no intentional time delay. In the event that the downstream breaker does not trip, the upstream breaker shall trip after the preset time delay.

3. Auxiliaries and Accessories
   a. 1 No. ammeter and voltmeter with selector switch.
   b. Operation counter.
   c. ON/ OFF/ Fault/ Control Circuit fault indication light with lamp test facilities.

2.9 MOLDED CASE CIRCUIT BREAKERS (MCCB)

A. General

1. Molded case circuit breakers shall conform to the latest editions of IEC 600947. The MCCB's shall be fixed or motorized type as indicated on Design Drawings for serving the specified load shedding scheme. The breaker should be occupied with LSIG protection. All MCCB's mounted inside MDB's and Freestanding SMDB's shall be of with draw-out type. While the MCCB's mounted inside wall mounted SMDB's shall be Plug In type.
2. The MCCB's shall have a minimum service short circuit capacity similar to the panel board where the same is installed.
3. MCCB's shall be of the heavy-duty quick make quick break type. Each breaker shall have adjustable type thermal over current and magnetic release and also an instantaneous magnetic trip.
4. 3 No. pole breakers shall have a common trip with a single operating handle and designed ensuring that any overload in 1 No. 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.
5. The MCCB's at the MDB's shall be provided with the necessary number of change over auxiliary switch and with signaling unit which shall be connected to the BMS system in order to provide information on the breakers conditions and alarms where required.
6. Draw-out type MCCB's shall be provided with safety shutter to cover the live parts when the breaker is withdrawn.
7. Wherever indicated on the Design Drawings or required by K-Electric, MCCBs shall be provided with earth leakage alarm relay or earth leakage relay of fixed/ adjustable sensitivity.

B. MCCB from 100 to 630 A

1. The molded-case circuit breakers shall be in accordance with IEC 60947-1 and 60947-2 standards. They shall be of category A with a rated service breaking capacity (Ics) equal to the ultimate breaking capacity (Icu) - on all the operational voltage range for the ratings up to 630 A.
2. The molded-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.

C. Construction

1. 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.
2. The operating mechanism of the molded-case circuit breakers shall be of the quick make, quick-break type with fault tripping over ridding manual operation. All poles shall operate simultaneously for circuit breaker opening, closing and tripping.
3. The molded-case circuit breakers shall be front operated by a toggle or handle that clearly indicates the 3 No. positions: ON, OFF and TRIPPED.
4. The molded-case circuit breakers shall be equipped with a "push to trip" button in front to test operation and the opening of the poles.
5. Where required, motor operated mechanism, shunt trip, under voltage release, auxiliary switches up to 4 No. 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.

D. Current Limiting

1. The molded case circuit breakers shall be capable of greatly limiting currents.
2. These characteristics shall allow high cascading performance with moulded-case or miniature circuit breakers.

E. Auxiliaries and Accessories

1. The addition of motor mechanism or a rotary handle shall in no way affect circuit breaker characteristics.
2. Only 3 No. stable tripping mechanism positions (ON, OFF and TRIPPED) shall be possible with the motor mechanism.
3. Suitability for isolation shall be provided by positive contact indication (ON and OFF) in front of the motor mechanism module.
4. The molded 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.
5. The addition of a motor mechanism, module or a rotary handle, etc., shall not mask or block devise setting.
6. It shall be possible to equip the molded case circuit breakers with devices indicating faults without tripping the circuit breaker.
7. Provide 2 NO and 2 NC spare contacts.

F. Protection Function General Recommendations

1. Moulded case circuit breakers with ratings up to 250A shall be equipped with inter changeable Thermal-magnetic trip units when used in MDB's and non-interchangeable thermal -magnetic trip unit when used in SMDB's and FDB's.

2. 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.
3. Electronic trip units shall be in accordance with appendix F of IEC 947-2 standard (measurement of RMS current values, electromagnetic compatibility, etc.).
4. Electronic and interchangeable thermal-magnetic trip units shall be adjustable and it shall be possible to fit lead seals to prevent unauthorized access to the settings.
5. Protection settings shall apply to all circuit breaker poles.

2.10 MINIATURE CIRCUIT BREAKERS

A. General

1. MCBs shall be in accordance with BS EN 60947-2 (10kA rated).
2. MCBs shall be 35mm symmetrical rail mounted type and available in one, two, three or four poles version.
3. MCBs can be reverse fed without reduction in performance.

B. Construction

1. 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".
2. 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.
3. The operating handle shall be of the toggle type.
4. Each pole shall be provided with bi-metallic thermal element for overload protection and magnetic element for short circuit protection.
5. 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 indicated in the schematic diagram.
B. KWH meters shall be K-Electric approved type.
C. All meters (indicating instruments) shall be of class 1.5.
D. Instruments shall temperature compensated to operate between -25°C and + 55°C and shall be tropical version.
E. All meters shall be in accordance with IEC 60051.

2.12 CURRENT TRANSFORMERS

A. Current transformers shall be in accordance 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).

1. For indication Class 1.
2. For metering Class 1.

E. The manufacturer shall ensure that the current transformers are such that the relays shall operate correctly when set at any point within their ranges.

F. 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.

G. Shorting links shall be provided for each current transformer.

H. Current transformers shall be cast resin insulated.

2.13 VOLTAGE TRANSFORMERS

A. Voltage transformers shall be in accordance with IEC 186.

B. Voltage transformers shall be suitable in rating and accuracy for their functions, loads and duties.

C. As a minimum they shall have following accuracy.
1. Protection applications Class 5P.
2. Indication and metering applications Class 1.

D. 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.

E. Voltage transformers shall be cast resin insulated.

F. The manufacturer shall provide MCBs with auxiliary contacts or alternatively 4-pole MCBs on the secondary side of the voltage transformers.

2.14 EARTH LEAKAGE CIRCUIT BREAKERS (ELCBS)

A. Current operated earth leakage circuit breakers shall be in accordance with BS EN 61008 providing the functions of isolation, switching and earth leakage protection of electrical circuits.

B. The ELCB's shall have a residual current operated electro mechanical release.

C. The ELCB's shall incorporate a filtering device to eliminate unwanted tripping due transient voltage.

D. A test push button is to prove operation.

E. A trip free mechanism is required to ensure that the unit cannot be held closed against an earth fault.

F. The tripping device is connected directly to the secondary of the current balance transformer.

G. No amplifiers or rectifiers are to be used.

H. The breaker shall be double pole when used for single phase and 4 poles when used for three phase circuit protection.

I. The ELCB's shall have 30mA or 100mA sensitivity as indicated in the Design Drawings.

2.15 TIME SWITCH CONTROL

A. Each time switch shall be of the quartz movement type with minimum 24-hour battery reserve or operated by a 230-volt synchronous motor and of the type incorporating separate motor supply and control switch terminals and be with a minimum of a 24-hour self-winding clockwork spring reserve.

B. Unless more sophisticated operation is indicated elsewhere, then each time clock shall be capable of 2 No. 'on' and 2 No. 'off' operations every 24-hour period. Also, any control time switch incorporated within the panel, shall be complete with an associated bypass selection facility to manually override 'on/ off'.

2.16 OVERLOAD RELAYS

A. 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.

B. The relays shall be selected such that the full load current of the equipment protected falls at the center of the relays adjustment range.

C. In case of Star Delta starter, the overload relays shall be placed on the main's contactor.

2.17 CONTROL RELAYS

A. Shall be of the encapsulated plug-in type and incorporate visual indication that the operating coil is energized.

B. 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.

C. 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° rotation by means of knurled knob with timing guide marks. The relay shall be equipped with 2 No. electrically separated time delayed contact 1 No. normally open and 1 No. normally close.

2.18 INDICATION LAMP

A. These are generally used to indicate main's presence, run, trip and fault and to give fault alarm or indicate any other function.

B. Indicator lamps shall be of the low voltage 24-volt transformer with twin LED lamp type and accord with the signaling colors laid down in BS 4099.

C. 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.

D. Terminations shall be screw grip to receive spade typing crimpled/ soldered lugs.

2.19 SELECTOR SWITCH

A. 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.

B. Hand off auto selection switch shall have 3 No. positions with center position off and shall be key operated wherever necessary.

C. 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.

1. Set of extension rails, if required.

2. Hoisting device for removing breakers.
3. Set of test plugs.
4. Levering out device, if required.
5. Manual maintenance closing lever, for electrically operated breakers.
6. Set of special tools and hardware.

2.21 RISER DIAGRAM

A. Provide to the Employer/Owner 2 No. framed as-built single line diagrams of the electrical distribution system. Install in Main LV room and Generator house or as directed by the Consultant.

2.22 DISTRIBUTION BOARDS IN PUBLIC SPACES.

A. All internal cabinets for Distribution boards in public spaces shall be 2 hours fire rated as per K-Electric requirements.

PUBLIC PROCUREMENT REGULATORY AUTHORITY (PPRA) EPADS

PART 3 - EXECUTION

3.1 ELECTRIC SERVICE

A. Electric service at 415/ 230 V, 3 phase, 4 wire, 50Hz AC shall be rendered from power transformers as indicated on the Design Drawings.

B. Requirements

1. All work performed as part of this section for the electric service shall conform to K-Electric requirements.

2. Make all required arrangements with the authorities, perform all required work, obtain and pay for all required permits and certificates required by the utility in order that the electric service is installed and put into operation at the proper time.

3.2 INSTALLATION OF MAIN LOW VOLTAGE PANELS

A. Install switchboards as noted on the Design Drawings. Ensure sufficient access for servicing and maintenance. Switchboard shall be provided at the base with 100mm reinforced plinth.

B. Contractor to provide 5mm thick rubber matt with electrostatic flooring inside the complete LV switchgear room at ground floor and basement-01 floor.

3.3 INSTALLATION OF SUB MAIN DISTRIBUTION BOARDS AND FINAL DISTRIBUTION BOARDS

A. Provide factory assembled distribution and final distribution boards as indicated on the Design Drawings, each complete with panel board directories.

B. Support cabinets and enclosures independent of connecting conduit and accurately install with reference to wall finishes.

C. The Contractor shall include for all necessary brackets, angle iron frameworks, supports, etc. for fixing of panel boards. The Contractor's attention is specifically drawn in this respect to the need for frameworks where panel boards are mounted on dry lining stud partitions, where support frames shall fix to and span between, vertical steel supports to partition lining.

D. Equip panel boards with suitable lugs or provisions to accommodate the main and branch conductors scheduled.

E. Turn over to the Employer/Owner upon acceptance of the project, 2 keys for every panel board complete with key rings, tags and key cabinets to the Consultant 's acceptance.

F. Where 2 or more panel boards are installed in 1 No. cabinet, equip the panel board with double lugs and increase gutter capacity to accommodate additional cabling. Busbars shall be rated for the combined current carrying capacity of the panel boards.

G. On all flush mounted panel boards stub 2 - 50mm empty conduits into ceiling space above panel board.

H. Complete all panel board circuit directories to the Consultant 's acceptance.

I. Fill in panel board directories using a typewriter, to identify circuits. Panel board directory shall be laminated and kept in a secure transparent pocket fixed to the interior of the board door.

3.4 AUTOMATIC POWER FACTOR CORRECTION EQUIPMENT

A. Set capacitor bank in place as indicated on the Design Drawings.

B. Connect the feeder breaker CT's and PT's.

C. Test the system before energizing the capacitor bank.

D. Commissioning of the system to be as per the manufacturers recommendations.

E. Demonstrate that the system is in perfect operating condition.

3.5 TESTING AND COORDINATION STUDY OF DISTRIBUTION

A. Inspection Testing

1. Include in the tender price the cost of on-Site Consultant inspection and testing of the following main distribution equipment.

   a. Switchboards.
   b. Distribution Equipment.
   c. Emergency Generators.
   d. Generator Switchboards and Synchronization Panels.

2. This Consultant inspection and testing shall be done prior to the system being energized and shall include the following items where applicable.

   a. Insulation resistance test

      1) Locations: phase-phase and phase-ground each vertical section.
      2) Test voltage: 1000 volts for 1 minute.
      3) Resistance: 2 meg-ohms minimum.
      4) Check buses for continuity and short circuits.
      5) Operate each switch and circuit breaker at least 3 No. times.
      6) Disconnect control wiring prior to testing.
      7) All testing shall be in accordance with the manufacturer's testing requirements.
      8) Testing, cleaning where necessary and calibrating all relays and circuit breaker trip devices. (Calibration of all protective devices shall conform to requirements of accepted coordination curves).
      9) Function test of associated control devices.
      10) Megger test interconnecting cables.
      11) Carry out fault loop impedance test.
      12) Continuity of protective conductors.
      13) Earth resistance test.

   b. Under a minimum of 80% rated load conditions perform an infra-red scan of the bus duct. Remove bus duct cover and torque all connections to manufacturer's standards.

c. Preparation of testing, inspection and commission report on the function and operation of the automatic transfer switches associated with the emergency generator.

d. An acceptance test in the presence of and satisfaction of the Employer/Owner and the Consultant.

e. The presence, for the length of the required, or qualified and competent equipment service representatives during start-up.

f. Forward for acceptance prior to energizing of the distribution system and equipment, form neat typewritten copies of the Consultant and testing report.

g. The Consultant and inspection testing shall be carried out by an independent Consultant testing company specializing in this type of work.

B. Factory Testing

1. Notify the Consultant 4 weeks in advance of final factory tests of the switchboards. The Employer/ Owner and the Consultant shall be entitled to witness all or any of the factory tests. Bear all costs associated with the factory testing.

2. Submit copies of certified test results.

3.6 COORDINATION STUDY

A. The protective system devices have been selected such that protection is adequate and good coordination is possible, however, since differences do exist between manufactures, some changes in trip rating or relay settings may be necessary and shall be carried out.

B. Carry out the following.

1. Immediately upon award of the contract and prior to the manufacture of the switchboards, prepare a set of coordination curves on time current characteristic graph paper and forward 2 copies to the Consultant for his acceptance. Make any changes as directed by the Consultant to no additional charge to the Employer/ Owner.

2. This shall be accompanied by supporting symmetrical as well as asymmetrical fault current calculation data with tabulations to verify protection of the various elements of the system under maximum and minimum fault conditions at the various points in the system.

3. The time-current characteristic curves for the following shall be plotted:

a. The relays and breakers protecting the incoming service.

b. Main and feeder protective devices at all voltage levels used in the distribution system.

c. Protective devices associated with the largest motor in each MCC, the refrigeration compressor and largest device in each distribution panel.

d. Motor generator protective devices, damage areas and current decrement areas.

C. It shall be the responsibility of the Contractor to examine the plans and specifications to ensure that all the relays and protective devices installed in the distribution system shall provide satisfactory coordination.

D. Breaker frame sizes, sensors and delay types shall be provided in accordance with the approved coordination study.

E. Testing procedures shall be in accordance with the following Regulatory Authorities, British Standards Institution and International Electro-technical Commission IEC.

3.7 TRAINING

A. The Contractor shall engage a factory-authorized service representative to provide start-up services and to demonstrate and train for up to 5 no. Employer/ Owner's representatives for 2 normal workdays at a job Site location determined by the Employer/ Owner.

B. Upon successful completion of a demonstration of the automated sequences of operation by the manufacturer and acceptance by the customer, the manufacturer shall provide an 8-hour "hands-on" training course for the customer's operating personnel which shall cover the following topics:
   1. Overall System Description and Theory of Operation.
   2. Modes of Operation as listed in the Sequence of Operations to include at a minimum:
      a. Automatic Operation.
      b. Manual Operation.
   3. Engine Safeties and Protective Relaying.
   4. Recommended System Check Lists and Log Sheets.
   5. Recommended Preventive Maintenance.

C. The training session shall be conducted by a manufacturer's qualified representative. Training program shall include instructions on the assembly, circuit breaker, protective devices and other major components.

- END OF SECTION –

SECTION V-05 (ANNEXURE A)

Standard Operating Procedure (SOP) and Power Management Philosophy

This document outlines the detailed operational sequences and requirements for the LV Power Management System, addressing the synchronization and automation requirements.

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1. System Overview and Philosophy

1.1 Power Sources & Configuration

The LV Panel utilizes a fully redundant power supply system comprising:

- Two (2) 1000 kVA Oil Type Transformers (T1 & T2 at Redundancy Mode).
- 500 kVA Diesel Generator Set (G1) operating at daytime emergency.
- 600 kVA Diesel Generator Set (G2) operating at additional backup.
- 200 kVA Diesel Generator Set (G3) operating at nighttime emergency.
- The LV busbar is physically split into **Bus Section 1** (fed by T1 or Genset) and **Bus Section 2** (fed by T2 or Genset), interconnected by an **Automatic Bus Coupler**.

1.2 Synchronization and Transfer Philosophy

- **Generator-Generator:** G1, G2 & G3 can operate in continuous parallel mode (Isochronous Load Sharing) when active.
- **Utility-Generator Transfers:** All transfers between the Utility source (T1/T2) and the Generator source (G1/G2/G3) shall be **Closed Transition** (Make-Before-Break). This requires **Forward and Backward Synchronization** capability to prevent momentary power interruptions to critical loads.
- **Bus Coupler:** The operation shall be **Automatic**, managed by the Power Management System (PMS).

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2. Hardware and Module Requirements

The following minimum hardware requirements must be met by the switchgear and genset vendors for implementation:

2.1 Synchronizing Module Requirements

Function	Requirements/Specifications
Control G1, G2 and G3 synchronization and load sharing.	Must be a recognized brand. Must support parallel operation and closed transition transfer.
Centralized logic controller for the entire LV Panel.	Required to supervise both Utility sources, manage the Bus Coupler logic, and interface with the GPRs. Must support load shedding functionality.
T1/T2 Main Breakers and G1/G2/G3 Breakers.	Must be electrically operated, draw-out type (as mentioned in SLD), with motorized closing/opening mechanisms suitable for high-speed synchronization sequences.

3. Detailed Operational Sequences (SOP)

3.1 Normal Operating Mode (Redundancy – Running one Transformer)

1. The system operates with **MB-T1 closed and MB-T2 open (or vice versa)**, and the **Bus Coupler closed**.
2. If the active transformer (T1) fails, the **MB-T1 trips**.
3. The **Bus Coupler remains closed**, allowing the remaining active source (T2) to supply both bus sections.
4. If both T1 and T2 fail, the AMF sequence (3.2) is triggered.

3.2 Loss of Utility (AMF Sequence - Auto Main Failure)

This sequence initiates **full auto-operation with no human intervention**:

1. **Fault Detection:** PMS detects loss of voltage or under-voltage on the active Utility feed (T1) for a pre-set delay.
2. **Isolation (T1):** The Main Breaker (MB-T1) trips and locks open.
3. **Automatic Transfer Attempt (T2):** The PMS checks the status of the redundant feed (T2). Since T2 is off, the system proceeds to emergency power.
4. **Generator Start:** PMS sends an auto-start command to Generator G1 (if fails then to the backup generator G2, and then third priority G3).
5. **Load Transfer:** The Generator GCB-1 breakers close, transferring the entire LV bus load to the Generator.
6. **Bus Coupler Status:** The Bus Coupler remains closed, ensuring the generator power up both Bus Section 1 and Bus Section 2.

3.3 Utility Restoration (Auto Return Sequence)

1. **Detection:** PMS detects the stable return of voltage/frequency on the Utility feeders (T1 or T2) for a minimum monitoring period.
2. **Backward Synchronization:** PMS initiates the synchronization routine to match the incoming Utility supply to the running Generator Group.
3. **Closed Transition:** The Utility Breaker (MB-T1) closes while the Generator Breaker (GCB-1) are still closed (brief parallel operation).
4. **Transfer Back:** After a short overlap period (e.g., 100 ms), GCB-1 trip open, isolating the generator from the load.
5. **Cool-Down:** The Generator enter a programmed cool-down period while running unloaded.
6. **Shutdown:** After the cool-down period, the Generator receive a stop command and the system returns to the Normal Operating Mode (3.1).

3.4 Split Bus Operating Mode (Both Transformers Active)

This is the alternative Normal Operating Mode where the bus is deliberately split into two independent sections.

A. Normal Operating Mode (Split Bus)

Component	Status	Function
MB-T1	**Closed**	Feeds **Bus Section 1**
MB-T2	**Closed**	Feeds **Bus Section 2**
Bus Coupler	**Open**	Isolates Bus Section 1 from Bus Section 2.

Component	Status	Function
Generators	Standby	Ready for automatic start upon loss of either Utility source.

B. Scenario: Loss of One Transformer (e.g., T1 Trips)

This sequence is designed to restore power to the affected Bus Section 1 using the healthy transformer (T2) via the Bus Coupler, before the generators are started.

1. **Fault Detection:** PMS detects loss of voltage on **MB-T1** for a pre-set delay (e.g., 1-2 seconds).
2. **Isolation (T1):** The Main Breaker **MB-T1 trips** and is confirmed open.
3. **Bus Coupler Command:** PMS checks the status of the remaining Utility source (T2). Since T2 is healthy and closed, the PMS sends a close command to the **Bus Coupler** ACB.
4. **Load Restoration:** The **Bus Coupler closes**, connecting Bus Section 1 to the healthy T2. Power is immediately restored to Bus Section 1 via T2 and the system returns to the Normal Operating Mode (3.1).

C. Scenario: Restoration of Failed Transformer (T1)

This sequence returns the system to the preferred Split Bus operation (3.4.A):

1. **T1 Restoration:** The fault on T1 is cleared, and T1 is ready to be brought back online.
2. **Synchronization:** The PMS initiates a synchronization routine to match the voltage, frequency, and phase of the incoming **T1** to the energized **Bus Section 1** (which is currently fed by T2 through the Bus Coupler).
3. **Closed Transition:** The Main Breaker **MB-T1 closes** while the Bus Coupler is still closed (brief parallel operation of T1 and T2).
4. **Isolation:** The **Bus Coupler opens** after a brief overlap period (e.g., 100 ms).
5. **Final Status:** The system returns to the Split Bus Normal Operating Mode (MB-T1 closed, MB-T2 closed, Bus Coupler open).

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4. Priority Settings and Generator Deployment Logic

The Power Management System (PMS) is programmed to strictly adhere to the following three-tiered priority structure when determining the source of power for the LV busbar.

4.1 Priority 1: Utility Power (T1 & T2 Redundancy)

The highest priority is always assigned to the utility grid supply via the Transformers (T1 and T2). The system operates in an Auto Transfer/Redundancy mode when utility power is available.

- **Logic:** If voltage is stable on **either T1 or T2**, the system will remain on utility power.
- **Transfer Mode:** Transfers between T1 and T2 (via the Bus Coupler) and transfers between Utility and Generator must be **Closed Transition** (synchronized) to maintain power continuity.
- **Normal State:** As defined in Section 3.1 (Redundancy Mode): Either T1 or T2 Closed, Bus Coupler Close.

4.2 Priority 2: Standard Diesel Genset (Day/Night Emergency)

If Priority 1 power is lost, the PMS uses the clock to determine which dedicated emergency generator to start, ensuring the optimal unit for the time of day is used.

Time Window	Generator Deployed	Purpose
Daytime Emergency	**500 kVA (G1)**	Handles the larger daytime load when the Utility fails.
Nighttime Emergency	**200 kVA (G3)**	Handles the smaller, essential nighttime load (Security, Life Safety, Minimal Lighting).

- **Logic:** Upon confirmed Utility failure, the PMS checks the real-time clock. It issues a start command *only* to the designated generator (G1 or G3).
- **Synchronization:** The selected generator synchronizes and closes its breaker onto the entire LV busbar (via the Bus Coupler).
- **Genset Shutdown:** This generator remains running until Priority 1 power is restored and confirmed stable.

4.3 Priority 3: Additional Backup Diesel Genset

This priority source is a dedicated fail-safe and manual backup system.

- **Generator: 600 kVA (G2)**
- **Deployment:** G2 is **not** included in the automatic AMF sequence (Priority 2). It is reserved for two specific scenarios:
    1. **Failure of Priority 2 Generator:** If the automatically started generator (G1 or G3) fails or trips out due to an overload or fault.
    2. **Manual Intervention:** An operator manually starts G2 and integrates it into the running system (usually in parallel with the functioning G1 or G3) to manage unexpected additional load or for maintenance on the other generators.
- **Synchronization:** If deployed, G2 must be synchronized with the running generator (G1 or G3) before its breaker can be closed.

5. Requirements for Manufacturing and Implementation

The finalized SLD and this SOP must be provided to all vendors (Switchgear, Genset, and Integration Contractor) to ensure:

- **Accurate Sizing:** All cables and busbars are correctly sized for closed-transition peak currents.
- **Correct Logic:** The vendor programs the PMS/GPRs exactly to the sequences defined in Section 3 and 4.
- **Manual Interlocks:** In Manual Operation Mode, all relevant breakers shall be electrically and/or mechanically interlocked to prevent unsafe parallel operation, connection of unmatched sources, or back-feeding the utility.
- **Testing:** Factory Acceptance Testing (FAT) and Site Acceptance Testing (SAT) must demonstrate flawless execution of all automatic sequences with no human intervention, and proper functioning of the manual interlocks.

SECTION V-06
MEDIUM VOLTAGE CABLE

PART 1 GENERAL

1.01 DESCRIPTION

A. Work Included:

1. Cables and related splices, terminations and accessories for medium voltage electrical distribution systems.

B. Related Work:

1. Drawings and general provisions of the Contract, including General and Supplementary conditions apply to this Section.

1.02 QUALITY ASSURANCE

A. Comply with requirements of Specifications.

B. Installer: Engage a cable splicer, trained and certified by splice material manufacturer, to install, splice, and terminate medium-voltage cable.

C. Testing Agency Qualifications: An Independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the International Electrical Testing Association or is a nationality recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the Inter National Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part3.

D. Source Limitations: Obtain cables and accessories through one source from a single manufacturer.

E. Product data: For each type of cable indicated. Include splices and terminations for cables and cables accessories.

F. Qualification data: For Installer.

G. Material certificates: For each cable and accessory type, signed by manufacturers.

H. Source quality-control test reports.

I. Field quality-control test reports.

1.03 PROJECT CONDITIONS

A. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or other unless permitted under the following conditions and only after arranging to provide temporary electric service according to requirements indicated:

1. Notify Architect no fewer than two days in advance of proposed interruption of electric service.

2. Do not proceed with interruption of electric service without Architect's written permission.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Available Manufacturers subject to compliance with requirements, manufacturers offering products that may be incorporated into the work include, but are limited to, the list of manufacturers and selected cables shall be KEMA Certified.

2.02 CABLES

A. Cable type: Medium Voltage (15 KV)

B. Comply with BS Standards.

C. Conductor: Copper

D. Conductor Stranding: Compact round, concentric lay Class B.

E. Strand Filling: Conductor interstices are filled with impermeable compound.

F. Conductor Insulation: Cross linked polyethylene.

G. Conductor Insulation: Ethylene-Propylene rubber.

1. Voltage Rating: 15KV

2. Insulation Thickness: 133 percent Insulation level.

H. Shielding: Copper tape, helically applied over semi conduction insulation shield.

I. Shielding and jacket: Corrugated Copper / Aluminum drain wires embedded in extruded, chlorinated, polyethylene jacket.

J. Three conductor cable assembly: Three Insulated, shielded conductors cabled together with ground conductors.

1. Circuit Identification: Color-coded tape under the metallic shielding.

K. Cable Armor: Interlocked aluminum applied over cable.

L. Cable Jacket: XLPE or PVC

2.03 SPLICE KITS

A. Connectors and Splice Kits: Comply with IEEE 404; type as recommended by cable or splicing kit manufacturer for the application.

B. Splicing Products: As recommended, in writing, by splicing kit manufacturer for specific sizes, ratings and configurations of cable conductors. Include all components required for complete splice with detailed instructions.

1. Combination tape and cold shrink rubber sleeve kit with re-jacketing by cast-epoxy-resin encasement or other waterproof, abrasion-resistant material.

2. Heat-shrink splicing kit of uniform, cross-section, polymeric construction with outer heat-shrink jacket.

3. Pre-moulded, cold shrink-rubber, in-line splicing kit.

4. Pre-moulded EPDM splicing body kit with cable joint sealed by interference fir of mating parts and cable.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install cable according to IEEE 576.

B. Pull Conductors: Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

1. Where necessary, use manufacturer-approved pulling compound or lubricant that will not deteriorate conductor or insulation.

2. Use pulling means, including fish tape, cable rope, and basket-weave cable grips that will not damage cables and raceways. Do not use rope hitches for pulling attachment to cable.

C. Install exposed cables parallel and perpendicular to surfaces of exposed structural members and follow surface contours where possible.

D. Install "buried-cable" warning tape 12 inches (305 mm) above cables.

E. In manholes, hand holes, pull boxes, junction boxes, and cable vaults, train cables around walls by the longest route from entry to exit and support cables at intervals adequate to prevent sag.

F. Install cable splices at pull points and elsewhere as indicated; use standard kits.

G. Install terminations at ends of conductors and seal multi conductor cable ends with standard kits.

H. Install separable insulated connector components as follows:

1. Protective caps: At each terminal junction, with one on each terminal to which no feeder is indicated to be connected.

2. Portable Feed – Through Accessory: Three

3. Standoff Insulator: Three

I. Arc Proofing: Unless otherwise indicated, arc proof medium voltage cable at locations not protected by conduit, cable tray, direct burial of termination materials. In addition to arc-proofing tape manufacturer's written instructions, apply arc proofing as follows:

1. Clean cable sheath.

2. Wrap metallic cable components with 10-mil (250-micrometer) pipe-wrapping tape.

3. Smooth surface contours with electrical insulation putty.

4. Apply arc proofing tape in one half-lapped layer with coated side toward cable.

5. Band arc-proofing tape with 1 inch (25 mm) wide bands of half-lapped adhesive, glass cloth tape 2 inches (50 mm) o.c.

J. Install fault indicators on each phase where indicated.

K. Ground shields of shielded cable at terminations, splices and separable insulated connectors, Ground metal bodies of terminators, splices, cables and separable insulated connector fittings and hardware.

3.02 FIELD QUALITY CONTROL

A. Testing: Engage a qualified testing and inspecting agency to perform the following **high pot on 18kV DC tests** and inspections and prepare test reports.

B. Perform the following field test and inspections and prepare test reports:

1. Perform each visual and mechanical inspection and electrical test stated in BS. Certify complains with test parameters.

2. After installing medium voltage cables and before electrical circuitry has been energized, test for compliance with requirements.

C. Remove and replace malfunctioning units and retest as specified above.

3.03 WARRANTY

A. Equipment, materials and workmanship incorporated into the work shall be warranted for a period of one year from the time of system handover to the client.

B. Within this period, upon notice by the Owner, any defects in the work provided under this section due to faulty materials, methods of installation or workmanship shall be promptly (within 48 hours after receipt of notice) repaired or replaced by this contractor at no expense to the Owner

C. Standard Warranty after testing commissioning after handing over to the client.

S.#	Description	Data To Be Submitted (By Bidder)	Remarks
A	**11 kV MEDIUM VOLTAGE CABLES (To be filled in for each size of cable)**		
1	Type designation		
2	Manufacturer		
3	Standard to which manufactured		
4	Test certificates:		
5	Issuing Institute		
6	Number and date.		
7	Maximum allowable temperature.		
8	At continuous operation		
9	Under short-circuit conditions.		
10	Conductor material		
11	Insulation material		
12	Sheath material		
13	Screening material		
14	Armoring material		
15	A.C. test withstand voltage level for 5 minutes, kV		
16	D.C. test withstand voltage level for 4 minutes, kV		
17	Short circuit current capacity (1 sec.)		

- END OF SECTION –

SECTION V-07

LOW VOLTAGE CABLES AND WIRES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, apply to this Section.

1.2 DESCRIPTION OF WORK:

A. Work Included: Provide low voltage electrical conductor, cable, wire, and connector work as shown, scheduled, indicated, and as specified.

B. Types: The types of low voltage electrical conductor, cables, wire, and connectors required for the project include, but are not limited to, the following:

1. 600/1000 volt building wire and cable.
2. 600/1000 volt building wire and cable connectors.
3. 300/500 volt control/signal wire and cable (LSZH).
4. 300/500 volt control/signal wire and cable connectors(LSZH)
5. 450/750 volt wiring cable(LSZH)

C. Application: The applications for cable, wire, and connectors required on the project are as follows:

1. Power distribution circuitry.
2. Lighting branch circuitry.
3. Appliance, receptacle and equipment branch circuitry.
4. Motor branch circuitry.
5. Control wiring.
6. Outdoor lighting and power.

1.3 STANDARDS:

A. Products shall be designed, manufactured, tested, and installed in compliance with the following standards:

BS 6346 PVC insulated, armoured cables for voltages of 600/1000V & 1900/3300V

BS6004 Low Smoke Zero Halogen (LSZH) insulated and LSZH over sheathed cables - up to 300/500V - for electric power and lighting.

BS6724 Thermosetting insulated armoured cables - 600/1000V to 1900/3300V - with low emission of smoke and corrosive gases when affected by fire.

B. Where application of applicable codes, Trade Association standards, or publications appears to be in conflict with the requirements of this Section, an interpretation shall be obtained from the Architect/ Consultant.

1.4 QUALITY ASSURANCE:

A. Manufacturers: Provide products complying with these specifications and produced by the manufactures provide in the list

1.5 SUBMITTALS:

A. Shop Drawing submittals shall include, but not be limited to, the following:

1. The Contractor shall submit to the Consultant for review, a list of the proposed manufacturers of wire and cable, Imported cable lugs, Imported cable connectors and termination fittings listed herein. The Contractor may install wire and cable, cable lugs, cable connectors and termination fittings furnished by any manufacturer listed on the approved submittal.

2. Cut sheets on all 300/500 and 600/1000 volt conductors with manufacturers name, ratings and capacities, insulation characteristics, and available colors, clearly listed.

3. Cut sheets indicating all cable lugs, termination fittings and cable connectors.

4. Cut sheets indicating types of conductor identification bands.

1.6 DELIVERY, STORAGE AND HANDLING:

A. Provide factory-wrapped waterproof flexible barrier material for covering wire and cable wood reels, where applicable; and weather resistant fiberboard containers for factory-packaging of cable, wire and connectors, to protect against physical damage in transit. Damaged cable, wire, or connectors shall be removed from project site.

B. Store cable, wire, and connectors in their factory-furnished coverings, and in a clean, dry indoor space which provides protection against the weather.

PART 2 - EXECUTION

2.1 INSTALLATION

A. General: Install electrical cable, wire and connectors as shown, in accordance with the manufacturer's written instructions, the applicable requirements of "Standard of Installation", and recognized industry practices to ensure that products serve the intended functions.

B. Coordination:

1. Coordinate cable and wire installation work with electrical raceway and equipment installation work, as necessary for proper interface.

2. Installer shall examine the areas and conditions under which cable, wire and connectors are to be installed and notify the Contractor in writing of conditions detrimental to the proper and timely completion of the work. Inspect wire and cable for physical damage. Do not proceed with the work until unsatisfactory conditions have been corrected.

C. 600 Volt Building Wire and Cable:

1. Mains and feeders are to be run their entire length in continuous pieces without joints or splices [, unless otherwise indicated or noted].

2. Conductors may be run in multiple on sizes inclusive, provided all multiple conductors are the same size, length, and type of insulation, and are so arranged and terminated as to ensure equal division of the total current between all conductors involved.

3. Before any wire is pulled into any conduit, the conduit shall be thoroughly swabbed in such a manner as to remove all foreign material and to permit the wire itself to be pulled into a clean, dry conduit. All conductors shall be pulled into the conduit at the same time.

D. 300 Volt Control/Signal Cable and Wire:

1. Install all low voltage wiring in a suitable raceway except in areas with accessible (lay-in) ceilings unless otherwise noted on Drawings Where cable is routed without a raceway, bundle all cables and suspend to one foot above ceiling using loop rings on 5' centers. Do not run cable loose on top of suspended ceilings. Do not attach cables to suspended ceiling supports or any mechanical, plumbing, or sprinkler piping. Conceal conduit except in mechanical rooms and areas where other conduit and piping are exposed. Fasten flexible conductors, which bridge cabinets and doors, neatly along hinge side and protect against abrasion. Tie and support the conductors neatly.

2. Number code or color code conductors appropriately for future identification and servicing of the system. Refer to consultant's advice for additional requirements.

2.2 TESTING:

A. Feeder Insulation Resistance Test: Each new [and reused existing] 600 volt feeder conductor shall have its insulation resistance tested after the installation is complete except for connection at its source and point of termination.

1. Tests shall be made using a Biddle Megger or equivalent test instrument at a voltage of not less than 1000 volt dc. Resistance shall be measured between phase, neutral, and ground conductors and from conductors to raceway(ground). Readings shall be taken after 30 seconds and 60 seconds of Megger operation at slip speed and insulation resistance shall not be less than the 1 MΩ

2. New conductors which do not meet or exceed the insulation resistance values listed above shall be removed, replaced, and retested.

3. Where reused existing feeders fail to meet the above insulation requirements, notify the Consultant in writing for direction prior to placing the existing feeders back in service.

B. Neutral Testing: After all feeder and branch circuit conductors are terminated, neutral to ground testing shall comply with the following:

1. The resistance of the system's neutral to ground shall be greater than 10 kΩ with the system bonding jumper disconnected.
2. Repeat neutral to ground test for neutrals of separately derived systems.

C. Pre-energization Check: Prior to energization, check all new [and reused existing] branch circuit cable and wire for continuity of circuitry and for short circuits. Correct malfunction when detected. No submittal is required for this test.

D. Voltage and Current Values: The voltage and current in each main feeder conductor shall be measured and recorded after all connections have been made and the feeder is under load.

E. Submittals: Contractor shall furnish all instruments and personnel required for tests. Submit four copies of certified test results to Architect for review. Test reports shall include conductor tested, date and time of test, test results, relative humidity, temperature, and weather conditions.

2.3 AS BUILT DRAWINGS

A. As-Built Drawings: Refer to Section, "Electrical General Provisions", for applicable requirements.

2.4 IDENTIFICATION

A. Identification: Refer to Section, "Identification for Electrical Systems", for color coding and markings for all conductors and cables.

2.5 WIRING CABLE SELECTION

A. All Wiring Single Cables upto 4Sqmm shall be solid with LSZH Insulation.

2.6 WARRANTY

A. Equipment, materials and workmanship incorporated into the work shall be warranted for a period of one year from the time of system handover to the client.

B. Within this period, upon notice by the Owner, any defects in the work provided under this section due to faulty materials, methods of installation or workmanship shall be promptly (within 48 hours after receipt of notice) repaired or replaced by this contractor at no expense to the Owner

D. Standard Warranty after testing commissioning after handing over to the client.

PUBLIC PROCUREMENT REGULATORY AUTHORITY (PPRA) EPADS

S.#	Description	Data To Be Submitted (By Bidder)	Remarks
A	**400 V, LOW VOLTAGE CABLES (To be filled in for each size of cable)**		
1	Type designation		
2	Manufacturer		
3	Standard to which manufactured		
4	Test certificates:		
5	- Issuing Institute		
6	- Number and date.		
7	Maximum allowable temperature.		
8	- At continuous operation		
9	- Under short-circuit conditions.		
10	Conductor material		
11	Insulation material		
12	Sheath material		
13	Screening material		
14	Armoring material		
15	A.C. test withstand voltage level for 5 minutes, kV		
16	D.C. test withstand voltage level for 4 minutes, kV		
17	Short circuit current capacity (1 sec.)		

- END OF SECTION –

SECTION V-08

BUSWAYS / BUS TIE DUCTS

The work under this section consists of supplying installing, testing, connecting, commissioning of all material and services of the Bus-bar Trunking System and accessories as specified herein and/or as shown on drawings and given in BOQ.

The contractor shall discuss the electrical layout with the Engineer and coordinate at site with other services for exact route, location and position of the Bus-bar Trunking System. Final field measurements shall be made by the Contractor prior to release of the Bus-bar trunking for fabrication by the manufacturer.

The Bus-bar Trunking System with accessories shall also comply with the General Specifications for Electrical Works and with other relevant provisions.

The Bus-bar trunking (Bus way) shall be a standard design of reputed manufacturer who shall have similar units in operation for similar applications. The manufacturer shall also have adequate maintenance facilities in the vicinity of the Project with technically qualified and experienced personnel trained for operation and on-site maintenance of the system offered by the contractor.

It shall be totally enclosed in an earthed trunking of duct and as shown on the drawings. The enclosure shall be boltless. The system shall be of sandwich type construction without any air gap between bus-bars except at plug-in openings. The complete system shall comply with the requirements of IEC 60439-1/2, IEC 61439-1 (2009-10) & IEC 61439-6 (2012-05).

Bus-bar trunking system shall be capable to withstand the seismic conditions. All the components of the system such as joints, plug-in/tap off units, end boxes, cable tap boxes, reducers, elbows, flange ends, spring type hangers, supports, etc. shall be purpose made prefabricated items by the same manufacturer.

Bus-bar trunking shall be low impendence, 690V rated, 5-conductor system, aluminum, 3-phase 4-wire with 100% neutral and 50% separate protective earth conductor, suitable for operation on a 415V, 50Hz supply system.

The continuous rated current shall be according to the designed load of each system and temperature compensated for 50 deg. C indoor ambient condition. The minimum short circuit withstanding capacity at 415 VAC for one second shall be equal to or higher than the perspective fault level of installation, but shall not be less than 50 kA. Vendor is to submit documents in support.

All technical data relevant to Bus-bar trunking system like current carrying capacity, de-rating factors, voltage drop, and short circuit withstand capacity, etc. shall be submitted by the manufacturer for Engineer's approval.

Bus-bar trunking system shall have protection against mechanical damage, dust accumulation and weather proof to IP-55 degree of protection.

External fire barriers shall be provided for Bus-bar trunking, and shall also be positioned when it passes through fire insulating ceiling and walls. These fire barriers shall be effective in the space between the trunking and the protective sleeve of the ceiling.

Vendor shall submit details of all the tests, which will be carried out at the factory as per Standards prior to delivery.

APPLICABLE STANDARDS / CODES

The latest editions of the following standards and codes shall be applicable for the material specified within the scope of this section.

IEC	60439	Low Voltage Switchgear & Control gear Assemblies.
B S	1432	Bus-bars.
B S	7671	IEE Wiring Regulations for Electrical installations.
IEC	60947-2	Low Voltage Switchgear and Control gear.

MATERIAL

Bus-bar Trunking

The Bus-bar trunking system shall be established as specified on the drawings. The housing shall be constructed of code gauge steel and aluminum to reduce hysteresis and eddy currents and shall be provided with a suitable protective finish of grey epoxy paint or as approved by the Engineer.

The Bus-bar trunking including all joints shall be totally enclosed, non-ventilated, water proof to minimum IP-55 standard. Any length of the assembled bus-bar trunking shall be possible to remove without affecting the other lengths connected at the edges, to facilitate future additions and maintenance work.

All the joints and terminations shall be bolted type ensure proper contact pressure. No loose connection shall be allowed in the system. The high strength steel bolts with washers shall be torque indicating type and at earth potential.

The bus-bars shall be high grade tin plated aluminum and shall comply with Standards. Current rating shall be as shown on drawings at required ambient temperature. The earth conductors shall be properly bonded with body on both sides and bonded with the joints as well as adjoining Busbar piece.

The conductors shall be color coded and insulated with Class F 155 deg.C certified flame retardant mylar over the entire length to be applied by automatic process and higher impact strength of minimum 150lbs. The temperature rise at any point in the bus-bar trunking shall not exceed 550C rise above ambient temperature when operating at rated load current. Dielectric strength shall be 2.7kV/mil for 7.5mil thickness and total breaking capacity 40kV for two layer of mylar and 81kV for four layer of mylar.

- Verification of resistance of insulating materials to abnormal heat
- Verification of dielectric properties
- Verification of Temperature rise limits
- Verification of resistance to flame propagation
- Verification of fire resistance in building penetration of the Busbar system along with the fire barriers
- Compliance to 50 Deg C Ambient temperatures without any de-rating

All plug-in openings shall be covered by hinged doors, which cover the openings when not in use. The hinged door shall have padlocking facility to prevent opening by unauthorized persons. All openings shall be usable simultaneously.

All contacts on joints and plug-in openings should be bimetallic Aluminum or silver plating copper to avoid electrochemical corrosion and minimize the contact resistance.

INSTALLATION

The Bus-bar trunking system shall be installed at locations shown on the drawings. The Contractor shall be responsible to ensure co-coordination with the civil works for providing any opening, holes, etc. to avoid any breakage to completed works. In case the provision in civil works for installation of above electrical works are not made or made incorrect, the same shall be rectified by the Contractor at his own cost and to the satisfaction of Engineer.

The contractor shall be responsible for routing the trunking on-site after co-ordination with all other services. Final measurements shall be made by the contractor prior to release of the trunking for fabrication. Complete site installation including alignments, joints, meggering etc. must be certified by the manufacturer's representative and signed off by Contractor and Vendor prior to offering the installation for commissioning.

Bus-bar trunking shall be preferably installed in such a way that plugs are side mounted to permit practical use of all plug-in openings.

The Bus-bar trunking system shall be supported throughout the entire length as per manufacturer's requirements to withstand its own weight and abnormal forces created on short circuit conditions/seismic conditions. However, the spacing between hangers/supports of bus-bar trunking shall not exceed 6 feet for horizontal runs and 10 feet for vertical runs.

Bus-bars expansion fittings shall be provided at all building expansion joints and for long lengths as recommended by the manufacturer. Spring type hangers shall be used for fixing of Bus-bar trunking when they run vertically. Purpose made fittings, supports and accessories should be used throughout the installation.

Fire barriers, when installed shall prevent fire, smoke and hot gasses passing into the next story and according to Civil Defense regulations.

Bus-bar trunking should be covered with plastic envelope until building is clean and the Bus-bars are ready to be tested and energized.

TESTING INSPECTION AND COMMISSIONING

The tests to be carried out in accordance to International Standards at Manufacturer's factory. Test report shall be provided and shall include but not necessarily be limited to:

1. Inspect physical and mechanical condition.

2. Inspect anchorage, alignment and grounding.

3. Prior to system commissioning, perform all Electrical tests including:

    - Insulation Resistance Test
    - Dielectric Voltage Withstand Test
    - Contact Resistance Test
    - Thermal Imaging Test

- END OF SECTION -

SECTION V-09

CONDUITS AND PIPES

SECTION 26 05 33_CONDUITS & ACCESSORIES

PART 1 - GENERAL

1.1 WORK INCLUDED

A. This section supplements the main contract conditions and forms part of every section of Division 26 Electrical trade and shall be read in conjunction with all sections of the specification.

B. Provide all labour, materials, products, equipment and services to supply and install the conduit and accessory systems as indicated on the drawings and specified in these specifications.

C. Conduits shall be installed to protect and enclose cables as required by the current edition of BS7671 and the local power supply authority.

D. Generally, all surface mounted conduit shall be electro metallic tubing (EMT) type. PVC conduit shall only be permitted for cast-in or embedded in concrete use, unless specifically approved otherwise by the Engineer.

E. Contractor to consider all installation requirements to cast all of the conduits within the slab as part of the main contract.

1.2 REFERENCE STANDARDS

A. All electrical installations shall be carried out in accordance with the best International Standards and Codes of Practice specifically with the current issue of the IEE Regulations (BS 7671) and the requirements of the local supply authority.

B. The entire installation shall be installed and tested in accordance with the relevant British and International Standards and requirements of the local power authority.

C. Wherever reference is made to a British Standard (BS), a British Standard Institution recognized equivalent European Standard would also comply. (See latest BSI Standards Catalogue etc) Each type of equipment/material selected shall comply fully with either the BS or the European Standard.

D. Listed below are the British Standards and codes referred to in this section.

1. BS 31: Specification, Steel Conduit and Fittings for Electrical Wiring.

2. BS 731: Part 1 Flexible Steel Conduit and Adaptors for the Protection of the Electric Cable.

3. BS 4568: Specification for Steel Conduit and Fittings with Metric Threads of ISO Form for Electrical Installations.

4. BS 4607: Non Metallic Conduit and Fittings for Electrical Installations.

5. BS EN 61386-25 ***:*** Specification for Conduit Systems for Electrical Installations.

6. BS EN 60423: Conduits for Electrical Purposes – Outside Diameters of Conduits for Electrical Installations and Threads for Conduits and Fittings.

1.3 REFERENCE STANDARDS – LOCAL AUTHOIRTIES WITH JURSIDICTION

A. In addition to the requirements indicated on the Design Drawings, or specified in Division 01 General Requirements, the Particular Specifications and the MEPF Scope of Works, the Work shall be in accordance with the relevant statutory authority requirements published by the local authorities having jurisdiction.

1. K-Electric
2. Pakistan Electricity Rules 1937
3. Building Energy Code of Pakistan
4. Building Code of Pakistan- Fire Safety Provisions
5. Any other local authority Guideline applicable for this project

1.4 SYSTEM DESCRIPTION

A. Generally conduits will be utilized for the final run out to terminal equipment and devices.

B. Identify conduit with colored paint dabs as identified under this section.

C. The minimum conduit size used shall be 20mm

D. All bends formed in conduits shall be made in a conduit bending machine fitted with a former of the correct radii for each conduit size. The bends shall be made without altering the section of the conduit or opening the seams of the conduit. The inside radius of all bends shall exceed 3 times the external diameter of the conduit.

E. All conduits shall be secured in an efficient pipe vice whilst being cut, screwed and reamed.

F. Conduits shall be installed either vertically or horizontally and generally be installed in line or perpendicular to the building structure.

G. The whole of the conduit installation shall be coordinated with other services to be installed in the building or buildings, and routes shall be agreed with the Engineer prior to the commencement of the installation. Conduits shall be installed at least 250mm from hot water pipes and at least 50mm from other service pipes, cables and ducts.

H. Conduits shall be bonded to other services in accordance with the requirements of the current edition of BS7671.

I. Unless otherwise noted all conduits must be concealed, being run in roof spaces, behind suspended ceilings, under floors, within in situ cast concrete, or in cut/cast chases into walls. Surface run conduit installations will only be permitted at the discretion of the Engineer. All conduits that are to be concealed shall be inspected and tested prior to enclosure. Surface conduit work shall only be allowed where methods of construction preclude the concealment of the conduit and on fair faced brickwork or block work subject to approval to the Engineer.

J. Conduit runs shall be planned to obviate the need for draw in boxes, but where the use of such boxes is unavoidable they shall be accessible at all times and be fitted with covers.

K. Conduit systems shall be complete and continuous throughout. Luminaires and other equipment bodies shall not be used for through wiring.

L. Where conduits cross expansion joints proprietary expansion couplings shall be utilized. Earth continuity shall be maintained by LSF sheathed green/yellow copper conductors with minimum cross sectional areas of 4mm connected to each side of the expansion joints by proprietary earth clamps.

M. Prior to the drawing of any cables the complete conduit system shall be swabbed to remove any debris or moisture.

N. Conduits shall be stored in dry conditions prior to installation. All conduits damaged mechanically or by oxidization will be rejected.

O. The installation of conduit boxes in floors shall generally be avoided but where it is essential it shall be agreed with the Engineer. The floor mounted boxes shall be fitted with brass covers recessed to accommodate the floor finish. The covers shall seal the box against the ingress of moisture.

P. Conduit boxes used for drawing in purposes shall be installed complete with well-fitting rubber gaskets unless detailed otherwise.

Q. When conduits are specified as being installed on the surface the runs must be arranged to render the whole system as neat and inconspicuous as possible having regard to existing Architectural features. All vertical and horizontal runs must be plumbed and levelled respectively.

R. Particular care must be taken to obtain a symmetrical layout where conduits converge and run together near distribution centres. The distance between conduits shall be maintained through bends and sets and shall not noticeably vary.

S. All conduit runs must be designed to permit wiring to be readily installed after the complete erection of the conduits through the available draw-in, accessory and luminaire suspension boxes.

T. No conduit runs will be allowed to be laid underground in any circumstances whatsoever.

U. Cable drawing facilities shall be provided no greater than 6m apart for straight lengths of conduit installation and after every 2 right angle bends or equivalent sets.

V. In cases where it is necessary to install draw in boxes, where a number of circuits of the same voltage run together in the same direction, adaptable junction boxes of the required size to take all conduits shall be fixed in the run to facilitate the drawing-in of the cables instead of inserting a separate circular box in each individual run.

W. In all positions where the appearance of the conduit layout would be improved by the introduction of dummy lengths of conduit and in all cases where a more secure fixing for the suspension of fittings is considered necessary and would be obtained by continuing the conduits from their respective normal terminations, such dummy conduits and continuations must be included for and introduced.

X. Where surface mounted equipment (other than luminaires) is specified all concealed conduits shall be terminated in a conduit or an adaptable box installed recessed into the wall at every surface mounted equipment position. The recessed box shall be completely covered by the surface mounted equipment. Provision shall be made in the back of the surface mounted equipment for the conveying of cables (including protective conductor) from the conduit system via a suitably bushed opening.

Y. Any opening between the recessed box and the surface mounted equipment shall be closed when the surface mounted equipment is fixed, to prevent the ingress of dirt etc.

Z. Where surface mounted luminaires are to be fixed to a concealed conduit system the boxes shall be circular. Screwed metal caps or plugs shall be used to protect the open ends of conduits and boxes. Special care shall be taken to prevent foreign matter entering the conduit. Cork plugs shall be used at temporary conduit terminations to prevent the ingress of foreign matter.

1.5 CAST-IN CONDUITS

A. Cast in conduits shall be provided to suit the works programmes for the concrete walls and floor slabs as necessary.

B. Runs of conduit shall be installed vertically straight wherever possible.

C. Allow for full coordination with the Structural Contractors drawings and take full cognisance of his programme and sequence of works.

D. Install conduit runs in time to suit concrete pours.

E. Provide shop drawings detailing the setting out of cast in conduits prior to installation.

F. Cast in conduit to be high impact plastic.

PART 2 - PRODUCTS

2.1 GENERAL

A. All products should be tested as per international standards and local authority regulations in the accredited laboratory certified by the governing body with authorization.

B. All products should be subject to the required tests following a standard sample format or procedure as per the operational performance requirements.

C. All life safety related systems and products should be approved by the Civil Defense

D. All Products' warranties shall be as per client's requirements.

2.2 CONDUIT & ACCESSORIES (CLASS 4)

A. All metal conduits shall be new, heavy gauge, seam welded, Aluminum tube screwed conduits manufactured to BS 4568 " Aluminum Conduits And Fittings with Metric Threads of ISO Form for Electrical Installations", BS EN 60423 and BS EN 50086. All conduits shall be appropriately selected such that they are fully compatible with the local environmental conditions in which they are to be installed, and also for the surfaces that they are to be fixed to. Indoor conduits shall be Class 2, conduits located outside or in damp situations shall be Class 4.

B. Any conduits and fittings which do not conform to specification or are damaged due to poor storage and handling on or off site shall be rejected and removed from site.

C. Where a Class 4 installation is utilized in damp conditions or externally, gaskets shall be fitted to all boxes. Adaptable boxes in such circumstances shall have external fixing lugs.

D. All conduit and accessories shall be **18 SWG Aluminum:**

1. Plantrooms and wet areas
2. External areas
3. Where additional mechanical strength required.
4. In ceiling voids/plenums which are used for smoke extract

E. Conduit shall be provided from an approved manufacturer / supplier

2.3 CONDUIT FITTINGS

A. Conduit fittings and accessories shall be finished to match the conduit system and shall comply with BS EN 4568, BS EN 60423 and BS EN 50086. All conduit fittings shall be screwed or loop in malleable iron type fitted with covers secured by brass screws. Rectangular adaptable hot dip galvanized steel boxes may be used on multi-conduit runs.

B. Male and female bushes shall be brass and shall be manufactured to comply with the same BS as for other conduit fittings noted above. All screwed couplers, lock nuts and reducers shall be made of malleable iron.

2.4 FLEXIBLE CONDUIT

A. Conduit connections to motors or other such items of removable equipment, unless otherwise stated, shall be made with LSF sheathed metallic flexible conduit, in accordance with the attached Schedules and to BS.731.

B. All such metallic flexible conduit shall be composed of double aluminum with bitumen infused paper interleaf, with a LSF overall sheath. Each end of the flexible conduit shall be terminated by a coupler comprising a union, lead seal and screwed nut. Each coupler shall have a male thread for connecting to a standard BS.4568 box or an equipment terminal box.

C. Flexible conduit shall be provided from an approved manufacturer / supplier.

2.5 ACCESSORIES BOXES

A. All accessory boxes shall be metallic and manufactured in accordance with BS.4662.

B. All boxes shall be minimum 35mm deep.

2.6 PLASTIC CONDUIT & ACCESSORIES

A. Insulated conduits shall be heavy gauge, high impact and manufactured to comply with BS 4607 non-metallic conduits and fittings for Electrical Installations. All conduit boxes, couplings, draw-in boxes, etc., shall be of the same manufacture and quality as the conduit. They shall be of the heavy gauge, high impact type, self-extinguishing PVC/LSF, free from imperfections with smooth internal and external surfaces and have a minimum diameter of 20mm. The conduit shall be suitable for use in ambient temperatures up to 55oC. The conduit shall be non-hygroscopic and self-extinguishing.

B. All bends and sets shall be in accordance with Part 5 of the current edition of BS7671 formed with the aid of a helical spring fitted internally, with, if necessary, the conduit warmed sufficiently for it to move without deformation of the bore, and without avoidable wall thinning on the outside of the bend.

C. Accessories boxes for small power outlets shall be metallic with plastic branches/fixing supplied to suit for flush installation and plastic where surface.

D. Circular boxes shall be provided for all outlet points for luminaires and ceiling switches. Boxes shall have fitted brass earth terminals and be heat resistant and reinforced with tapped metal inserts for fitting and fixing screws. Extension collars shall be provided to bring the aperture of the box flush with the wall/ceiling finish.

E. Adaptable boxes shall be to the same specification as the conduit with the PVC lids fixed by brass or nylon screws. Adaptable boxes smaller than 75mm x 50mm or larger than 300mm x 300mm shall not be used. Where cable joints are permitted or specified, ensure boxes are of adequate size to contain the terminal block and space for making neat satisfactory connections.

F. Terminal blocks shall be porcelain type and fixed to the adaptable box using brass or nylon screws.

G. For surface mounted PVC conduits, saddles of the spacer bar type shall be provided with 3mm clearance. Fix saddles with brass screws.

PART 3 - EXECUTION

3.1 CONDUIT & ACCESSORIES BOXES

A. Circuits shall be segregated in accordance with the current edition of BS7671. Ancillary services, extra low voltage circuits and emergency lighting circuits shall in all cases be run in dedicated conduits.

B. Only circuit conductors originating from the same distribution board shall be run together in the same conduit/trunking system. Circuit conductors from different systems or from different distribution boards shall not be run in the same conduit system or conduit accessory box. All circuit conductors of a particular circuit shall be enclosed within the same conduit. A separate protective conductor shall be run in all cases.

C. At intersection points on the multiple conduit runs, Aluminum adaptable boxes with light Aluminum covers (overlapping for concealed conduit work) shall be used in accordance with Standard Sheets No. 3a and 3b in BS.4568 Part 2. All such adaptable boxes shall have a minimum depth of 1.5 times the largest conduit entry. Cables from more than one distribution board shall not enter any single adaptable box.

D. No cables apart from draw wires shall be drawn into a conduit system until it is completely finished. No conduits shall be filled beyond the maximum capacities set out in the appropriate tables within the current edition of BS7671.

E. Any conduit work rejected by the Engineer shall be replaced at no extra cost.

F. The manufacturer's threads applied to each length of conduit shall be reduced in length to conceal the thread in the conduit box fitting or accessory without protrusion and cleaned by means of conduit tap or die before installation. Each joint shall have however a minimum of 6 threads.

G. The ends of all conduits shall be reamed internally to give a smooth bore. No thread shall be exposed except at running couplers.

H. Running couplers shall be backed by a securely locked heavy gauge lock nut and excess threads painted with zinc-rich paint for H.D.Z.C.S.

I. All couplers shall be securely tightened and care shall be taken to ensure that conduits butt-up inside the couplers.

J. No conduit bearing traces of rust or damage shall be used. The conduits shall be cleaned and free from oil before installation.

K. Conduit shall be laid as far as possible in straight lines with easy sets or bends. Conduit to be formed shall be bent cold without altering the section with an approved type of machine. Such bends and sets shall be painted with good quality paint wherever the finish has been removed. The conduit shall be run so as to be self-draining to switch boxes, incorporating, as necessary, an approved means of draining.

L. Where condensation is likely to occur, the section shall be isolated by means of non-hardening plastic compound in a conduit box installed for this purpose at a high level in the run.

M. Conduits entering equipment or accessories shall do so through clearance holes only and connection shall be made by means of a hexagonal male brass bush, earth continuity washer and coupler. Connections to cable trunking and large sheet Aluminum adaptable boxes shall be made by means of a hexagonal male brass bush of the long threaded type, earth continuity washer, washer and flanged coupler.

N. Standard round boxes in accordance with Standard Sheet 4 of BS.4568 Part 2 and with 50.8mm fixing centres and of malleable iron shall be used for all intersection and outlet points, except where the conduit terminates in accessories such as lighting switches, socket outlets, etc.

O. At intersection points on the multiple conduit runs, Aluminum adaptable boxes with light Aluminum covers (overlapping for concealed conduit work) shall be used in accordance with Standard Sheets No. 3a and 3b in BS.4568 Part 2. All such adaptable boxes shall have a minimum depth of 1.5 times the largest conduit entry. Cables from more than one distribution board shall not enter any single adaptable box.

P. Conduits of a capacity sufficient to carry a full number of distribution board circuit way cables shall be installed between trunking and distribution boards. Conduits for sub-mains supplying the distribution board shall be considered separately.

Q. Adaptable boxes and distribution boards, where not fixed to trunking, shall be installed with 20mm or 25mm clearance holes suitably plugged, with at least two holes for adaptable boxes and holes equal to spare ways for distribution boards

R. Manufactured solid or inspection elbows or tee pieces shall not be permitted.

S. The conduit work shall be arranged so that the wiring can be drawn in and out, and later renewed from draw-in box and point box positions. Draw-in boxes and point boxes shall be of ample size to enable this to be carried out.

T. Where conduits are cast in, the Contractor shall include for packing out boxes etc to ensure that pathways remain clear. The Contractor shall include for rectifying any instance where conduits are blocked for whatever reason.

U. No boxes shall be provided in voids where access cannot be readily obtained. No draw-in boxes other than point boxes shall be installed in the plaster wall or ceiling surface, where the conduit work is flush, except within cupboards and switch-rooms, or where specific permission is given by the Engineer. If permission is given, each box shall be made permanently accessible and so arranged to be neatly finished, flush with the finished surface of the walls, ceilings or floors.

V. Conduit buried in concrete or plaster and chased into walls shall be secured by holdfasts or crampets spaced at intervals not greater than 120mm and there shall be not less than 20mm covering over the final projection of any holdfast coupling, conduit, etc. This Contract is to include chasing for concealed conduit, the making of ways for the conduit shall be carried out by machine raggling of all necessary walls, floors, ceilings, etc. and it shall be noted that no other method of raggling shall be accepted.

W. Conduits shall be tested for electrical continuity before plastering or screeding and prior to drawing in cables. A record shall be kept of all such tests.

X. Horizontal wall chases shall be limited to a maximum of 600mm.

Y. All surface conduit fixed to walls, ceiling and to the roof Aluminum work shall be fixed by means of heavy gauge distance saddles at Standard Sheet No.23 of BS.4568 Part 2 spaced at intervals not greater than 1200mm apart with additional saddles as necessary at bends and joints and within 275mm of such points. Draw-in points shall be available on such conduits every 8.00m of a straight run or after not more than two right bends. Where such points are provided exclusively for draw-in purposes, they shall be in the form of rectangular junction boxes.

Z. No conduit or accessories smaller than 20mm shall be allowed and the number of cables drawn into each conduit shall not exceed that stated in the latest I.E.E. Regulations.

AA. Conduit shall be threaded to the correct length as indicated in BS 4568 Part 1 or BS 31, recessed at both ends to remove all sharp edges and burrs after screwing.

BB. Conduit runs shall be left clear of gas and water pipes by a minimum distance of 150mm. Where conduit is, or may be, in contact with any structural Aluminium work, an efficient and permanent connection shall be made between the conduit and the metal work.

CC. No part of the conduit shall be under mechanical stress and each length of conduit shall be swabbed out prior to the installation of the cables.

DD. All conduit boxes, saddles and point boxes shall be fixed by not less than 40mm x No.8 wood screws with suitable approved plugs in concrete or brickwork, and not less than 25mm x No.8 wood screws in structural timber. No fixing shall be made to building boards or to plaster, but only to concrete, brickwork, timber structures and block or tile partitions.

EE. Countersunk screws shall be used to fixing only where special countersunk holes have been drilled or provided. Round head screws used for all fittings shall be black japanned finish. Screw heads shall have all burrs and sharp edges removed before wiring commences and all screws are to be driven into their correct depth. Box lids shall be fitted by means of brass round headed M.4 screws.

FF. Conduits crossing expansion joints shall be fitted with expansion couplers at the position of the expansion joint. An earth wire shall be installed between the nearest conduit box at either side of the coupler. The back of the conduit box shall be drilled

and tapped to a size not less than M.4 and the earth connection made by means of an approved combination of terminal washer and brass screws.

GG. Where conduits pass from inside the building to the outside, free circulation of air shall be prevented by the insertion of a conduit box, which shall be filled with plastic compound after the cables have been drawn in.

HH. All flush boxes installed shall be recessed approximately 3mm below the finished wall or ceiling surface. The Contract shall include for verification on site with the Contractor for the finished thickness of all walls and ceilings.

II. Attention shall be paid to the installation of surface conduits. All corners and angles shall be neatly negotiated with vertical and horizontal runs kept straight. No diagonal runs shall be permitted and all branches shall be taken off at right angles.

JJ. The phase and neutral conductors of the same circuit or circuit shall be drawn into the same conduit.

KK. The conductors forming the various systems shall be installed in separate conduits or trunking compartments unless specifically agreed otherwise in writing by the Engineer.

LL. All conduit which is left with screw ends for the reception of outlet boxes, etc., shall be fitted with a coupler and screwed plug to protect the end.

MM. No conduit shall be installed in the vertical ducts specifically reserved for the installation of the mechanical trade without the permission of the Engineer.

NN. Where conduits are installed in floors where the screed is not be completed within three days of the installation, then the conduits shall be immediately protected by means of a haunching of a cement and sand mixture.

OO. Conduits set through walls shall not be permitted. Where conduits change direction through a wall, a back outlet box shall be used.

PP. A running coupler socket within 300mm above or below the floor on all vertical drops or pieces respectively shall be provided where conduit is cast into or passes through structural floors.

QQ. No outlets shall be installed immediately behind each other (i.e. back-to-back) in a common wall or partition, unless agreed in writing by the Engineer. Separate conduits shall be taken to each outlet.

RR. Where electrical conduits are required to be distinguished from pipe lines or other services these shall be coloured orange as the basic identification colour in compliance with BS.1710.

3.2 CONDUIT FITTINGS

A. All circular type boxes must be fitted with long screwed spout conduit entries with the screwed thread terminating within the spout and the edges of the internal orifice of the box rounded and smoothed to act as a bush, excepting adaptable Aluminum rectangular boxes and loop in conduit boxes, in which case male bush and flanged coupling must be used for conduit connections.

B. At multi conduit junctions where standard conduit boxes are impractical to use, malleable cast iron adaptable boxes shall be utilized. The size of the box shall be determined upon the volume and type of cables being installed. The minimum box

dimension shall be 150 x 150 x 50mm deep, all boxes to be used shall be verified with the engineer at the earliest available opportunity. The boxes shall be complete with a malleable cast iron flush lid secured by 4 No M4 brass pan head screws.

C. Where such boxes are required on flush conduit systems, they shall be fitted with a 1.5mm galvanized Aluminum lid which shall overlap the box by a minimum of 6mm on all sides.

D. In situations where more than 3 No 25mm conduits are required to terminate in one side of an adaptable box, the box size shall be increased accordingly.

E. In concealed installations boxes shall be fixed with the rims flush with the finished surfaces, but when for any reason whatever the rims are below the surface, suitable extension rings of the required depth shall be provided and installed to finish flush with the surrounding surfaces and with the lids of sufficient oversize (7.5mm minimum all round) to cover the junction between box and plaster.

F. In no case will the use of proprietary bends, sets, elbows, inspection elbows or tees be permitted, unless specifically allowed in writing by the Engineer to meet specific conditions.

G. Where the conduit system is the sole support of the luminaires via conduit boxes, additional saddles disposed symmetrically about and near to the point of suspension must be introduced for security of fixing.

H. Galvanized, sherardized or cadmium plated screws shall be used in all cases where galvanized conduit is installed.

I. When conduits are required to be run on shuttering, prior to the laying of concrete in-situ, additional security must be provided near to every box and at intervals of not more than 1.2 metres by the introduction of short lengths of Aluminum wire, of not less than 2mm diameter twisted around the conduit and reinforcing Aluminum. The conduits shall be adequately fixed to prevent excessive movement and damage during the pouring and settling of concrete and shall be protected from mechanical damage.

J. Where conduits are left "open ended" prior to wiring they shall be protected by caps or plugs to prevent the ingress of building materials etc.

K. The building construction may require particular treatment in respect of the fixing of conduit and/or fittings in order to obtain permanent security. The drilling and tapping of non-structural Aluminum work, the supply and fixing of metal straps, supports, clips, clamps and plates and the introduction of additional conduits of larger sizes than actually required for wiring, together with all fixing devices, must be included for wherever such practices are necessary, and particularly when luminaires etc., have to be supported independently of specially suspended ceilings. The Engineer's written approval shall be obtained before any hole is drilled or cut in structural Aluminum or structural concrete.

3.3 LOCKING, BUSHING & COUPLING

A. All conduit ends must be filed square and reamed before erection to ensure freedom from internal burrs and roughness. All inside surface of the conduit system shall be free from projections.

B. Running couplings shall only be used where absolutely necessary. All running couplings shall be secured by means of lock nuts or lock rings.

C. Care shall be taken to ensure all locknuts seat firmly into the adjoining surface.

D. On galvanized Aluminum conduit installations galvanized internal threaded couplings shall be used.

E. Every conduit connection to equipment, boxes, distribution boards, loop-in boxes, cable trunking etc. shall be made by means of a smooth bore brass bush. The smooth bore bush shall be fitted to secure the conduit to the item connected via a purpose made clear hole only sufficiently large to permit the bush to be rotated, the hole to be closed by the bush and coupling with all bushes on the inside of the item of equipment. Bushes shall be fitted and tightened by means of correctly fitting spanners.

F. Damaged bushes must not be fitted, and any bushes damaged whilst being fitted must be removed and replaced.

G. Conduits connecting by couplings shall be connected by means of a 15mm long threaded section and shall have a gap of approximately 2mm between the adjoining threads. No threads shall be exposed except at running couplings.

H. All free ends of conduit shall be fitted with brass female bushes.

I. The complete conduit system shall be so arranged to ensure that any condensation arising in any part of the system shall drain to a suitable drainage point.

J. Specific anti condensation measures shall be taken where appropriate.

3.4 CONTINUITY & EARTHING

A. The whole of the conduit installations shall be mechanically and electrically sound. The integrity of the conduit continuity shall be tested with an appropriate test instrument, all in accordance with the current edition of BS 7671

B. Install a separate protective conductor in all conduit systems.

3.5 PAINTING OF CONDUIT

A. All exposed threads shall be painted and all conduits which have suffered minor damage shall be made good to prevent oxidization. Lubricants or cutting compound shall be removed from conduit prior to painting. Galvanized conduit which is slightly damaged shall be primed and painted with a metal based paint to match the colour finish of the conduit.

B. Conduits which are in the opinion of the Engineer more than slightly damaged shall be rejected and replaced.

3.6 FLEXIBLE CONDUIT

A. Flexible conduit shall be terminated using approved glands, couplings and bushes with serrated washer fitted to all bushes on the inside of the equipment. External terminations shall also have a neoprene or rubber washer between coupling and equipment.

B. In all instances a separate PVC insulated green and yellow coloured protective conductor complying with the current edition of BS7671 shall be installed and terminated at each end into purpose made earthing terminals.

C. Under no circumstances will flexible conduit be accepted in lieu of sets and bends in rigid conduit installations.

D. In normal circumstances flexible conduit shall have a minimum length of 300mm and a maximum unstretched length of 700mm. It shall permit a full range of withdrawal, adjustment or movement of the equipment.

E. Each length of flexible conduit shall be complete with an approved integral copper earth wire of 2.5mm sq minimum size incorporated during manufacture. As an alternative, an independent earth wire of 2.5mm sq minimum size and complete with butyl rubber insulation shall be installed in all such flexible conduit and shall be connected to the accessory terminal at one end and an M.4 brass screw and washer tapped into the back or side of a BS.4568 conduit box at the other. This is to ensure electrical continuity across the flexible joints.

F. Flexible conduits shall not be less than 300mm and more than 1.00m in length unless permitted in writing by the Engineer.

3.7 ACCESSORIES BOXES

A. Boxes shall be fixed by not less than 40mm x no.8 wood screws with suitable approved plug in concrete or brickwork and not less than 25mm x no.8 wood screws in structural timber.

B. Where boxes are provided in partitions, noggins shall be provided to enable a firm and rigid fixing.

C. All flush boxes installed shall be recessed approximately 3mm below the finished wall. Where installed in dry lining, boxes shall be supplied with extension collars to achieve this.

D. No box shall be installed immediately behind each other (i.e. back-to-back) in a common wall or partition, unless agreed in writing by the MEP Consultant.

3.8 PLASTIC CONDUIT & ACCESSORIES

A. Plastic conduits shall generally be installed in accordance with the requirements for Aluminum conduit, using plastic fittings, circular, boxes, bends and sets to BS.4607 Part 1 and 5 as applicable.

B. Lengths of conduit shall be coupled together by means of couplings secured by an adhesive solution approved by the conduit manufacturer. All other plastic accessories shall be fixed in a similar manner. Insert square cut conduits to the full depth of the spout.

C. Bends and sets in plastic conduit shall be formed by the use of a helical spring fitted within the conduit. The conduit shall be warmed sufficiently for the bend to be formed without deforming the conduit and causing excessive thinning of the conduit bore on the outside of the bend.

D. Connections to boxes on equipment shall be by means of plastic bushes fitted within the equipment and locking rings fitted externally.

E. Expansion couplers shall be fitted every 6.0m on straight lengths secured to one conduit and a sliding fix to the other using flexible adhesive to prevent the ingress of moisture.

F. Where conduits are to be embedded in concrete they shall be to BS.4607 Part 3 and be installed to the manufacturers recommendations.

G. Conduits shall be secured by plastic spacer bar saddles at the following distances:

H. Maximum horizontal spacing 1.0m

I. Maximum vertical spacing 1.2m with saddles fitted 150mm each side of bends or sets.

J. Cover conduit buried in floor and/or roof screeds with at least 25mm depth over the entire length. Plan and install conduit routes so that crossings are avoided, and lay parallel conduit 150mm apart.

K. Where concealed in plastered walls, cover conduits with 12mm cover along the entire length. Avoid horizontal routes.

L. Ensure conduits laid in in-situ concrete are securely fixed to the reinforcement Aluminium work. Fix conduit boxes to the shuttering.

M. Make fixings by means of single hole plastic half-clips. Place these at intervals to comply with the Current Edition of BS.7671 and at all changes of direction to prevent displacement.

N. Standard boxes shall be circular pattern with push fit spouts to BS.4607, with a PVC lid held in place with brass or nylon screws.

3.9 CONDUIT IDENTIFICATION DABS

A. Use coloured paint dabs on the inside of outlet boxes and paint interior side of the panel covers as they are installed. In ceiling spaces, provide colour to outside of boxes.

B. Paint colour to match system colours as defined in finishes. Paint colour code shall be as follows:-

1. Red - Life Safety System
2. Pink - Intercom & Public Address System
3. Black - Annunciator & Buzzer System
4. Green - 230V IPH Circuits
5. Purple - Telephone/data communication system
6. Blue - 220/380V Circuits
7. Orange - Security Alarm System

3.10 CLOSEOUT SUBMITTALS

A. Comply with the requirements of Division 01 General Requirements, Divisions 26, 27 & 28 and MEPF Scope of Works.

1. Warranty after testing commissioning for 1 year from the date of handing over to the client

END OF SECTION –

PUBLIC PROCUREMENT REGULATORY AUTHORITY (PPRA) EPADS

SECTION V-10
CABLE TRAY & LADDERS

1.1 SCOPE OF WORKS

1. Under this section of the specification cable tray shall be installed to support distribution cables, communication cables and all wiring cables not generally installed in conduit and or trunking.

2. The cable tray shall be installed in such a manner to enable easy access for cable installation.

3. The cable tray shall vary in type, i.e: where large cables are installed, ladder rack type cable tray shall be permitted. Where smaller type communication cables are installed, bottom perforated type cable tray shall be permitted in compliance with item # 6.

4. Cable trays / Ladder shall be as follows for different areas or as specified

5. Cable ladders shall be installed in risers for the full length of the risers unless otherwise instructed by the Consultant.

6. The Selected Cable Tray shall be 14SWG Aluminum with Cover and Cable Ladder shall be **12 SWG MS HOT DIPPED GALVANIZED With Cover.**

7. The Selected Cable Tray / Cable Ladders Accessories shall be **Imported** Fisher, Link, Diamond Walraven.

8. The Selected Cable Tray / Cable Ladder supports shall be with tool less seismic bracing cable with all required accessories

9. The selected thread rods and accessories shall be M12 as per ASTM-A123,DIN975 and DIN976.

1.2 QUALITY ASSURANCE

1. Acceptable Manufacturers

2. Subject to compliance with the requirements of the Contract Documents, acceptable manufacturers are to be firms regularly engaged in manufacturer of all materials specified in this section of types and sizes required, whose products have been in satisfactory use under similar service conditions for not less than ten years.

1.3 SUBMITTALS

1. Submit the standards to which the cable tray is manufactured to.

2. Submit shop drawings and data in accordance with the general requirements of the contract.

3. Show actual cable tray installation details, size and suspension system with hangers at every 2'-6" at max or as specified by consultant.

2.0 PRODUCTS

2.1 GENERAL

The cable tray system shall be of one manufacturer and shall include factory made trays, tray fittings (Elbow, Tee, Colar, Neck connections, complete with accessories and supports to form a complete tray/Ladder support system.

The cable tray / Ladder system shall include the following factory made tray elements. Straight trays and ladders, fittings and horizontal and vertical bends of various angles crosses, tees, wyes, reducers, vertical riser elements, connectors, joint plates and all necessary fixing accessories including supports. No local or site fabrication of any cable tray / ladder is allowed, tray system including ceiling and wall supports are acceptable.

CABLE TRAY

1. The cable tray and associated fittings, supports, spring hangers for vertical runs shall be manufactured in accordance with ASTM-A123 standards, the hot dipped Galvanized accessories for installation of complete cable tray shall be used,

2. The selected thread rods shall be M12 with minimum as per DIN975 and DIN976 HDG High Strength steel grade

3. The selected C channel shall be **2x62x41x2.5mm** hot dipped galvanized.

4. Cable trays shall be constructed from Aluminum, the Height shall be 100mm or as specified in Drawings. Flange height shall be 125mm or as indicated in drawings and documents.

5. Insert elements, bolts, screws, pins etc. shall be Hot dipped galvanized

6. Tray work shall have oval perforations. Ladder type trays shall be used as required and/or approved by the Consultant.

7. All trays (straight and fittings) to be heavy duty returned flanged type unless specified otherwise.

8. Tray components are to be accurately rolled or formed to close tolerance and all edges rounded. Flanges are to have full round smooth edges.

9. Unless indicated otherwise on drawings, cable trays shall be used in the range and 150mm to 750mm wide, in five preferred standard sizes: 150, 300, 450, 600 and 750mm.

10. Other sizes shall be used where specified or previously agreed with the Consultant.

11. Return flanges shall be a minimum of 10mm deep, unless otherwise specified.

12. Minimum radii at side rails, horizontal, and vertical tees and crosses shall be in accordance with the Manufacturer's standard.

2.3 CABLE LADDER

1. The cable ladder and associated fittings, supports, spring hangers for vertical runs shall be manufactured in accordance with ASTM-A123, and DIN976 HDG High Strength steel grade standards, the hot dipped Galvanized accessories for installation of complete cable ladder shall be used,

2. The selected thread rods shall be M12 with minimum as per DIN975 and DIN976 HDG High Strength steel grade

3. The selected C channel shall be **2x62x41x2.5mm** hot dipped galvanized

Insert elements, bolts, screws, pins etc. shall be Hot dipped galvanized

All ladder (straight and fittings) to be heavy duty returned flanged type unless specified otherwise.

Ladder racks for widths up to and including 300mm shall be constructed from G.I HDG sections of minimum thickness 12 gauge. Height shall be 60mm or as specified. Ladders in excess of 300mm width shall be C Section construction with a minimum thickness of 12 gauge. Height shall be 100mm or as indicated in drawings. The rungs shall be spaced at a maximum 200mm.

3.0 EXECUTION

3.1 INSTALLATION

1. Install all cable trays and ladder racks strictly in accordance with IEE and local authorities requirements.

2. Drilling, machining or cutting shall not be carried out after application of protective coat, unless previously agreed by the Consultant. If cutting or drilling is necessary, edges shall be cleaned up and painted with zinc based paint before erection.

3. Provision shall be made when installing all cables and cable trays for the expansion and settlement of the building.

4. Cables shall be fixed to the trays/ladders by means of PVC cleats and flame retardant cleats for flame/fireproof cables with galvanized bolts, nuts and washers. Use galvanized metal trefoil cleats with rubber pad for single core cables with distance of every 5 feet.

5. Control cables run and clipped in groups shall not exceed twelve in number and shall be not more than double banked. Power cables shall be laid in a single layer except with the prior approval of the Consultant. Power cables should be spaced 2D between centres of cables throughout the run of cables. Submit calculations for voltage drop for cables and increase the size if necessary.

6. Vertical distances between trays mounted horizontally shall be minimum of 250mm. Local reduction of distances between trays will be allowed to a minimum of 150mm with approval from the Consultant.

7. Trays shall be adequately supported to prevent sagging by more than 3 Deg. between fixed points. All supporting steel work shall be fixed at not more than 250 mm centers unless otherwise specified.

8. Where cable tray pass through floor arrange for 100mm concrete curb around opening and fire sealants shall be provided.

9. The Contractor shall submit calculations relating to tray / ladder work and tray / ladder supports demonstrating acceptable mechanical stresses and sag.

10. Where cable tray must pass below a beam a short length of tray shall be installed on the underside of the beam with 25mm spacers between the tray and the beam underside surface. Cables shall be strapped rigidly to the tray to prevent any possible sag in the cables.

11. Where cable tray is intended to cross a series of beams the tray shall be supported from each beam it crosses by metal supports suspended from below the underside of the beam - the space between the tray and the beam underside surface shall not exceed three times the diameter of the largest cable to be carried on the tray.

12. Covers **shall be required for all installed cable tray / cable ladder.**

3.2 EARTHING

The entire cable tray and ladder system shall be bonded using Tinned 12mm x 1.5mm braided copper, which shall be bolted across each joint in the system by means of galvanized nuts and bolts, complete with flat and spring washers.

Tray systems shall be bonded to the main building earthing system as required or directed by the Consultant

3.3 FIRE BARRIERS

Arrange for opening in fire rated walls, and floor for width and depth of cable tray to run through in addition to the specified clearance of the above cable trays.

Fire mortar to be applied for floors or walls after cables have been installed. For all floor openings of all risers (telephone, power) except vertical telecom cable risers where grating

shall be provided.

All openings / sleeves within floor slabs and fire rated walls shall be sealed with proper fire rated material.

3.4 CERTIFICATION

A. Submit certification documents at the completion of the Works confirming the installation complies with the manufacturers' recommendations.

3.5 WARRANTIES

A. Warranty after testing commissioning for 1 year from the date of handing over to the client

END OF SECTION

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SECTION V-11
INTERIOR LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including general and supplementary conditions and Division 01 Specifications sections, apply to this section.

B. Read this section in conjunction with other related sections, the design drawings,

C. Conduit, wire and cable installations performed under this division shall comply with the requirements of Division 26.

1.2 SUMMARY

A. Where no material, product or supplier is specified, propose suitable materials and systems prior to the Contract Award which comply with the visual intent indicated and specified design and performance requirements, and be fully responsible for the Detailed Design of the work.

B. Where a particular material, product or supplier is specified, the material, product or supplier shall be deemed indicative representing the Engineer's Design Intent only. Complete the installation using the specified or other product acceptable to the Engineer, in writing. Be fully responsible for the Detailed Design and performance of the work.

C. Complete the Detailed Design of all interfaces with adjoining trades prior to commencement of manufacture.

D. Ensure that all interfaces are fully coordinated prior to commencement.

1.3 REFERENCE STANDARDS

A. In addition to the requirements indicated on the Design Drawings and the MEPF Scope of Works, the Work shall be in accordance with the following standards, codes and relevant statutory requirements.

1. National Fire Protection Association (NFPA) Standards.
2. British Standards Institution (BSI) Group,
3. European Committee for Electrotechnical Standardizations, CENELEC Standards.
4. Institute of Electrical and Electronics Engineers, IEEE Standards.
5. International Electrical Testing Association, NETA Standards.
6. National Electrical Manufacturers Association, NEMA Standards.
7. International Electrotechnical Commission, IEC Standards:

    a. IEC 60061 - Lamp Caps and Holders.
    b. IEC 60598 - Luminaires, incorporating:

        1) Part 1: 60598-1, General requirements and tests.
        2) Part 2: 60598-2, Particular requirements including 60598-2-1; fastened general purpose luminaires, 60598-2-2; recessed luminaires, 60598-2-5; Floodlighting - 1979, 60598-2-19; chain suspensions.

1.4 REFERENCE STANDARDS – LOCAL AUTHOIRTIES WITH JURSIDICTION

A. In addition to the requirements indicated on the Design Drawings, or specified in Division 01 General Requirements, the Particular Specifications and the MEPF Scope of Works, the Work shall be in accordance with the relevant statutory authority requirements published by the local authorities having jurisdiction.

1. K-Electric Supply Corporation
2. Pakistan Electricity Rules 1937
3. Building Energy Code of Pakistan
4. Building Code of Pakistan- Fire Safety Provisions
5. Any other local authority Guideline applicable for this project

1.5 SUBMITTALS

A. General: Comply with the requirements of Division 01 General Requirements and MEPF Scope of Works procedures and submit the following.

B. Post Contract Submittals

1. Shop Drawings

a. Shop Drawings shall indicate dimensions, description of materials and finishes, general construction, specific modifications, component connections, anchorage methods, hardware, and installation procedures, including specific requirements indicated. Submit Shop Drawings for each system or assembly.

2. Product Data

a. Submit product data for each manufactured component including:

1) Candle power distribution curve.
2) Efficiency.
3) Reflector brightness data.
4) Data indicating each luminaire type's maximum and minimum ambient operating temperatures, and special features, where applicable to withstand onerous conditions, i.e. high ambient temperature, intense direct sunlight blowing sand and grit, salt laden air, etc.

3. Supplementary Product Literature

a. Include a statement from the manufacturer for the design life of the system.
b. Each type of lighting fixture detailing:

1) Catalogue illustrations of luminaire proposed for each specified application.
2) Design and installation requirements.
3) Photometric curves and isolux diagrams for each luminaire with indication of minimum light output ratio.

4. List of tests included.

5. Certified test data.
6. Outline technical specifications reflecting proposed materials and systems.
7. A list of proposed suppliers and Subcontractors intended to be used.
8. Preliminary Method Statement.
9. Preliminary Quality Plan.
10. Summary of deviations from the Specification.

C. Post Contract Samples: Samples and Prototypes.

1. All lighting equipment shall be currently available, working samples shall be required for submission and are to be accepted by the Engineer.

2. Should a sample of a standard, or prototype of a special luminaire or variant of a standard luminaire be ordered, its cost shall either be incorporated in a Tender price, or shall be invoiced to the Employer or his nominated representative separately as agreed.

3. Any such sample prototype or variant shall be in accordance with the Lighting Design Specification, and shall be submitted to the Lighting Consultant, together with full photometric and dimensional data if specifically requested, to enable both its accurate assessment and the detailing of any adjustments deemed necessary prior to the commencement of full production.

4. Samples and Shop Testing

a. The lighting fixture manufacturer shall obtain from the ceiling manufacturer a 3m x 3m sample of the ceiling assembly for the typical floors. The light fixture manufacturer shall finalize the details and dimensions of the light fixture to be coordinated with and accommodate the ceiling assembly.

b. Inform the Engineer 14 days in advance of the assembly being completed and obtain the Engineer acceptance for the assembly.

1.6 CLOSEOUT SUBMITTALS

A. General: Comply with the requirements of Division 01 General Requirements and MEPF Scope of Works, and submit the following:

2. Warranty after testing commissioning for 3 year from the date of handing over to the client

3. Operation and Maintenance (O&M) Manuals: Include component list with manufacturer's reference numbers, descriptions of materials and procedures for repairing.

4. Spare Parts:

a. Lamps: Provide 10% spare lamps and 10% tubes of each lamp installed.

b. Control Gear: Provide 10% control gear of each control gear type installed

c. Louvers and Lenses: Provide 5% spare lenses and louvers of each type installed.

1.7 QUALITY ASSURANCE

A. All equipment supplied shall be in accordance with the relevant standards currently in force in the project's country of origin.

1. The cost of obtaining any necessary approvals shall be included in any Tender price, detailed as a separate item.

B. All lighting fittings and equipment shall have ENEC and/ or IEC and/ or BS markings.

C. Provide testing and inspections in accordance with Division 01 General Requirements, MEPF Scope of Works and Section 26 01 26 – Maintenance Testing of Electrical Systems.

D. Preconstruction Testing/ Reports

1. Submit reports of independent tests demonstrating that the products and systems are in accordance with the specified performance requirements.

2. Where test results for a material or product are not available, undertake testing to show compliance with the Specification at an independent testing laboratory acceptable to the Engineer.

3. The provision of testing data or the carrying-out of tests does not relieve the Contractor of his responsibilities regarding the performance requirements, durability or service life requirements.

E. All materials supplied and installed shall be new and the best quality obtained for the intended purpose and shall, where applicable, conform to the standards.

F. All materials required for installation under the Specification shall be subject to the acceptance of the Engineer. Where no specific indication as to the type or quality of material or equipment is indicated, a first class standard article to the Engineer's acceptance shall be furnished.

1.8 WORK INCLUDED

A. This section supplements the main contract conditions and forms part of every section of Division 26 Electrical trade and shall be read in conjunction with all sections of the specification.

B. Provide all labour, materials, products, equipment and services to supply and install the lighting systems as indicated on the drawings and specified in these specifications, to provide a complete and operational installation.

1.9 COORDINATION

A. Liaise with the Contractor to arrange for correct size openings in ceilings (particularly plasterboard), determining suitability of edge details of luminaires and correct location of luminaires.

B. Supply plaster rings for recessed luminaires and install in conjunction with ceiling tile or plaster ceiling section in their correct location.

C. Ensure no light spill around the abutting edge detail occurs unless the luminaire/lighting design is intentional.

1.10 COORDINATE WITH FINISHES SCHEDULE

A. Prior to placing orders for luminaires check the luminaire finishes details, compare these against the room finishes schedule to ensure that luminaires are coordinated with the finishes schedule.

1.11 LIGHTING LEVELS

A. For Back of House areas; as per CIBSE Lighting Guides.

B. For Front of House and External lighting refer to the specialist and landscape lighting designers design packages.

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PART 2 - PRODUCTS

2.1 GENERAL

A. Supply all labour, tools, services and equipment and provide all the materials required to complete the work.

B. The lighting installation for this Project shall be as indicated on the Design Drawings and including but not be limited to:

1. General internal lighting as indicated on the Design Drawings and luminaire schedules.

a. Front of House areas – Refer to Specialist Lighting Designer packages
b. Landscape Lighting – Refer to Landscape Lighting Designer packages
c. Façade lighting – Refer to Specialist Lighting Designer packages.

C. Generally, the lighting installation shall be carried out by installing conduits within the building structure and walls forming a flush installation. In mechanical rooms, electrical switch rooms and other service and unfinished areas the installation shall be surface mounted.

D. Generally, the lighting installation shall be switched by switches, group switches, motion sensors, timers, dimmers and by remotely controlled programmable lighting panels as indicated on the Design Drawings.

E. The Contractor shall supply and fasten the light fittings and points complete with all accessories, wiring, trunking, conduiting, boxes, etc. Lighting fittings shall be complete with suspension system, tubes, ballasts and accessories as specified and indicated on the Design Drawings. The Contractor is advised to refer to the structural Design Drawings related to ceilings and beams for proper coordination of the Shop Drawings.

F. Fittings housing, frame or canopy shall provide a suitable cover for the fixture opening. Fittings shall be installed at mounting heights as detailed on the Design Drawings or instructed by the Engineer.

G. Fittings are indicated in provisional position. They shall be exactly located after the final layout of the ceiling and other equipment is prepared.

H. Fittings and/ or fitting outlet boxes shall be provided with hangers to adequately support the complete weight of the fitting.

I. Design of hangers and method of fastening other than indicated on the Design Drawings or herein specified shall be submitted to the Engineer for acceptance.

J. Flush mounted recessed fittings shall be suitable for the type of suspended ceilings used, and shall be installed so as to completely eliminate leakage within the fitting and between the fitting and adjacent finished surface.

K. Pendant fittings within the same room or area shall be installed plumb and at a uniform height from the finished floor. Adjustment of height shall be made during installation. Fittings shall bear the manufacturer's name and the factory inspection label. Legalized documents pertaining to the country of runner for the lower temperature (fluorescent) and impregnated asbestos for the higher temperature.

L. Lighting fittings employing tungsten filament lamps and having metal back plates shall not be fastened direct to boxes of thermoplastic material. Only metal boxes shall be used in such situations. Heat resistant type lamp holders shall be used with flexible

cords and enclosed type lighting fittings regardless of the lamp cap position, i.e. cap-up or cap down.

M. Lamp holders incorporated in weatherproof fittings shall be porcelain or brass. Light fittings shall be installed with plug-in ceiling rose connected through heat resistant cable of 85°C. Fittings installed in damp locations shall be totally enclosed and shall prevent the ingress of moisture. All metal fittings or metal parts of fittings shall be effectively earthed. Fittings installed in positions subject to vibration shall be of the anti-vibration type.

N. Recessed fittings shall be constructed so as to fit into tile suspended false ceilings, tile fastened to ceilings or other suspended false ceilings or plastered ceilings without distorting either the fitting or the ceiling and including all necessary labour cutting and making good.

O. Fittings with hinged diffuser doors shall be provided with spring clips or other retaining devices to prevent the diffuser from moving and the diffuser shall remain hanging during maintenance.

P. Shop Drawings for non-standard fitting types shall be submitted for acceptance by the Engineer. Detailed catalogue cut sheets for all fittings and sample fittings shall be submitted for acceptance by the Engineer before orders for the fittings are placed, if requested by the Engineer.

2.2 LIGHTING AND LIGHTING FIXTURES

A. All the lighting fixtures used in this project are LED type for lighting design.

B. Provide lighting control requirement through manual switches, occupancy sensors, absent detectors & over rides as indicated in the drawings.

2.3 COMPONENTS

A. Comply with Lighting Fixture Schedule indicated on the Design Drawings and fixture manufacturer's requirements.

2.4 LUMINAIRE TYPES

A. For luminaire types, description and Specification refer to the Luminaire Schedule within the specification and as indicated on the Design Drawings.

2.5 DESIGN CRITERIA

A. Interior back of house lighting selection shall achieve the recommended illumination levels, proper colour rendering and temperature for each task as well as suitable degree of protection of the fixture enclosure to suit the location. The lighting system design shall be in accordance with the recommendations of the Chartered Institution for Building Services Engineers UK (CIBSE) issued by CIBSE UK.

B. Lighting control strategy

- Toilets, Corridor, Stair & store - Presence detector in individual areas and Override switch in Electrical rooms in each zones (If any fault occurs in presence detector, this can be override from electrical room located in that respective zone(which also avoid public access to override switch))

- Office or any occupied areas – Occupancy sensors and local override push buttons (If any fault occurs in occupancy sensors, local override will be possible).

- Plant rooms – Manual switch and Absence detector (Recommend manual switches as this will be easy when operation team need to access in case of emergency. Absence detector will switch off the lights automatically if operation team forget, which will save energy).

2.6 LED FITTINGS

A. The drivers for all LED luminaries to be supplied by the same vendor as the respective luminary and to be suitable for the lighting control system proposed for the project.

B. Manufacturer shall have at least ten years of experience designing, selling, and supporting intelligent LED systems, and shall be able provide a reference listing installations using its intelligent LED-based systems. LED luminaires must have a minimum 3 year manufacturer's warranty.

C. All LED packages used in the LED luminaire shall be high brightness and of proven quality from established and reputable LED manufacturers.

D. Manufacturer shall utilize an advanced production LED binning process to deliver a common and repeatable color point to maintain color consistency from luminaire to luminaire and project to project over time, while ensuring a reliable supply of LED packages from the supplier.

2.7 QUALITY CRITERIA FOR LED LUMINAIRES

A. Both 'initial performance' and 'performance over time' shall be evaluated in order to give confidence about how a LED luminaire shall perform and how long LED packages shall sustain their rated characteristics over their years of operation.

B. Quality criteria to be considered when evaluating manufacturer's 'initial' performance claims shall comply with the following documents:

1. IEC/PAS 62722-1 Performance requirements for luminaires – General
2. IEC/PAS 62722-2-1 Performance requirements for LED luminaires
3. IEC/PAS 62717 Performance requirements for LED modules

C. Overtime performance claims be based on the Annex C Lifetime Metric for LED based products in IEC 62717 which is under progress.

1. Initial rated input power (in W);
2. Initial rated luminous flux (in lm);
3. Initial LED luminaire efficacy (in lm/W);
4. Luminous intensity distribution;
5. Initial Correlated Colour Temperature (CCT in K);
6. Initial rated Colour Rendering Index (CRI);
7. Initial rated chromaticity co-ordinate value and expected tolerance (x,y) < x SDCM;
8. Useful Life (corresponding to the gradual light output degradation (Median Useful Life: # hrs at L80B50)

9. Time to Abrupt Failure (corresponding to the abrupt light output degradation) of the LED based luminaire at rated life. (Driver failure rate at 2000hrs);
10. Rated ambient performance temperature (tq) for a luminaire.

2.8 LED FIXTURE REQUIREMENTS

A. Thermal Parameters

1. LED module mounting shall be designed to ensure the junction temperature of any LED does not exceed the manufacturer's recommended maximum operating temperature. Thermal dissipating of the module shall be designed for the operating temperature and wattage of the unit.

2. LED luminaries shall be thermally tested to ensure maximum junction temperature is not exceeded whilst operating in any environment. Internal and external temperature parameters to be assumed as follows:

   a) Internal: -10°C to +38°C.
   b) External: 0 to +45°C.

B. Optical Parameters

1. LED batches shall be from the same color bin, with no greater than:

   a) Interior and all continuous line applications - 2 step MacAdam Ellipse.
   b) Exterior - 3 step MacAdam Ellipse.

2. LED supplier shall provide LED batch bin number, recording luminous flux, wavelength/ color and forward voltage of LED. Batch information to be included as part of the Operations and Maintenance (O&M) Manual or as part of the fixture's order/ serial number.

C. Color Rendering Index

1. White LEDs shall have a CRI greater than 80.

D. LED Lamp Life

1. LED minimum lamp life shall be:

   a) Forward current lamp life to 50% lumen.

   b) Output of original output.

      1. 350 mA 50,000 hours.
      2. 700 mA 50,000 hours.
      3. 1005 mA 20,000 hours.
      4. 1400 mA 20,000 hours.

E. IP Rating

1. Wall and in ground LED luminaries shall be in IP68 enclosures with IP68 cable glands.
2. All luminaire shall be IP rated suitable to operating environment as indicated in the luminaire schedule.

F. Transformers

1. Generally, transformers shall match optimum and maximum current to suit the LED over the whole range of input voltages.

2. Dedicated transformers shall be provided with the following features as a minimum:

a) Automatic reset in the event of a fault.
b) Isolation between the primary and secondary sides.
c) Dimming with linear characteristics.
d) Operation in ambient temperatures of -20°C to +50°C.
e) Low power loss.
f) Integral electronic overload protection circuitry.
g) Integral electronic over temperature protection circuitry.
h) Integral electronic short circuit protection circuitry.

G. Minimum Luminous Efficacy

1. Optical light output ratios related to power:

a) White 95lm/ W.
b) Warm White 85lm/ W.
c) Blue 45lm/ W.
d) Red 80lm/ W.
e) Green 80lm/ W.
f) Amber 45lm/ W

2.9 SPARE LAMPS

A. Provide spare lamps as 10%

2.10 REQUIREMENTS FOR LUMINAIRES

A. All luminaires shall be of the manufacture, size and type specified in particular specification and shall comply in all respects to EN 60598 Electric Luminaires, CIE 24/CIE 27, EN 10598-1, EN 10598-2 & EN 60598-2-22.

B. All luminaires shall be manufactured in accordance with the appropriate sections of BS.4533.

C. All luminaires shall incorporate simple means of dismantling diffusers for cleaning.

D. Metalwork on all luminaires (other than specular surfaces) shall be phosphate treated and finished with acrylic paint to the colour identified in the schedules.

E. All internal wiring shall be carried out in 16/0.2mm high temperature PVC.

F. Where the diffusers for luminaires are of a thermoplastic material the Contractor shall include for supplying the appropriate diffusers. The diffuser panels shall be fire retardant to Class 1 BS.476: Part 7.

G. All thermoplastic diffusers for recessed luminaires shall be of the TP(a) type as defined in the UK Building Regulations.

H. Glass used for lenses, reflectors and diffusers in luminaires shall be tempered for high impact and heat resistance.

I. All parabolic cones and plastic for lenses and diffusers shall be guaranteed against discoloration for a minimum of ten years, and in the event of premature discoloration, brittlement, or loss of light transmittance they shall be replaced by the manufacturer, including both materials and the cost of labour.

2.11 GENERAL REQUIREMENTS

A. Final connections to all luminaires shall be made by means of an approved nylon connector terminal block, complete with two screws, brass ferrules for connecting to the final sub-circuit wiring. Push fit/clamp type termination for final circuit wiring is not acceptable.

B. Each luminaire shall be packaged with complete instructions and illustrations showing how to install it and shall be installed in strict conformance with manufacturers recommendations and instructions.

C. Luminaires shall not be delivered to building or stored therein until dry and protected space is available for proper storage of luminaires.

D. Luminaires shall be completely assembled in factory and shall be delivered to building in cartons or in palletized form, as directed.

E. Luminaires to be supplied complete with proprietary plug and socket arrangement to allow quick installation/interface with lighting control wherever feasible.

F. Lay-in type diffusers shall be retained by concealed devices to prevent the panel or louvre from lifting when doors etc are opened or closed.

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PART 3 - EXECUTION

3.1 INSTALLATION

A. Luminaires which do not incorporate insulated shrouding material to the lamp holder shall be earthed. Under no circumstances shall the suspension chain, wire or non-rigid tube be used as the earth continuity conductor. Flexible earth wires shall be provided across all ball/socket joints.

B. Where luminaires are installed in a flush installation the appropriate number of conduit boxes shall be installed. Final circuit connection at discharge luminaires shall be left long enough to terminate at the connections within the luminaire such that cables do not pass over starting/control equipment. Where this cannot be achieved heat resistant sleeving shall be installed over the cables.

C. Where recessed luminaires are used in conjunction with a suspended ceiling, the luminaires shall be suitable for being supported from the ceiling grid system via adjustable mounting brackets. For Tender purposes however, the Contract shall include for the cost of independent conduit tube suspensions.

D. The ceiling details shall be checked for suitability of taking the support of the luminaires prior to ordering the luminaires or commencing the lighting installation and, if suitable, an instruction shall be issued accordingly. Under no circumstances shall any independent conduit suspension for luminaires be used to support the ceiling system.

E. Continuous rows of luminaires shall be rigidly aligned for true in-line appearance.

F. Luminaires suspended by means of conduit drops shall be fitted to ball joints allowing a swing of at least 20° all round. Reliable earthing between the fixed and moving parts shall be provided by means of a flexible braided copper tape. The ball joints shall have a stop to prevent rotation by more than 360°. Any deviation from this form of suspension must be agreed with the Engineer.

G. Where conduit suspension is used final circuit wiring shall be contained within the conduit and terminated directly within the luminaire.

H. Luminaires incorporating tube suspensions shall be complete with non-rigid connections to the general conduit system, the conduits being of the hook plate type. Ball socket joints shall be provided if the suspension tubes exceed 600mm in length or are suspended from sloping surfaces.

I. Luminaire heights and locations in mechanical and electrical plantrooms shall be coordinated to clear plant and equipment and to adequately illuminate meters, gauges, panels, and equipment.

J. Luminaires which do not incorporate insulated shrouding material to the lamp holder shall be earthed. Under no circumstances shall the suspension chain, wire or non-rigid tube be used as the earth continuity conductor. Flexible earth wires shall be provided across all ball/socket joints.

K. Unless otherwise stated, each luminaire in this specification shall be mechanically connected to a metal conduit box by means of suitable brass R.H. screws finished to match the metalwork of the luminaire. The terminal block shall be enclosed in the conduit box.

L. All batten lamp holders not fitted with shades shall be complete with insulated skirt. Shade carrier rings shall be provided with all lamp holders not incorporated in fittings.

M. After testing the installation, lamps and tubes shall be removed from the luminaires and replaced prior to handover to ensure that all lamps are new at handover.

3.2 REFLECTORS, LENSES & CLEANING

A. All glassware, diffusers, reflectors, etc, shall be left in a clean condition. Allowance shall be made for all plastic surfaces which reflect or transmit light or are visible to view to be treated with an antistatic solution to prevent static electricity.

B. Reflectors, reflector cones and visible trim of all luminaires shall not be installed (or otherwise protected in an approved manner) until completion of plastering, ceiling tile work, painting and general clean-up. They shall be carefully handled to avoid scratching or finger printing and shall be completely clean at the time of handover by methods as recommended by the manufacturers.

C. All broken parts shall have been replaced and all lamps shall be operative.

D. Allow, to ensure that at handover all luminaires and lamps provided are in pristine condition.

3.3 AIMING AND ADJUSTMENT

A. All adjustable luminaires shall be aimed, focused, locked etc, by the Contractor to the requirements of the Engineer. This shall be carried out once the installation is complete. All necessary ladders, scaffolds etc. shall be provided by the Contractor.

B. Where possible units shall be focused during the normal working day. However, where daylight interferes with viewing or proper adjustments, aiming shall be accomplished at night.

END OF SECTION 26 51 00

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SECTION V-12
DIESEL GENERATORS

10.1 SCOPE OF WORK

The work under this Section consists of supply, installation, testing and commissioning of Diesel Generator set, material and the accessories as specified herein.

The generators are **Prime rated,** shall be placed at located as drawing on 12" raised RCC pad or as required by generator supplier.

The contractor shall do transportation. The contractor shall discuss the electrical layout with the Consultant and coordinate at site with other services for the exact route, location and position of electrical lines and equipment.

10.2 TECHNICAL SPECIFICATIONS

General Performance Requirements

The generating sets shall be of standard design of reputed manufacturer as described in approved manufacturer list and other control to be of the generator manufacturer's, who shall have similar units in operations under similar applications & field conditions.

The set shall be specially designed for low ambient noise level, suitable for outdoor use with a maximum noise level (db). The bidder shall state with his bid the value of noise during operation.

Each generating set shall after reducing the power absorbed by the auxiliaries deliver continuous specified power output at 415 volts and 0.8 power factor, 3-phase, 50 Hz under full load condition should have capability of voltage variation from 400-415V.

All auxiliaries, accessories and connection systems along-with all necessary cables, fittings, hardware etc. for complete vibration proof installation of prime-mover, generator, control panel including starting, inlet, exhaust, cooling system, etc. are to be included in the scope of supply.

The engine shall be directly coupled to the generator with a maximum r.p.m **speed from**

1500 to 2250 or as recommended by OEM

The engine-generator package shall be mounted on vibration proof spring / rubber pads. Heavy duty lifting eyes and jacking screws shall be provided on the skids. Supplier shall provide foundation design and shall supply foundation bolts and any other material / hardware for complete installation of the package. Any excessive torsional vibration shall be avoided for both engine and alternator.

Supply Installation of Sound Acoustic Treatment procedure of all the openings, radiator hot air exhaust louvers, Air intake Fans, Exhaust Fans and ceiling, Walls of generators area on ground floor including sound barriers in between generators to achieve maximum 70 dB at 1m outside building.

Supply, installation, testing and commissioning of Auto Synchronization module (Wood Word, Data com, Deep sea, and Deif or any other which is capable to synchronize all the gensets of following capacities 5 Nos. DG Sets (2000 kVA DIESEL GENSET) + 1 No. DG Sets (1250 kVA

DIESEL GENSET)) as shown in the schematic riser diagram, Control wiring & Containment between DG Set + Synch Module and synch Module on already provided motorized ACB's inside enclosure or LV Panel and with other accessories for above DG Set system for Auto Synchronizing, Load Sharing and Load Management facilities. The Synch. Modules shall be enclosed in already provided MS Panel with ventilation fan. The work also includes control cabling, cable containment etc

1 Job Complete in all respect.
Note: Please find attached drawing of take-off panel for your perusal, specify size & spaces you require to install synchronizing modules and for control cabling into panel

10.2.1 Specifications for Diesel Fuel Engine Prime Mover

Engine shall be four stroke, compression ignition engine.

Starting shall be done by the electric starter motor operated form 24V D.C lead acid batteries mounted on the skid. Batteries shall be provided by the contractor. The engine shall be equipped with an alternator type automatic charging system to charge the batteries during normal engine operation. The charger and batteries shall be adequate to satisfy the following requirements.

a. Crank the engine at firing speed for at least 15 second.

b. Crank the engine three times for the above duration.

c. Fully charged the discharged batteries with in eight hours.

Overload Capabilities

Engine shall be of continuous rating with overload capability of at least 10% above the normal rating for upto 1 hour continuously in any 12 hour period. The rating of gen-set shall be in accordance to ISO 8528 and overload capability shall be in accordance to the ISO 3046.

Air Intake

Air intake shall be naturally aspirated, equipped with suitable filter.

Engine Cooling

Engine shall be fan cooled, water radiator type supplied with guard. Cooling system shall have an engine centrifugal pump for cooling water circulation.

Exhaust System

Exhaust system shall be equipped with double residential type silencer complete with muffler exhaust manifold, flexible connector, exhaust elbow, rain cap, and associated fittings. The exhaust line shall be taken outside the building in the shortest possible way and not to include too many bends. The exhaust line should be insulated along its way from the engine to the termination point at the wall.

At the termination, protection shall be provided form rain, etc. All the piping should be insulated with the glass wool wrap and then steel jacket.

Speed Governor

Electronic / mechanical governor (to be mentioned clearly along with the bids) shall regulate engine speed so as to maintain the generator frequency with in + 2 % of the specified output frequency. Stable engine speed shall be restored with in 10 second after the engine has been started shall be restored within 8 second of any sudden load change from no load to full load. During the change of load surging period, the speed shall not vary by more than rated speed.

Instruments

Skid mounted panel shall have calibrated gauge / meters to measure the following
Engine speed.
Lube oil pressure.
Engine oil temperature.
Engine water temperature.
Engine running hours.
Diesel level meter / indicator.
Battery charging current.
Pressure Gauge meter

10.2.3 Fuel System

For Diesel Engine:

Engine shall be operated on commercial high speed diesel oil. A fuel oil strainer / filter shall be provided in the fuel line. Fuel system for diesel shall not require any priming.

Contractor shall also include complete fuel storage and transfer system. The tank shall have level gauge and pump to facilitate the pumping of diesel from drums / reservoir.

Contractor shall submit with the bid, details of fuel system and estimated fuel consumption at half, three quarter and full load operation. It shall have a vernier throttle control for speed adjustments.

The selection of the Diesel pump shall be done by the supplier as per OEM recommendation

10.2.3 Specification for Generator

Type generator shall be synchronous.

Excitation.

Excitation shall be brush less rotating diodes for 3-phase full wave rectification on mounted on the main shaft.

Windings

Alternator winding shall have class-H insulation with anti-condensate heater for winding and shall be impregnated for tropical use.

Voltage Regulation

Voltage Regulator shall be solid state with provision for manual setting. Regulator shall be so designed as to protect the exciter when the generator is running at reduced speed during

starting or idling of the Prime-mover. Voltage regulation shall be +2.5% from no-load to full load.

Over Load Capability

The generator shall be capable of carrying 1 hour overload of 10% of nominal rated current with field set for normal rated load excitation for any 12 hour period. The rating of gen-set shall be in accordance to ISO 8528 and overload capability shall be in accordance to the ISO 3046.

Short Circuit Protection

Generator shall be capable of withstanding, without injury a 30 seconds three phase short circuit at its terminal when operating at rated KVA and power factor.

Over Speed

Synchronous generator shall be so constructed that in case of emergency they will withstand an over speed of 25% without mechanical injury at least for 2 minutes.

Deviation Factor

The deviation factor of the open-circuit line to line terminal voltage shall not exceed 0.1.

Specifications for Control Penal

Control panel shall be skid mounted front access part of the engine-generator package. Removable bolt-on glands shall be provision to suit bottom entry. Panel shall be complete with all control wiring, pressure clamped terminal and lugs. Control panel shall be wired by flexible PVC insulated cable. All cables shall be suitable color coded and numbered for circuit identifications. Contractor shall submit with the bill all electrical and mechanical details and installation drawings. Panel shall be provided with connection for remote shut off operation.

10.2.4 Unit Control Section

This shall incorporate measuring instruments, instrument transformers, circuit breakers, voltage regulator, governor, voltage adjusting rheostat, battery charger, enunciators, indicating lamps etc.

Instruments

Following measuring instruments shall be provided.

a. Ammeter with selector switch.
b. Voltmeter with selector switch.
c. Frequency meter (dial type).
d. Kilowatt hour meter.
e. Ammeter (charging current).

Safety Devices

Following alarm/shutdown enunciators and safety device shall be provided.

a. Alarm and shutdown for.
-- High crank case low oil level.

b. Alarm and lockout.
-- Over crank.
c. Alarm and shutdown
-- Engine Over speed.

d. Alarm for battery charging

e. Winding temperature light alarm and shut down.

After shut down this set shall lock out and it shall not be possible to restart unless the fault has been removed and manually reset.

Battery Charger

Battery charger shall be static type and shall supply a float charge to the batteries when the engine is not in operation. Work also includes the wiring from Nearest DB till the charger.

10.3 TOOLS

A complete set of tools for routine operating and maintenance of engine and generator shall be furnished without additional cost. (List to be provided as per OEM recommendations)

10.4 TECHNICAL DATA

Details to be provided with this quotation.

10.5 ENERGY METER / HOUR METER

An energy meter of suitable rating and to meet the requirement of electrical inspector to record the total operating hours of the generator an HOUR-OPERATION-METER shall also be provided.

10.6 The generators should be securely fixed & mounted on rubber pad foundation to avoid transfer of vibrations to earth, foundation of building, walls etc.

10.7 MAINTENANCE

The contractor shall be responsible for the complete maintenance of the generator systems for a period of 12 months from the date of acceptance by the Consultant of the complete generators installation and shall include for cleaning, oiling and inspection of the generators and all the associated equipments,
The Contractor shall also give notice that any fault notified will receive immediate attention on the day of the notification.

10.8 GAURANTEE

The contractor shall forward the manufacturers guarantee that all material, equipment supplied and workmanship by them to be free from all defects of workmanship and material. The contractor manufacturers shall have to replace at their own expense at any time within one year after installation is accepted by the Consultant any or all parts, materials and equipment that may be found defector or faulty

During the DLP period the contractor shall be responsible for services maintenance and replacement of any faulty and already installed part without any additional charges.

10.9 TESTING INSPECTION AND MANUFACTURERS PREMISIS

The tests to be carried out in accordance to International Standards and in p presence of client, design consultant, supervision consultant and supplier at the Manufacturers premises (FAT), the supplier / contractor shall manage the complete visit including all expanses as per requirement of consultants and client.

All routing and special Tests shall be included in inspection and test report shall be provided and shall include but not necessarily be limited to:

- Inspect physical and mechanical condition.
- Inspect anchorage, alignment and grounding.
- Comprehensive report should be submitted in soft copy format as well as paper form. These tests shall be witnessed and certified by the Consultant in the presence of installer / manufacturer.
- Load banks along with cabling and necessary accessories for connection with generator to reach 80% of the rating or as per OEM recommendation shall be tested at site and provided by the Contractor. All such charges shall be incurred in the provided bid value

10.10 WARRANTY

The Contractor shall provide the Warranty of at least 1 years from the date of issuance of acceptance certificate from consultant/client for successful operation of generators for unlimited hours on Prime.

11.0 SALIENT FEATURE

- Radiator 50C Tropically designed
- Permanent Magnet Generator Excitation
- IP Protection alternator class H insulation
- Power Command Control systems for automatic synchronization & auto load sharing
- Alternator Battery Charger
- Sub Base Anti-vibration mounts
- Electronic Governor
- Emergency Push button
- User O&M Manual
- Exhaust Industrial muffler(Supplied Loose)
- Exhaust Flexible(Supplied Loose)
- First oil filled & Coolant Filled.
- Engine Sump oil & Coolant drain tap
- Earth Leads
- Set mounted lead acid
- Flue Gas Pipe back pressure calculation report based on the design drawings route shall be submitted for consultants approval.

12.0 CONTROL CABLES (IMPORTED BELDEN):

- 2 x 2C-1.5 Sqmm + 2 x 4C-1.5 Sqmm CU PVC/PVC flexible shielded control cable shall be laid from each generator to the load take off (synch panel) for battery charger. jacket water heater, AMF and other allied auxiliaries.
- The proposed control cables configuration is tentative and shall be confirmed by the generator supplier as per the OEM requirement.

END OF SECTION

SECTION V-13
FUEL TRANSPORTATION SYSTEM

1.0 SCOPE OF WORKS

The work under this section consists of supplying, installing, testing and commissioning of all material and accessories of the complete fuel transportation and monitoring system as specified herein and/or shown on the drawings.

The Contractor shall discuss the electrical layout with the Engineer and co-ordinate at Site with other services for exact locations and positions of complete fuel transportation and monitoring system.

2.0 QUALITY ASSURANCE

- Approval by Contracting Officer is required of products or services of proposed manufacturers, suppliers and installers, and will be based on Contractor's certification that:

- Manufacturers regularly and currently manufacture tanks, tank and piping accessories, tank fluid level monitoring and leak detection systems, and fuel quality management systems.

- The design and size of each item of equipment provided for this project is of current production and has been in satisfactory operation on at least three installations for approximately three years. Current models of fluid level and leak detection systems with less than three years' service experience are acceptable if similar previous models from the same manufacturer have at least three years' service experience.

- Apply and install materials, equipment and specialties in accordance with manufacturer's written instructions. Conflicts between the manufacturer's instructions and the contract drawings and specifications shall be referred to the COR for resolution. Provide copies of installation instructions to the COR two weeks prior to commencing installation of any item.

- All equipment shall be free from defects that would adversely affect the performance, maintainability and appearance of individual components or overall assembly.

- Tanks, Secondary Containment Systems for Piping, Plastic Piping and Containment Systems, Tank Level Monitoring Systems, Leak Detection Systems, Fuel Quality Management Systems, Catholics Protection Systems: Authorized manufacturer's representatives shall provide onsite training of installers and supervision of the installation and testing of the equipment and systems to assure conformance to written instructions of manufacturers.

- Tank and piping installation contractor shall be certified as acceptable by local control authorities.

- Pipe Welding: Conform to requirements of ASME B31.1. Welders shall show evidence of qualification. Welders shall utilize a stamp to identify their work. Unqualified personnel will be rejected.

- Label of Conformance (definition): Labels of accredited testing laboratories showing conformance to the standards specified.

3.0 AS-BUILT DOCUMENTATION

- Submit manufacturer's literature and data updated to include submittal review comments and any equipment substitutions.

- Submit operation and maintenance data updated to include submittal review comments, VA approved substitutions and construction revisions shall be in electronic version on CD or DVD inserted into a three-ring binder. All aspects of system operation and maintenance procedures, including applicable piping isometrics, wiring diagrams of all circuits, a written description of system design, control logic, and sequence of operation shall be included in the operation and maintenance manual. The operations and maintenance manual shall include troubleshooting techniques and procedures for emergency situations. Notes on all special systems or devices shall be included. A List of recommended spare parts (manufacturer, model number, and quantity) shall be furnished. Information explaining any special knowledge or tools the owner will be required to employ shall be inserted into the As-Built documentation.

- The installing contractor shall maintain as-built drawings of each completed phase for verification; and, shall provide the complete set at the time of final systems certification testing. Should the installing contractor engage the testing company to provide as-built or any portion thereof, it shall not be deemed a conflict of interest or breach of the 'third party testing company' requirement. Provide record drawings as follows:

- Red-lined, hand-marked drawings are to be provided, with one paper copy and a scanned PDF version of the hand-marked drawings provided on CD or DVD.

- As-built drawings are to be provided, with a copy of them on AutoCAD provided on CD or DVD. The CAD drawings shall use multiple line layers with a separate individual layer for each system.

- As-built drawings are to be provided, with a copy of them in three-dimensional Building Information Modeling (BIM) software version provided on CD or DVD.

- The as-built drawings shall indicate the location and type of all lockout/tagout points for all energy sources for all equipment and pumps to include breaker location and

numbers, valve tag numbers, etc. Coordinate lockout/tagout procedures and practices with local VA requirements.

- Certification documentation shall be provided to COR 21 working days prior to submitting the request for final inspection. The documentation shall include all test results, the names of individuals performing work for the testing agency on this project, detailed procedures followed for all tests, and provide documentation/certification that all results of tests were within limits specified. Test results shall contain written sequence of test procedure with written test results annotated at each step along with the expected outcome or set point. The results shall include all readings, including but not limited to data on device (make, model and performance characteristics), normal pressures, switch ranges, trip points, amp readings, and calibration data to include equipment serial numbers or individual identifications, etc.

4.0 UNDER GROUND STEEL TANKS AND DAY TANKS

- Factory-fabricated all welded double-wall steel, vertical cylindrical configuration, atmospheric pressure, internal and external corrosion protection as specified. Tanks shall be fabricated in accordance with Steel Tank Institute (STI) design standards by manufacturer that participates in STI Quality Assurance Program.

- Construction:

- ASTM A36/A36M steel, UL 58 double-wall, 360-degree secondary containment.

- Conform to NFPA 30 or NFPA 31 as applicable.

- The bottom 60 degrees of all lap or offset circumferential interior seams shall be seal welded 30 degrees each way from bottom centerline to retard corrosion.

- Design for surcharge loads such as backfill and paving as shown. In addition, in paved areas, design for AASHTO H-20 14,515 kg (32,000 pound) axle loading.

- Leaks and abrasions are prohibited. Maximum out-of-roundness is one percent of the diameter.

- Outer wall shall provide leak tight secondary containment that covers 100 percent of tank volume and shall permit migration of any inner tank leakage to the lowest part of the tank where leak detectors are located. Make provisions for leak detectors to be furnished at lowest part of interstitial space between tank walls.

- Factory Cleaning: Clean interior and exterior. Remove all mill scale, dirt, rust, oil, welding debris, loose coatings and coatings and material incompatible with fuel

stored or protective coating to be furnished. Sandblast exterior in accordance with NACE 3/SSPC-SP6 and STI corrosion protection system requirements.

- Cathodic Protection: Conform to UL 1746 and STIP3 and NACE SP0169 consisting of galvanic anodes, wire conductors welded to the tank and connected to test stations and anodes, insulating devices to electrically isolate the tank from piping, test stations properly connected to permit required tests.

- Cathodic Protection System Test Stations:

- STI P3 system for tanks.

- High-impact-resistant plastic terminal board, cadmium-plated or zinc-plated hardware, accessible from front and rear, sufficient terminals for all required connections.

- Steel, fiberglass or polyethylene. Reinforce to prevent deflection. Leak-tight attachment to tank. Clean and coat interior and exterior of steel enclosure as specified for exterior of tank.

- For steel enclosures, provide cathodic protection system and test station as specified for the tanks.

- Access to Manhole Enclosure: Cast iron manhole frames and covers, rated for traffic, minimum opening as shown. Comply with Fed. Sidewalk type metal doors as shown and as specified under Section 055000, METAL FABRICATIONS.

- Pipe Connections to Tanks:

- Conform to UL 58.

- Pipe sizes 100 mm (4 inches) and smaller, threaded. Pipe sizes 150 mm (6 inches) and larger, raised faced slip-on flanges, 1034 kPa (150 psig) ASME rating.

- Welded joints required on steel piping located inside tanks.

- Provide and coordinate tank connection quantities, sizes and types with requirements of fluid level gauge unit; leak detector sensor; sounding rod; vent, fill, supply and return pipes; and other pipes as shown.

- Dielectric insulation on all connections to steel piping.

- All tank piping connections, except vent, shall be within the tank manhole enclosure.

- Tank Manholes: Provide quantity shown. Bolted cover type, gasketed. Zinc plated bolts, nuts, washers.

- Internal Ladder: Provide as shown and shall have 50 mm x 6 mm (2 inch x 1/4 inch) sides, 20 mm (3/4 inch) diameter rungs on 300 mm (12 inch) centers. Provide slide supports to allow for tank movement.

- Wear (Striker) Plates: Provide 300 mm (12 inch) square, 6 mm (1/4 inch) thick steel plates rolled and seal-welded to bottom of tank directly under all openings.

- Lifting Lugs: Provide for rigging tanks.

- For Sizes of tanks and interconnections of pipes, refer the design drawings.

5.0 TANK AND PIPING ACCESSORIES

- Vent Caps: Galvanized cast iron or cast aluminum with brass or bronze screens, arranged to permit full venting and to prevent entry of foreign material into the vent line. Same pipe size as vent pipe.

- Fill Boxes:

- Spill-container type enclosing a fill cap assembly with cam lock hose connector with closure coordinated with fittings used by fuel supplier.

- Fill cap shall be lockable, tight-fill design with provision for padlock on the top of the cap. Fill cap shall screw onto threaded adapter that can be removed without removing fill box. Entire assembly shall seal tight with no leakage during filling and when cap is in place.

- Provide special tools necessary for opening fill boxes and fill caps.

6.0 PIPING, VALVES, FITTINGS

- Fuel supply and return, tank fill, vents, sounding, and pump out.

- Steel Pipe and Fittings:

- Piping: Steel, seamless or electric resistance welded (ERW), ASTM A53/A53M Grade B or ASTM A106/A106M Grade B, Schedule 40. Aboveground piping shall be painted. Refer to Section 09 91 00, PAINTING.

- Joints: Socket or butt-welded. Threaded joints are prohibited except at valves, unions and tank connections.

- Fittings:

- Butt-welded joints: Steel, ASTM A234/A234M, Grade B, ASME B16.9, same schedule as adjoining pipe.

- Socket-welded joints: Forged steel, ASME B16.11, 13,790 kPa (2000 psig) class.

- Unions: Malleable iron, 2070 kPa (300 psig) class.

- Companion flanges: Flanges and bolting, ASME B16.5.

- Welding flanges: Weld neck, ASME B16.5, forged steel ASTM A105/A105M, 1034 kPa (150 psig).

7.0 SECONDARY CONTAINMENT FOR UNDERGROUND FUEL PIPING SYSTEMS

- Enclose the fuel supply, return and fill pipes in factory-engineered and fabricated secondary containment conduit systems. The systems shall be complete with end seals, with 25 mm (1 inches) minimum continuous annular space, 40 mm (1-1/2 inches) between carrier pipes, which shall contain all leakage and which has provisions for leak detection system as specified.

- Steel Conduit with Fusion-Bonded Epoxy Coating and Cathodic Protection:

- Galvanized carbon steel pipe, ASTM A53/A53M, Grade B, Schedule 40 for diameters through 125 mm (5 inches), 3.4 mm (0.134 inch) thick for diameters greater than 125 mm (5 inches) up through 660 mm (26 inches). All welded construction.

- Sand blast exterior per NACE 3.

- Coat exterior with 0.5 mm (20 mils) thick fusion-bonded epoxy.

- Provide cathodic protection designed by corrosion specialist and consisting of galvanic anodes, test stations, interconnecting wiring in conformance with UL 1746 and NACE SP0169. Electrical isolation required between all connecting systems in manholes and buildings.

- Steel Conduit with Fiberglass Reinforced Plastic (FRP) Coating:

- Carbon steel pipe, ASTM A53/A53M, Grade B, Schedule 40 for diameters through 125 mm (5 inches), 3.4 mm (0.134 inch) thick for diameters greater than 125 mm (5 inches) up thru 660 mm (26 inches). All welded construction.

- Blast clean exterior per NACE 4/SSPC-SP7.

- Apply fiberglass reinforced polyester (FRP) external cladding at least 2.5 mm (0.10 inches) thick with ultra-violet inhibitor. Cladding on field joints shall be equivalent to factory-applied cladding applied on remainder of system.

- Test entire system for holidays using a 35,000-volt holiday detector.

8.0 LEAK DETECTION SYSTEMS

- Automatic digital continuous monitoring systems responsive to the presence of water and hydrocarbons in the interstitial space of the double-wall tanks, in the tank manhole access enclosures, and in the secondary containment of fuel piping systems. System shall distinguish between hydrocarbon and water and identify location of leak as to individual tank and piping system. System may be combined with tank fluid level monitor and alarm system specified in paragraph, TANK FLUID LEVEL MONITOR AND ALARM SYSTEM.

- Functions and Arrangement:

- Single control station to monitor all sensing probes.

- Visual indicator to monitor and identify leaks as water or hydrocarbon and location.

- Indicators showing system status including faults and alarms.

- On board printer that provides complete reports of all system functions upon command.

- Panel circuit test button.

- 95 dB audible alarm with silencing control to sound when leak is detected.

- Eight-hour memory backup system with battery.

- NEMA 250 Type 4 cabinet.

- UL or other accredited testing laboratory listing.

- RS 232 Modbus communications with engineering control system boiler plant computer workstation to indicate system in service and alarm conditions.

- Sensors:

- Designed for required locations including: Insertion between walls of double-wall tanks, in sumps in double-wall piping systems and in tank manhole enclosures. Sensing points shall be at lowest point of each tank or sump. Intrinsically safe design.

- Sensing units shall detect presence of water and a minimum 3.2 mm (1/8 inch) thick layer of hydrocarbon on surface of water and minimum 50 mm (2 inch) thickness of hydrocarbon in area that has no water present.

- Sensors shall be arranged to allow replacement of individual sensors without disturbing other portions of leak detection system or fuel storage and piping system. Underground sensors shall be accessed through caps as grade.

- Materials of construction shall be non-corroding.

- Transmit status signal to control unit.

- Components:

- Provide manholes at grade for each sensor cap similar in construction to fill boxes. Manholes shall be cast iron, quick-opening cover, watertight, minimum size necessary to accommodate sensor caps. Provide identification plates, similar to those specified for fill points, labeled “MONITORING/OBSERVATION WELL-DO NOT FILL”. Provide special tools if necessary for opening covers.

- Sensor housings from tank and piping to grade shall be Schedule 40 PVC, or stainless steel.

- Underground wiring between probes and control unit: Place in water-tight corrosion-resistant conduit system conforming to Section 26 05 41, UNDERGROUND ELECTRICAL CONSTRUCTION.

9.0 TANK FLUID LEVEL MONITOR AND ALARM SYSTEMS

- Digital systems for central monitoring of fuel and water levels in all fuel oil storage tanks in the project. High and low level visual and audible alarms. Volumetric tank-tightness testing. Complete with all transducing, transmitting, and receiving devices.

On board printer to provide complete report of all system functions upon command. System may be combined with leak detection system specified in paragraph, LEAK DETECTION SYSTEMS.

- Fluid Level Monitor:

- Digital continuous readout, showing tank oil and water levels in liters gallons, smallest reading, one liter, one gallon. Provide identification of product measured, measuring units, and the tank number.

- Tank and fuel characteristics contained in preprogrammed non-volatile field-replaceable databases. Protected power supply.

- High and Low Fluid Level Alarm System:

- Automatic continuous on-line monitoring of all tanks.

- Visual and audible indicators combined with fluid level monitor. Identify the tank that is in alarm condition.

- Manual alarm test and silencing controls.

- Low level alarm actuation adjustable 0-25 percent of tank capacity. High level alarm actuation adjustable 75-100 percent of tank capacity.

- Locate all indicators, selector switches, alarms on face of wall-mounted NEMA 250, Type 4 panel.

- Remote Alarm Annunciator:

- Visual and audible high-level alarms adjacent to tank fill box locations. Locate in NEMA 250 Type 4X weatherproof exterior wall or pole-mounted panels.

- Alarm shall include flashing red light with 180-degree visibility for each tank and 95 dB horn or 100 mm (4 inch) diameter bell. Provide alarm silence control.

- Provide identification sign: "WHEN ALARM SOUNDS - FUEL TANK FILLED TO CAPACITY - DO NOT OVERFILL".

- Modbus communication to engineering control system boiler plant computer workstation to indicate tank fluid level and alarm conditions. Telephone modem communication capability.

- System Performance: Accuracy plus or minus 2.5 mm (0.10 inch) of fluid height in inventory mode and 0.25 mm (0.01 inch) in leak detection mode. Automatic compensation for fluid temperature changes. Volumetric tank tightness sensitivity of 0.4 lph (0.1 gph).

- Sensors:

- Provide sensor types such as magneto strictive, capacitance, float, hydrostatic and other types as necessary for the applications.

- Apply in accordance with manufacturer's instructions with provisions for easy future replacement without need for excavation.

- Provide for each hydrostatic sensor a constant flow differential pressure regulator and transmitter protected from fuel contamination. Air supply shall include filter and over-pressure protection. Provide desiccant-type dryer on air supply designed for removal of water vapor. Dryer rating, minimum 4.6 L/s (10 SCFM). Provide moisture indicator. Dryer may be deleted if air supply source has a refrigerated dryer.

- Float-type units shall be designed for installation and removal through a 100 mm (4 inch) diameter vertical pipe mounted in the top of the tank.
- Underground Wiring and Piping: Enclose in water-tight corrosion-resistant conduit system sized and arranged as recommended by system manufacturer and conforming to Section 26 05 41, UNDERGROUND ELECTRICAL CONSTRUCTION.

- Code Conformance: NFPA70.

10.0 WARRANTY

b. Standard Warranty after testing commissioning after handing over to the client.

END OF SECTION

SECTION V-14
EARTHING SYSTEM

1.01 SCOPE OF WORK

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.

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.

1.02 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.

1.03 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 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 : ≤ 1 Ώ
- Earthing For Static Discharge : ≤ 10 Ώ
- Earthing For Lightning Protection : ≤ 10 Ώ
- Instrument Clean Earth : ≤ 1 Ώ

- Any other standard referred to in above standards or these specifications.

1.04 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.

1.05 EARTHING ACCESS ORIES

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.

1.05.1 Earthing by Copper Plates

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.

1.05.2 Earthing by 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.

1.05.3 Double Flange Earth Electrode Seal

Provide waterproof Double Flange Earth Electrode Seals for use in constructions where internal earths are specified to be installed in concrete slabs in basements or any other location where ingress of water specifically sub-soil water is expected. These double flange seals shall at least comply with following specification:

- Nominal thickness: 300mm (Provide extended seal tubes if concrete slab thickness is more).
- Withstand maximum pressure: 80 psi (5.5 bars).
- Material: High Density Plastic unless otherwise approved by the Engineer.
- Standard: BSEN 62561-5 (2011) and an extended 5 day test following BSEN 62561-5 test conditions.

1.05.4 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.

1.05.5 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.

1.05.6 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.

1.05.7 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.

1.06 EARTHING INSTALLATIONS

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.

1.06.01Installation of Earth Electrodes (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 2x70mm^2 bare Cu. Conductor shall be taken to the bus bar in the inspection chamber through 50mm G.I pipe for watering purpose.

1.06.02Installation 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 point's earth connection shall be made to individual point as marked in drawing.

1.06.03Installation of Double Flange Earth Electrode Seals

The Double Flange Earth Electrode Seals must be installed fully in accordance with the manufacturer's instructions and under the supervision of manufacturer's trained and certified staff. Earth electrode seal flange and components must be free from dust/ debris/ grease/ paint before pouring the concrete to achieve highest quality and fully compacted to ensure full sealing from water. It shall be possible that additional Earth Rods can be driven at a later date, with no additional parts or causing damage to the Earth Rod Seal. The main concrete slab must not be shuttered out and the Earth Rod Seal fitted later.

1.06.04Installation of Earth Electrode where 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.

1.07 EQUIPMENT GROUNDING

1.07.01Non-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.

1.07.02Grounding of Fence

All metallic fences shall be grounded by driving earth rods at a distance of 50 meter.

1.08 INSPECTION AND TESTS

Earth resistance tests 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.

- END OF SECTION –

SECTION-E-15
ELECTRICAL IDENTIFICATION

1.01 SUMMARY

A. Electrical Identification Materials and Devices:

Identification for raceway and metal-clad / armored cable.

Identification for conductors, communication and control cable.

Underground-line warning tape.

Warning labels and signs.

Instruction signs.

Equipment identification labels.

Miscellaneous identification products.

1.0 QUALITY ASSURANCE

A.Comply with ANSI A13.1 and ANSI C2.

3.0 PRODUCTS

A. Raceway and Metal-Clad Cable Identification: Adhesive labels, wraparound plastic sleeves, colored adhesive tape and underground-line warning tape.

B. Conductor and Cable Identification: Colored adhesive tape, marker tape, write-on tags and brass or aluminum tags.

C. Equipment Labels: Printed adhesive film, printed adhesive film with clear protective overlay, engraved plastic and stenciled legend.

D. Warning Signs: Baked enamel or metal backed butyrate.

E. Instruction Signs: Engraved, laminated acrylic or melamine plastic.

- END OF SECTION -

SECTION-E-16
POWER FACTOR CORRECTION CAPACITORS (PFI)

1.01 SUMMARY

A. Automatic power factor correction equipment rated 600 V and less.

1.02 QUALITY ASSURANCE

A. Quality Standards: Relevant BS Standard, IEC Standard, IEEE wiring Regulations

- Capacitors	IEEE 519, IEC 831-1,2
- Series Reactors	IEC 76
- Contactors	IEC 947-4-1
- Fuses	IEC 269
- Circuit Breakers	IEC 947 – 1,2
- Degree of Protection	IEC 144

All such equipment shall be manufactured only by manufacturer having ISO 9001 certificates.

1.03 PRODUCTS

A. Capacitor Cells: Dry, metalized-dielectric, encapsulated type.
B. Capacitor-Bank Fuses: Current-limiting, non-interchangeable type.
C. Discharge resistors.
D. Fixed Capacitors: Integrally fused.
E. Automatic Power Correction Factor Units: Capacitor banks, contactors, and solid-state, microprocessor-based controls installed in independent enclosures.
   1. Adjustable Target Power Factor: 0.80 lagging to unity.
   2. Local Display: LED or LCD in door of enclosure.
   3. Alarm indication.
   4. Current transformer.
   5. Main circuit breaker.
   6. Remote monitoring components.

1.04 SOURCE QUALITY CONTROL

A. Power Factor Correction Equipment: Tested according to NEMA CP 1.

1.05 FIELD QUALITY CONTROL

A. Testing Agency: Owner / Contractor

SECTION-E-17

ENERGY ANALYSIS AND METERING SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including general and supplementary conditions and Division 01 Specifications sections, apply to this section.

B. Read this section in conjunction with other related sections, the design drawings, contractor conditions and MEPF Scope of Works.

C. Provide all labour, materials, products, equipment and services to supply and install the electrical systems as indicated on the drawings and specified in these specifications.

1.2 SUMMARY

A. Energy analysis & metering system shall be microprocessor digital based system consisting of energy analyzers/meters, serial communication ports, data loggers; RS-485/LAN cable network, power supply & LAN/WEB based on-line viewing, recording and analysis software. In this project this system is further referred Centralized Energy Monitoring System (CEMS)

1.3 REFERENCE STANDARDS

A. In addition to the requirements indicated on the Design Drawings or elsewhere within this Specification, the work shall be in accordance with the following standards and codes, latest and current editions.

1. IEC 61557-12, “Electrical safety in low voltage distributions systems up to 1,000 VAC and 1,500 VDC – Equipment for testing, measuring or monitoring of protective measures – Part 12: Performance measuring and monitoring devices (PMD).”

2. IEC 62052-11, “Electricity Metering Equipment (AC) - General Requirements, Tests and Test Conditions - Part 11: Metering Equipment.”

3. IEC 62053-23, “Electricity Metering Equipment (AC) - Particular Requirements - Part 23: Static Meters for Reactive Energy (Classes 2 and 3).”

4. EMI/ EMC standard as per IEC 61326-1 specification

5. IEC 61000-4-2: “Electromagnetic compatibility (EMC) - Part 4-2: Testing and measurement techniques –Electrostatic discharge immunity test.”

6. IEC 61000-4-3: “Electromagnetic compatibility (EMC) - Part 4-3: Testing and measurement techniques - Radiated, radio-frequency, electromagnetic field immunity test.”

7. IEC 61000-4-5: “Electromagnetic compatibility (EMC) - Part 4-5: Testing and measurement techniques - Surge immunity test.”

8. IEC 61000-4-6, “Electromagnetic compatibility (EMC) - Part 4-6: Testing and measurement techniques - Immunity to conducted disturbances, induced by radio-frequency fields.”

9. IEC 61000-4-8, “Electromagnetic compatibility (EMC) - Part 4-8: Testing and measurement techniques - Power frequency magnetic field immunity test.”

10. CE marking as per IEC specification

11. IEC 61010-1 Ed 3 : " Safety requirements for electrical equipment for measurement, control, and laboratory use –Part 1: General requirements"

12. IEC 61326-1: "Electrical equipment for measurement, control and laboratory use – EMC requirements –Part 1: General requirements"

1.4 REFERENCE STANDARDS – LOCAL AUTHOIRTIES WITH JURSIDICTION

A. In addition to the requirements indicated on the Design Drawings, or specified in Division 01 General Requirements, the Particular Specifications and the specification Scope of Works,

- K-Electric Supply Corporation
- Pakistan Electricity Rules 1937
- Building Energy Code of Pakistan
- Building Code of Pakistan- Fire Safety Provisions
- International Electrotechnical Commission

1.5 SUBMITTALS

A. Detailed test reports, settings, Record Documents, Maintenance manuals, As-built Drawings (Auto Cad made) shall be provided to the Consultant, displaying location of all devices, zones, routing of all cables, including a detailed schematic wiring diagram.

B. Comply with the requirements of Section 01 of the specifications for Closeout Submittals and submit the following.

1. The Contractor shall provide a three-year warranty, covering materials, softwares and labour from the date of commissioning of the system.

2. Operation and Maintenance (O&M) Manuals, which shall include a list of components with manufactures reference numbers, descriptions of materials and procedures for repairing and cleaning of finishes, inclusive of required cleaning frequency.

1.6 QUALITY ASSURANCE

A. Products to be procured from manufactures specializing in the manufacturing of the products specified within this section, with a minimum of 5 years documented experience.

1.7 TECHNICAL SUPPORT SERVICE PLAN

A. The software vendor shall maintain global technical support centers, with sufficiently trained engineers to provide support escalations from the contractor, and efficient management of software faults/bugs.

B. All Technical support cases should be tracked to ensure alignment within the context of a defined Service Level Agreement.

C. The contractor shall furnish a support service plan, which provides the user of the Energy Analysis Software with priority access to technical support.

D. The support service plan shall include:

1. On-Demand Technical Support

   a. Priority access to a support engineer
   b. Live telephone support, response within four hours.
   c. Email, response within four hours.
   d. Priority escalation channel to Expert level resources for critical cases.
   e. Digital tools for remote connection/troubleshooting of the system.

2. Meter System Validation:

   a. The software vendor shall possess tools to provide ongoing reporting on the validation of the metering equipment, confirming the data is accurate and repeatable.

   b. Validation reports shall be provided on required intervals to satisfy reporting requirements of ISO50001:4.6.1 (Monitoring, measurement and analysis).

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PART 2 - PRODUCT – ENERGY ANALYZER SOFTWARE

2.1 SYSTEM REQUIREMENTS:

A. The System should be a network-enabled system capable of monitoring an entire distribution of utilities.

B. The software should provide 03 level password security systems.

C. The system should be capable for multiuser at same time.

D. Graphical displays of information.

E. Reporting tools with standard report templates.

F. Interactive historical data display and trending (minimum 03 years).

G. Real-time data tables with standard views.

H. Interactive alarm analysis with standard views.

I. Consumption & utilization of Water, compressed air, natural gas, electricity, steam, diesel monitoring and reporting, as required.

J. Device Support

K. The system should provide factory-tested, built-in support for at least 1000 hardware devices (energy and power meters, protection relays, circuit breakers, PLCs, etc.) that include ready-to-go, pre-engineered, interactive graphical display screens for viewing and analyzing real-time and historical device data.

L. Pre-built device features should be offered to monitor and control the remotely connected devices.

M. The Selected Energy Analyzer shall have 30min explosion proof battery pack

N. The Energy Analyzer shall be password protected to avoid theft or tempering

0. The Energy Analyzer shall have inbuilt feature to manage Multiple tariffs at the Peak, off
Peak and generator.

2.2 SOFTWARE

A. The energy analysis software platform shall facilitate applications in the broad categories of (i) energy performance, (ii) power availability, quality and reliability, and (iii) sustainability performance. At a high level, the feature-set shall provide functions in:

1. Real-time monitoring.
2. Alarming and event management.
3. Energy cost analysis.
4. Energy, power, and sustainability data analytics and visualization.
5. Real time recording

B. The software platform shall be certified for use as a part of an ISO50001 program and verifiably support compliance. In addition, the functionality shall support ongoing ISO50001 programs per the following areas of Section 4 of the ISO standard:

1. Energy review.
2. Energy baseline.
3. Energy performance indicators.
4. Monitoring, measurement, and analysis.
5. Input to management review.

C. Shall verifiably support compliance with EN 16247-1 for energy audits

2.3 REAL TIME MONITORING

A. The energy analysis software shall provide a graphical monitoring and analysis application for power users (trained administrators, power system engineers, energy managers, facility managers, technicians, etc.) that provide a rich set of tools for energy analysis, Power Quality analysis, power system monitoring and control.

B. The graphical monitoring and analysis application shall be able to create a comprehensive set of linked hierarchical graphical diagrams showing all devices and their associated device specific diagrams in the power monitoring network (auto-diagram creation).

C. The graphical monitoring and analysis application shall support custom graphics/images and provide the ability to create graphical diagrams of the energy analysis software, including electrical one-line diagrams, facility maps, plan views, floor layouts, equipment representations, and mimic displays.

D. The graphical monitoring and analysis application shall be capable of writing to device registers for applications such as resetting, triggering, toggling, switching, manual waveform capture, controlling remote devices and equipment, including breakers.

E. The graphical monitoring and analysis application shall allow application and HMI design engineers to create custom diagrams with linkages to device registers even if the devices are offline / disabled.

F. Web-enabled real-time tables: The system shall have the following capabilities for interactive side-byside visualization of real-time measurements:

1. Display a tabular view to compare device readings from multiple meters in the power monitoring network quickly.

2. Permit users to create, modify, view and share table views through a browser without the need for a separate software application.

3. Have built-in functions that allow users to easily and instantly filter out measurements when viewing a table.

4. Support both physical and virtual devices defined in the system.

5. Support exporting real time tabular data into Excel formats.

G. Power monitoring trending: The energy analysis software shall include graphical charts for real-time trending of power usage (kW, Volt, Amp, and kWh) or any measurement supported by metered equipment such as generators and MV/LV switchgear. These trends shall include the capability to:

1. Trend up to 10 measurements on the same chart (limit may be increased if desired).

2. Customize attributes such as color, line thickness, overlays, display name, and display units for each data series.

3. View the trend using an auto-scaling or manual chart axis.

4. Adjust the desired time viewing window for the trend.

5. Inspect the trend by zooming and panning to focus in on key areas of the trend.

6. Provide drill-down detail for the highlighted trend data point to help identify root causes of concern.

7. Trend measurements with different units on the same chart using two different axes.

8. Provide calculated values of minimum, maximum, and average values for a trend.

9. Configure a target thresholdline for comparison against actual measurements.

   a. Configure up to two target bands with visual indicators to identify when a measurement is outside specified limits.
   b. Display real-time data and/or historical data per data series, with optional back-filling of the real-time data using historical data.

10. Export trend data to .CSV/Excel format.

11. Access trend data from a web browser or mobile environment.

12. Save specified trends in a library for later use.

13. Share trends with other users or restrict use.

14. Simultaneously view multiple trend charts, or alternatively maximize a selected trend to display it in full screen mode.

    a. Note: The time interval for recording shall be adjustable through software from 01 seconds up to several minutes individually for each meter for any of the values

    b. The waveform capture record times shall be consistent with specified sampling periods

    c. The software shall be latest windows based.

    d. Original software CD with keys/dongle/codes should be handed over to employer.

    e. The dual source energy meters shall where specified get signal from changeover switch to start recording consumption on the selected source without any delay.

H. Dashboard:

1. A built-in featured dashboard that should provide interactive display and trending of historical data. The focus of dashboards is to provide a state- of-the art, intuitive, and easy-to-access views of data.

2. Dashboards can be configured with multiple gadgets to show the following views:

   a. Consumption
   b. Cost
   c. Trends

3. Users should be able to create, modify, view and share their dashboard content (including graphics, labels, scaling, measurements; date ranges, etc.) from within the dashboard application without the need for a separate software application.

2.4 ALARM AND EVENT ANALYSIS AND NOTIFICATION

A. The energy analysis software shall provide alarm and event annunciation features that include the following:

1. An alarm viewer that provides a summary of the active alarms shall be provided. The viewer shall:

   a. Be visible in any screen when logged into the web interface of the system.

   b. Display the total number of unacknowledged alarms, and the breakdown of how many of those alarms are high priority, medium priority and low priority.

   c. Provide an audible alarm and a simple means for muting the alarm.

   d. Allow a simple mechanism to acknowledge alarms for users with appropriate user privileges.

   e. Allow a mechanism to set configurable alarm thresholds, for example, high, medium, and low.

   f. Allow a mechanism to create user defined alarm views that fit user defined criteria.

   g. Provide an intuitive, graphical display of all active and historical alarms and events in the power system such as over kW, breaker trips,and power quality disturbances to show alarms currently in the active state.

   h. The alarm viewer should provide a visual summary banner indicating the number of unacknowledged alarms for each alarm priority level. The banner will be shown at the top of each web application.

B. The energy analysis software shall provide an alarm notification system.

1. The alarm evaluation and notification system shall ensure that appropriate staff members are notified of power system events. The system shall collect data, evaluate alarm conditions, and annunciate the alarms to specified users through email or SMS text messages.

2. The alarm evaluation and notification system shall include:

   a. An alarm evaluation engine.
   b. An alarm notification/annunciation engine that supports annunciation through email and SMS text message.
   c. Flexible alarm scheduling capabilities.
   d. Web-based configuration tools for notification configuration, log viewing, and filtering.
   e. Message delivery mechanisms such as:

      1) Electronic mail (Email)
      2) Text messaging for cell phones (GSM Modem)
      3) Short messaging peer-to-peer protocol (SMPP)
      4) Simple Network Paging Protocol (SNPP)
      5) Simple Network Management Protocol (SNMP)
      6) Traditional dial-up Pager (TAP)

2.5 DATA ANALYTICS AND VISUALIZATION

A. The energy analysis software shall provide web-enabled dashboards.

1. The system shall have a web client interface that presents interactive auto-updating dashboard views that may contain water, air, gas, electric, and steam energy summary data, historical data trends, images, and content from any accessible URL address.

2. Users shall be able to create with configurable drag and drop gadgets to show the following data:

   a. Images from any web-based content
   b. Energy consumption
   c. Energy cost
   d. Energy comparison
   e. Energy savings
   f. Emissions
   g. Trends

3. The system shall facilitate kiosk displays by assigning individual dashboards to slideshows to run in unattended mode, scrolling through designated dashboards at a configurable time interval.

4. The system shall permit users to create, save, and share an unlimited number of dashboards and slideshows.

B. The system shall provide a web-enabled reporting platform.

1. The system shall provide a web-enabled reporting tool to view historical data in pre-formatted or user-defined report templates.

2. The system shall support reporting on all supported physical devices and virtual (or calculated) meters as defined in the device hierarchy.

3. The reporting tool shall provide standard pre-formatted or user-defined report templates for: Energy cost

   a. Load profile
   b. Energy consumption report of all utilities

c. System-wide interactive power quality report with CBEMA/ITIC evaluation
d. EN50160 compliance
e. EN50160 Edition 4 compliance
f. Energy Usage: period-over-period, by shift, single and multi-device comparison
g. Tabular, trend and multi-trend
h. Alarm and event history
i. System configuration
j. Hourly usage report
k. Single and multi-device usage reports

4. The reporting tool shall support exporting to the following output formats: HTML, PDF, TIFF, Excel, and .XML.

5. According to a configurable schedule by saving to network locations, email, or print.

6. The system shall support the ability to trigger the generation and delivery of a pre-configured report based on pre-specified event criteria. The system shall be capable of configuring event monitoring detection filters criteria.

7. The reporting tool shall have a framework to support:

a. Simple customizations to reports such as colors, image inclusions, turning report sections on/off, and logo changes without programming.

2.6 TECHNICAL INFRASTRUCTURE

A. The energy analysis software shall provide the following operating system and browser support:

1. All associated core components of the energy analysis software operate as Windows operating system services (latest version).

2. The web client interface shall support multiple browsers.

B. The energy analysis software shall provide the following data management support:

1. Microsoft SQL Server database engine per supported configurations SQL (latest).

2. All network configuration settings relating to device routing and addressing, communication gateways, distributed I/O servers, and load- distributing application servers shall be stored in the energy analysis software databases.

3. Archiving, trimming, and on-demand or scheduled capabilities shall be supported.

4. The capability to view historical data from archived databases shall be included.

5. The energy analysis software shall be capable of retrieving data from devices in the monitoring network and provide the following abilities:

a. Interrogate and download logs of interval, waveform, and alarm data stored onboard metering devices and related circuit breaker trip units.

b. Interrogate and download logs of interval data generated by the software system (software-based logging).

c. Interrogate and download logs of alarm and event data generated by the software system (software-based alarming).

d. Detect unknown measurement quantities provided by devices in the network, and automatically generate appropriate database references for those quantities without user intervention.

C. The energy analysis software system shall include an Administrative interface with the following management functions:

1. Security: administer groups and user accounts with role-based privileges.
2. Database: initiate backup, archiving, and trimming tasks.
3. Devices: Add or rename devices, map measurements, and communication settings.
4. Connections: Configure connection schedules and manage modem connections.
5. Events: View and manage software system events.

D. The energy analysis software shall support the following device support and management features:

1. Pre-engineered, interactive graphical display screens for viewing and analyzing real-time and historical device data.

2. All registers pre-mapped to standard measurement names without additional mapping of internal device registers.

a. The system shall support integration with other third party intelligent electronic devices (IEDs) not directly supported natively.

E. The system shall support extensibility in the following ways:

1. Provide a graphical, object-oriented application logic engine to create system-wide logic modules with arithmetic, XML data import, PC-based alarming, and logging capabilities.

2. The application logic engine shall have a comprehensive set of functions to create customized applications programs for functions such as weather or real-time price import, KPI calculations, energy units conversion, data aggregation, data normalization, data comparison, power loss calculations, power factor control, load shedding, etc.

F. The energy analysis software system shall support system integration in the following ways:

1. Device-level Modbus interoperability.

a. The system shall be capable of supporting Modbus communicating devices and be capable of functioning as a Modbus master to read/write registers in Modbus devices for monitoring and control applications.

b. The system shall be capable of Modbus device definition (device drivers) creation to enable integration of third-party Modbus protocol devices.

2. System-level OPC interoperability.

a. The system shall be OPC DA 2.0.1 compliant (as per the OPC Foundation Compliance Testing process) for OPC Server and OPC Client data sharing applications amongst OPC compliant systems.

b. The system shall provide default OPC Server tag mappings for all natively supported device types without the need to select, configure, or program the mapping of device registers to OPC tags.

3. Web application level integration.

a. The system shall include:

b. The capability to integrate other web applications into its web interface through the use of pluggable web content widgets.

c. The capability to supply content such as dashboards, reports, trends and diagrams to other external web applications through addressable URLs.

G. Web services integration

1. The system shall include web services integration capabilities for machine-to-machine interactions with other application software systems with the following characteristics:
2. Based on SOAP (Simple Object Access Protocol) protocol specification.
3. Provide a Web Services Description Language (WSDL), machine- readable description.
4. Allow access to real-time, historical (i.e., time stamped), and alarm/event type data.
5. Provide the ability to acknowledge alarms by authenticated and authorized clients.
6. Provide digest authentication functionality.
7. Provide the ability to be enabled or disabled.

H. The energy analysis software shall support system configuration and advanced analysis tools in the following ways:

1. **The system shall include a monitoring and analysis application with a rich set of power tools for electric system analysis, power quality analysis, power system monitoring and control, and include the following capabilities:**

a. Auto-diagram creation capability to create a comprehensive set of linked hierarchical graphical diagrams showing devices and their associated device specific diagrams in the network.

b. Ability to import custom graphics or images to create electrical one-line diagrams, facility maps, plan views, floor layouts, equipment representations, and mimic displays.

I. The system communications infrastructure shall support the following:

1. Multiple communications network topologies including Ethernet/TCP, serial RS-485/RS-232, and Modem dial-up connections.

2. The capability to communicate simultaneously with multiple devices, including devices on different physical communications channels.

3. Scalability to greater than a thousand devices.

4. The ability to automatically retrieve logged data (interval data, event data, and waveform data) from natively supported devices without additional configuration.

5. The ability to automatically disconnect modem connections when all device data is database synchronized (used to minimize long distance phone charges).

6. Software backup in CD & Hard disk (USB) from the vendor should be provided.

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PART 3 - PRODUCT - ENERGY ANALYSERS/METERS

3.1 GENERAL

A. Energy analyzers/meters shall be panel front mounted type with LCD displays; push buttons shall be provided on front for programming and data views.

B. The meters shall be suitable to use in 3-ph 3-wire (3 element) or 3-ph 4-wire (3 element – star/wye) or 3-ph 4-wire (2 element – delta) or 1-ph 2-wire system, 2-ph 3-wire system field configurable for balanced or unbalanced 3-ph/ 1-ph/ 2-ph and neutral system with a power factor ranging from zero lagging to unity to zero leading. The meters shall support different wiring schemes.

C. The vendor shall be ISO: 9001:2008, ISO: 14001:2004 and certified to demonstrate quality & environment standard compliance. Documentary evidence indicating the validity of process compliance shall be provided along with the tender documents.

D. The components included within the power equipment lineups shall be factory assembled, tested and calibrated prior to shipment to the job site.

E. Each device shall carry with valid test and calibration certificate traceable to national and international standards. The routine test conducted on each and every meter shall be (not limited) tested for basic, power and energy parameters.

F. The performance shall be validated with the type test report in accordance with the relevant products standards such as IEC 62053-21/ 22, IEC 62053-23/ 24 & IEC 62052-11. The complete type test reports conducted at internationally accredited external laboratory to be submitted along with the tender documents or whenever asked by the users.

3.2 ENERGY ANALYZERS

Energy analyzers/Meters shall be of following types as per accuracy requirements:

A. High Accuracy Meters (Type-EM)
High accuracy meter are required on incoming power source like Prime source of 11 kV/415 V transformer and all incoming supplies from standby generator.

Details of Parameters Monitoring & Data Recording:

1. General:

   a. Use on LV and HV systems.
   b. Current accuracy (1 A to 5 A) = 0.1% reading
   c. Voltage accuracy (57 V to 288 V) = 0.1% reading
   d. Energy accuracy 0.2% (0.2S)
   e. Number of samples/cycle or sample frequency = 1024
   f. Memory = 512 MB

2. Instantaneous RMS values:

   a. Current, voltage, frequency.
   b. Active, reactive, apparent power Total and per phase
   c. Power factor Total and per phase
   d. Current measurement range (Auto ranging) = 0.01 A to 20 A

3. Energy values

a. Accumulated Forward Energy (Real kWh, Reactive kVArh, Apparent kVAh)
b. Accumulated Reverse Energy (Real kWh, Reactive kVArh, Apparent kVAh)
c. Signed, Absolute, Net (Import, Export, Total, Net)
d. Life times: Active load times, Run hours, On hours and number of power outage
e. Settable-accumulation modes

4. Demand values

a. Current Present and max. values
b. Active, reactive, apparent power Present and max. values
c. Predicted active, reactive, apparent power
d. Synchronization of the measurement window
e. Setting of calculation mode Block, sliding

5. Power quality measurements

a. Harmonic distortion Current and voltage
b. **Individual harmonics via front panel = 63rd for LV Panels**
c. Waveform capture
d. Detection of voltage swells and sags
e. Detection and capture of transients = 20µs
f. Flicker
g. Fast acquisition of 100ms or 20ms data
h. EN 50160 compliance checking
i. IEC 6100-4-30 Class A
j. Programmable (logic and math functions)

6. Data Recording

a. Min/max of instantaneous values
b. High speed Data logs
c. Event logs
d. Trending/forecasting
e. SER (Sequence of event recording)
f. Time stamping

7. Communication

a. RS-485
b. Modbus protocol
c. IEC 61850 protocol
d. Ethernet port (Modbus/TCP/IP protocol, IEC 61850)
e. Ethernet gateway (Ether Gate)
f. Alarms (Automatic Alarm Setting)
g. Alarm notifications via e-mail and SMS (Short messaging services)
h. HTML web page server (web meter)
i. Internal Modem
j. Modem Gateway

8. Electrical characteristics

a. Type of measurement = True rms to 1024 samples per cycle
b. Measurement accuracy
c. Current and voltage = ±0.01 % of reading + ±0.025% of full scale
d. Power = ±0.075 % of reading + ±0.025 % of full scale

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e. Frequency =±0.005 Hz
f. Power factor =0.002 from 0.5 leading to 0.5 lagging
g. Energy =IEC 62053-22 0.2% (0.2S)
h. Data update rate =1/2 cycle or 1 second
i. Input-voltage characteristics
j. Measurement range 600 V L-L =Auto ranging 57 V through 347 V L-N / 600 V L-L
k. Impedance =5 M/phase (phase - Vref)
l. Frequency measurement range=42 Hz to 69 Hz

B. Intermediate Metering (Type-DEM)

Dedicated energy meter required on all major outgoing feeders and distribution panels.

Details of Parameters Monitoring:

1. General:

a. Use on LV and HV systems.
b. Current accuracy (1 A to 5 A) = 0.5% reading
c. Voltage accuracy (57 V to 288 V) = 0.5% reading
d. Energy accuracy 0.5%
e. Number of samples/cycle or sample frequency = 32

2. Instantaneous RMS values:

a. Current, voltage, frequency.
b. Active, reactive, apparent power Total and per phase
c. Power factor Total and per phase
d. Current measurement range (Auto ranging) = 0.01 A to 20 A

3. Energy values

a. Accumulated Forward Energy (Real kWh, Reactive kVArh, Apparent kVAh)
b. Accumulated Reverse Energy (Real kWh, Reactive kVArh, Apparent kVAh)
c. Signed, Absolute, Net (Import, Export, Total, Net)
d. Lifetimes: Active load times, Run hours, On hours and number of power outage
e. Settable-accumulation modes

4. Demand values

a. Current Present and max. values
b. Active, reactive, apparent power Present and max. values
c. Predicted active, reactive, apparent power
d. Synchronization of the measurement window
e. Setting of calculation mode Block, sliding

5. Power quality measurements

a. Harmonic distortion Current and voltage
b. **Individual harmonics via front panel = 35th for all SMDB's**
c. IEC 6100-4-30 Class S

6. Communication

a. RS-485
b. Modbus protocol
c. IEC 61850 protocol
d. Ethernet port (Modbus/TCP/IP protocol, IEC 61850)
e. Ethernet gateway (Ether Gate)
f. Alarms (Automatic Alarm Setting)
g. Alarm notifications via e-mail and SMS (Short messaging services)
h. HTML web page server (web meter)
i. Internal Modem
j. Modem Gateway

C. Basic kWh Metering (Type-E) (NOT PROPOSED IN THIS PROJECT, FOR REFERENCE AND CAN BE UTILIZED THERE IS ANY ADDITIONAL REQUIREMENT FROM CLIENT TO TRACK INDIVIDUAL LOADS)

Direct connection upto energy meter required on all outgoing feeders from distribution panels for loads less than or equal to 15kW except harmonic producing loads.

Details of Parameters Monitoring:

1. General:

a. Use on LV systems
b. Current accuracy (1 A to 5 A) = 1% reading
c. Voltage accuracy (57 V to 288 V) = 1% reading
d. Energy accuracy 1%

2. Instantaneous RMS values:

a. Current, voltage, frequency
b. Active, reactive, apparent power Total and per phase
c. Power factor Total and per phase
d. Current measurement range (Auto ranging) = 0.01 A to 20 A

3. Energy values

a. Accumulated Forward Energy (Real kWh, Reactive kVArh, Apparent kVAh)
b. Accumulated Reverse Energy (Real kWh, Reactive kVArh, Apparent kVAh)
c. Life times: Active load times, Run hours, On hours and number of power outage
d. Settable-accumulation modes

4. Demand values

a. Current Present and max. values
b. Active, reactive, apparent power Present and max. values
c. Predicted active, reactive, apparent power

5. Communication

a. RS-485
b. Modbus protocol
c. IEC 61850 protocol
d. Ethernet port (Modbus/TCP/IP protocol, IEC 61850)

e. Ethernet gateway (Ether Gate)
f. Alarms (Automatic Alarm Setting)
g. Alarm notifications via e-mail and SMS (Short messaging services)
h. HTML web page server (web meter)
i. Internal Modem
j. Modem Gateway

3.3 NETWORKING

A. The system shall be completely LAN/WEB based. The scope of electrical metering supplier/contractor must include:

1. LAN based data loggers with memory that also act as MODBUS RS-485/LAN convertor connected through a shielded RS-485 cable, maximum 20 devices to be connected to one data logger/convertor. The data logger shall have built-in memory and shall provide allow real time viewing and real time recording of measured data.

2. Industrial grade Ethernet switches with fibre/copper ports shall be used to develop a complete fiber optic ring based LAN network for complete system.

3. Horizontal category 6 UTP cabling from data logger to building LAN/communication rack.

4. DC supply with battery for providing auxiliary supply to industrial Ethernet switches, meters/data loggers/RTU.

5. DC supply cabling from DC supply to industrial Ethernet switches, meters/data loggers/RTU

6. Walla mounted rack to house:

a. data logger
b. DC supply
c. DC battery
d. PDU, etc.

1) The rack to be wall mounted in respective rooms near/housing energy meters.

The cable shall be laid in steel conduit rigid/flexible.

3.4 INTERFACE TO OTHER DEVICES/METERS

A. Following shall also be connected to energy metering system for parameter recording and analysis:

1. Active Harmonic filters (monitoring)
2. Medium voltage protection relay for fault/status monitoring
3. Motor operator of main LV panel ACBs for ON/OFF control
4. Battery chargers (monitoring)
5. UPS for

B. The supplier shall include the cost and quantity of required RTUs/PLCs/interfaces in the quoted cost.

3.5 SERVER/PC SOFTWARE & HARDWARE

A. The server and control station requirements for above system shall be as follows:

1. Main software server set reside in hardware server mounted in rack in FCC room
2. LAN based full function control station in control room
3. Remote LAN/WEB/android/IOS based viewing/alarm client

PART 4 - EXECUTION

4.1 EXAMINATION

A. The contractor shall verify the conditions and examine the area for compliance with the requirements for installation in full consideration of conditions affecting the performance of the proposed product.

B. Identify conditions detrimental to a proper and timely completion and notify the Engineer of any unsatisfactory conditions and proceed with the installation only after unsatisfactory conditions have been corrected.

4.2 INSTALLATION

A. The energy meter supplier shall ensure that CTs supplied and installed by switchgear manufacturer are as per his accuracy required.

B. All tests shall be carried out in accordance with manufacturer's guidelines. The system shall be commissioned by Engineer of equipment supplier.

C. After the installation is complete, the wiring/system shall be tested and commissioned by factory trained personnel of the manufacturer's local agent, local agent, in accordance with the manufacturer's recommended procedures, in the presence of the Employer's representative and Consultant. Test shall include, but not be limited to, the following:

D. All wiring shall be tested for proper connection, continuity, and resistance to ground.

E. The complete system shall be functionally tested.

F. Each circuit shall be tested for trouble, by inducing a trouble condition in the system.

G. The supplier/contractor shall program the software settings as per employer's requirements at the commissioning stage.

H. Additionally, changes in settings and software shall also be required to be made later as per employer's requirements.

4.3 TRAINING

A. The Contractor shall train the Employer's personnel in the use, operation, and administration/management of the system.

- END OF SECTION -

TECHNICAL SPECIFICATION (Civil Structure)

SECTION – 1

1.0 GENERAL

1.1 General Introduction

The scope of work includes Upgradation & Improvement of Electrical System at State Bank Pakistan for Service Block Building.

1.2 Location of Work

The State Bank of Pakistan Building in City of Peshawar of Province KP.

1.3 General Consideration

Since in this project, Upgradation & Improvement works of the Service Block Building and LT Room in the Tower Block Building are planned, it would entail an excavation of about 10ft depth for trenches, Genset pads, foundations, trenches, manhole, chamber & utility pits.

1.4 It would therefore be essential to plan an adequate shoring system strong enough to support all loads imposed temporarily to hold the surrounding earth pressure to protect the existing adjacent property as well as to provide working facilities for execution of the proposed works during entire construction period. **Any damage to the existing property of third party will be the responsibility of the Contractor.**

1.5 Since the existing ground water table certainly below 10 ft (the maximum excavation dept proposed in this project) from the E.G.L., therefore no dewatering problem due to sub-soil water is likely to be encountered during construction of the proposed works of cable trenches, manholes and Genset pads.

1.6 However due consideration is required to be given for providing adequate dewatering/bailing out arrangement of water that enters into the excavation area either from direct rain or from leakages of the existing water supply / sewerage line and storm water drains , etc**1.7** This General Specifications are 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.

1.8 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 may also supplement such specifications during the progress of work.

1.9 All materials and goods used shall be subject 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 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 testing.

1.10 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 specially of cement, sand, aggregates, steel, 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 approved by the engineer 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.

1.11 The Contractor must take all steps necessary to prevent interference with all supplies 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.

1.12 The Contractor shall protect from injury or damage due to any cause what so ever by covering or causing all work, internally and externally needing protection including new concrete, block work, surface renderings, floors, etc., to the satisfaction of the Engineer, including the work of his sub-contractors at his own cost.

1.13 The whole work shall be carried out in the most suitable 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.

1.14 The Contractor shall submit to the Engineer for his approval before beginning 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 commencement of work.

1.15 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.

1.16 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 structures 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 advertisement neither shall he permit advertisements to be displayed without the written consent of the Engineer.

1.17 The contract drawings are the working drawings to guide the Contractor generally about the alignment and size of all the transmission mains, allied 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, 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 / Employer, before doing any or all of that described above or as directed by the Engineer / Employer shall have the right to require the Contractor to make any changes in the designs which may be necessary in the opinion of the Engineer to make the material or equipment conform to the requirements and intent of these specifications, without any additional cost. Approval of the Contractor's drawings shall not relieve the Contractor from any part of his obligation to meet all the requirements of the specifications or correctness of his drawings.

1.18 Subsoil Conditions

The Contractor shall make his own assessment after detailed study of the area and getting further investigations conducted by him in this regard, if required by him. No claims will be entertained by Engineer / Employer on account of any omission or error found in such data.

1.19 Cooperation with other Contractor

The Contractor is required to work in close cooperation with other Contractor or Contractors working on this project or on nearby areas.

SECTION - 2

2.0 SITE CLEARING, GRUBBING AND SETTING OUT OF WORKS

2.1 SCOPE OF WORK

The work covered by this section of specifications consist of furnishing all labor, 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.

2.2 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.

2.3 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.

2.4 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 of by the Contractor as directed by the Engineer.

2.5 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.

2.6 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.

2.7 PAYMENT

No separate payment shall be made for the work covered in this section of the specification and all costs of site clearing and setting out shall be covered in the unit rates of the Contractor for other items.

SECTION - 3

3.0 EXCAVATION, FILLING, BACKFILLING AND DISPOSAL

3.1 SCOPE OF WORK

The work covered by this section of the Specifications consists of furnishing all Plant, Labor 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.

3.2 BORING LOG DATA

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.

3.3 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 submit to the Consultant for approval, drawing, specification and calculation showing the design and construction of the shoring and excavation method before the commencement of work. For effective shoring system the contractor is required to submit his contiguous piles proposal for deriving tangent piles all along the purifying of the proposed project. The contractor may submit any alternative arrangement in lieu then off for the approval of the Engineer.
"See Section 11 & 12"

(e) **Protection of utility lines:**

When any existing utility lines whether to be retained or be removed are encountered within the area of operations, the Contactor 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.

(f) Excess and undesirable material from excavation not required for fill or backfill of the building site, shall be disposed of, 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.

3.4 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, undulated 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 up to 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.

3.5 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.

3.6 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.

3.7 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.

3.8 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.

3.9 DISPOSAL OF SURPLUS EARTH AND RUBBISH:

All surplus earth and rubbish shall be disposed a location permitted by the local Authorities and as directed by the Engineer. The term disposal shall include all operations of loading, unloading, stacking, spreading, re-handling, 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, dewatering, 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. 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.

NOTE:

- No Separate payment shall be made of dewatering works.
- Imported earth filling from outside sources measured & paid separately.
- Stone soling from approved outside source measured & paid separately.

SECTION – 4

4.0 WATER

4.01 SCOPE:

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

4.02 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 sub soil brackish water will not be permitted. The suitability of water shall be subject to test when required by the engineer.

4.03 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.

Kinds of Ingredient	Permissible Limits
Dissolved Solids	2,000 ppm
Alkali Carbonate and Bicarbonate	1,000 ppm
Chloride*	500 ppm
	1,000 ppm
Sulfate (So_4)	3,000 ppm
Alkalis (Na_2O+0.658 K_2O)	600 ppm
PH – Value	6 to 8

* The maximum concentration of chloride (Cl) in pre-stressed concrete should not be higher than 500 ppm.

In general, for reinforcement concrete in moist environment, or concrete containing imbedded aluminum 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.

4.04 TEMPORARY STORAGE TANK:

The Contractor shall provide onsite 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.

4.05 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 – 5

5.0 CONCRETE

5.1 SCOPE OF WORK:

The work covered by this section of the Specifications consists of furnishing all plants, labor 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.

5.2 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.

5.3 MATERIALS:

5.3.1 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.232:1969 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.612:1969 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.

5.3.2 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: -

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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
B.S.SIEVE NUMBER	PERCENTAGE (BY WEIGHT) PASSING Grading Zone 1.	Grading Zone 2.
No. 14	30 - 70	55 - 90
No. 25	15 – 34	35 - 59
No. 52	5 – 20	8 - 30
No.100	0 – 10	0 - 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" (11 mm to 4.8 mm).

B.S.SIEVE NUMBER.	PERCENTAGE (BY WEIGHT) PASSING
1" (25.4mm)	100
3/4" (11 mm)	90 - 100
3/8" (9.5mm)	20 - 55
3/16"(4.8mm)	0 - 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)	90 - 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 1 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.

5.3.3 WATER shall be as specified under section on water.

5.4 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 150 x 150 mm (6"x6"x6") test cubes and minimum quantity of cement required per m3 or 100 cft. Of finished concrete for various mixes and under various conditions.

Class of Concrete	Nominal Min. Ratio.	Min. Qty. of Cement		Preliminary Cube Strength							
				At 7 days		At 28 days		At 7 days		At 28 days	
		Lbs. Per 100 Cft.	Kg/ Cum	Lb/Sq. in	N/Sq. mm	Lb/Sq. in	N/Sq .mm	Lb/Sq. in	N/Sq. mm	Lb/Sq. in	N/Sq. mm
A.	1:1:2	3024	485	4000	28	6000	42	3000	21	4500	31.5
B.	1:1½ 3	2520	404	3350	23.4	5000	35	2500	17.5	3750	26.2
C.	1:2:4	2016	323	2700	18.9	4000	28	2000	14	3000	21
D.	1:3:6	1344	216	1300	9.1	2000	14	1000	7	1500	10.5
E.	1:4:8	1008	161	850	5.9	1350	9.4	650	4.5	1000	7

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5.5 PROPORTIONING OF CONCRETE MIXES:

5.5.1 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-É 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 9 days and 28 days cube tests shall be used to establish the ratios between 9 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 proposition is less than 4O%, sand shall be decreased but not the cement.

5.5.2 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 at least four specimens. The maximum allowable water content for the concrete shall be as determined from this curve and shall correspond to 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.

5.5.3 SLUMP TEST:

The Slump for concrete, determined in accordance with PS No.422:1964 "Slump Test for Concrete" shall be minimum of Z25 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.

5.6 BATCHING AND MIXING:

5.6.1 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, according to the following table:

Class	Nominal Mix.	Cement	Sand Cft.	Sand Litre	Coarse Aggregate Cft.	Coarse Aggregate Litre
A	1:1:2	110 Lbs 50 kg	1 1/4	35	2 ½	70
B	1:1 1/2:3	110 Lbs 50 kg	1 7/8	53	3 1/4	106
C	1:2:4	110 Lbs 50 kg	2 1/2	70	5	140
D	1:3:6	110 Lbs 50 kg	3 ¼	106	7 1/2	212
E	1:4:8	110 Lbs 50 kg	5	140	10	280

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

5.6.2 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 reopen 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: -

MATERIAL	PERCENTAGE BY WEIGHT
Cement	1/2
Water	1/4
Fine Aggregate	1
Coarse Aggregate	2

5.6.3 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.

iii) 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.

5.7 SAMPLES AND TESTING:

5.7.1 GENERAL:

Test cubes of concrete shall be prepared and stored by the Contractor, in accordance with PS No.560:1965, 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.

5.7.2 CEMENT:

Cement shall be tested as prescribed in Pakistan Standard or British Standard or ASTM Standard.

5.7.3 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.

5.7.4 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.

5.7.5 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 cubes shall be 150 x 150 x 150 mm (6"x6"x6") size.

iii) All test cubes 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 560:1965 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.

5.8 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 labor, 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 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 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 equipment's.

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. In cases 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 laitance 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.

5.9 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.

5.10 FORMWORK:

5.10.1 General:

The form work shall be inclusive of all labor, 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.

5.10.2 Making Forms:

The steel form-work for columns, beams, slabs lintels fins, shells, blocks, panels, purees, surrounds for windows, and all other works whether to be precast or cast in situ shall be made of sound and properly. All 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 steel/fair face forms be properly lined with steel sheets or plywood to give a fair face concrete of a homogenous, perfectly even and smooth appearance in exposed surfaces of all beams, columns, walls, slabs, etc.

5.10.3 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.

5.10.4 Exposed Surfaces Left Un-plastered.

For concrete work covered in this contract where concrete Surface is to be exposed in the finished work and left un-plastered, 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 uniting 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.

5.10.5 Materials and Labor.

The Contractor shall supply all materials and labor, 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.

5.10.6 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.

5.10.7 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 permitted removal of rubbish etc.

5.10.8 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.

5.10.9 Joints/Corners in Form-works.

All joints/corners in the form work 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.

5.10.10 Treatment and Inspection of Forms.

All rubbish, particularly chipping, shavings, and saw dust etc. Shall be removed from the interior of the forms, immediately before placing concrete. Forms shall be coated with approved mold 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.

5.10.11 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 for the main classes of work:-

Removal of Shuttering	Cold Weather	Normal Weather
	Days	Days
Beams sides, walls Columns (unloaded)	5	3
Slabs soffits (scaffolding left Under)	10	7
Removal of scaffolding to slabs	18	14
Beams soffits (scaffolding left under)	13	10
Removal of scaffolding to beams, and shuttering under shells.	28	21

The Engineer or his Representative may require, however, that any wailings, 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.

5.10.12 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.

5.10.13 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.

The work under this section of the Specifications consists of furnishing all plant, labour, equipment, appliances and materials and in performing all operations in connection with the design, supply and installation of formwork for the purpose of shuttering in concrete work, complete in strict accordance with this section of the specifications and the applicable drawings and subject to the terms and conditions of the Contract.

It shall be the responsibility of the Contractor to perform the work by engaging well trained and experienced staff. The Contractor shall be responsible for the quality of work performed by the sub-contractor as per the requirements of these specifications.

5.10.14 MATERIALS

The Contractor shall use the following formwork materials for different purposes as stated below:

Timber

Form framing, sheathing and shoring.

Plywood

Form sheathing and panels.

Steel

- Heavy forms and false work
- Column and joint forms
- Permanent forms
- Welding of permanent forms

Form Ties Anchors and Hangers

For securing formwork against placing loads and pressures.

Coatings

Facilitate form removal.

Steel Joints

For formwork support.

Steel frame shoring

For formwork support.

5.10.15 DELIVERY AND STORAGE

Delivery

The delivery of formwork materials shall be done in such a manner that damage can be prevented.

Storage

Form work should be stored, after cleaning and preparing for reuse if used before in such a manner that access to all different materials is available.

Material which can be affected by weathering shall be stored in appropriate building or under covers and shade.

5.10.16 WORKMANSHIP

Forms shall have sufficient strength to withstand the pressure resulting from placement and vibration of the concrete and shall have sufficient rigidity to maintain specified tolerances.

Where required, details and locations of special forms to be used are set out on the drawings. The Engineer shall refuse any work in any part of the building, which has been constructed with a non-approved formwork. The Engineer shall refuse any concreting which will not be perfect or may not conform to the approved model.

Earth cuts shall not be used as forms for vertical surfaces of reinforced concrete work unless required as such or and permitted by the Engineer.

Mud centering shall not be permitted without the prior approval of the Engineer.

Formwork shall be of wrought timber, steel, plywood, proprietary building boards and such special materials, as may be shown on the drawings or approved by the Engineer, which give the required finish to the surface of concrete. Wooden formwork shall be free from loose knots and shall be well seasoned.

The formwork shall conform to the shape, lines and dimensions as shown on the plans, and be so constructed as to remain sufficiently rigid during the placing and compacting of the concrete, and shall be sufficiently tight to prevent loss of liquid from the concrete.

The design and Engineering of the formwork, as well as its construction, shall be the responsibility of the Contractor. Where necessary, to maintain the specified tolerances, the formwork shall be cambered to compensate for anticipated deflections in the formwork due to the weight and pressure of the fresh concrete and due to construction loads.

The Contractor shall establish and maintain in an undisturbed condition and until final completion and acceptance of the project, sufficient control points and bench marks to be used as references for checking upon tolerances.

Requirements for 'facing materials' are given in the Section relevant to 'Finishing of Formed Surfaces'. The maximum deflection of facing material reflected in concrete surfaces exposed to view shall be 1/240 of the span between structural members.

Where natural plywood-form-finish, grout-cleaned-finish, smooth-rubbed-finish, scrubbed-finish, or sand-floated- finish is required, forms shall be smooth (faced with plywood, liner sheets, or pre-fabricated panels) and true to line, in order that the surfaces produced will require little dressing to arrive at true surfaces. Where any as- cast finish is required, no dressing shall be permitted in the finishing operation.

Whereas-cast surfaces, including natural plywood-form- finish are specified, the panels of material against which concrete is cast shall be orderly in arrangement, with joints between panels planned in approved relation to openings, building corners, and other architectural features.

Where panels for as-cast surfaces are separated by recessed or otherwise emphasized joints, the structural design of the forms shall provide for locating form ties, where possible, within the joints so that patches of tie holes will not fall within the panel areas.

Forms shall not be re-used if there is any evidence of surface wear and tear or defect which would impair the quality of the surface finish. Forms shall be thoroughly cleaned and properly coated before re-use.

The formwork shall be designed so that the soffits of slabs and sides of beams, columns, and walls may be removed first, leaving the forms to the soffits of beams and their supports in position.

Forms shall be sufficiently tight to prevent loss of mortar from the concrete. Unless otherwise specified in the Contract Documents chamfer strips shall be placed in the corners of forms to produce bevelled edges on permanently exposed surfaces. Interior corners on such surfaces and the edges of formed joints will not require bevelling unless required by the Contract Documents.

Positive means such as wedges or jacks for accurate adjustment and for proper removal of shores and struts shall be provided and all settlement shall be monitored during concrete placing operation. Forms shall be securely braced against lateral deflections.

Where concreting of thin members is required to be carried out within formwork of considerable depth, temporary openings in the sides of the formwork shall be provided where necessary to facilitate the placing and consolidation of concrete. Small temporary openings shall also be provided at the bottom of the formwork for columns, walls and deep beams to permit the cleaning out of debris and observation immediately before concrete is deposited.

Form ties shall be constructed so that the ends or end fasteners can be removed without causing appreciable spalling at the faces of the concrete. After the ends or end fasteners of form ties have been removed, the embedded portion of the ties shall terminate not less than 2 diameter or twice the minimum dimension of the tie from the formed faces of concrete to be permanently exposed to view and in no case shall this distance be less than 20 mm. When the formed face of the concrete is not to be permanently exposed to view, form ties may be cut off flush with the formed surfaces.

Through bolts may be permitted, provided that they are greased to allow for easy withdrawal and the holes subsequently made good. Through bolts are not to be used on water-retaining structures.

At construction joints contact surface of the form sheathing for flush surfaces exposed to view shall overlap the hardened concrete in the previous placement by no less than 25 mm. The forms shall be held against the hardened concrete to prevent offsets or loss of mortar at the construction joint so as to maintain a true surface.

Wood forms for wall opening shall be constructed to facilitate loosening, if necessary to counteract swelling of the forms.

Wedges used for final adjustment of the forms prior to concrete placement shall be fastened in position after the final check.

Formwork shall be so anchored to shores or to other supporting surfaces or members that upward or lateral movement of any part of the formwork system during concrete placement will not occur.

Runways or planks for moving labor and equipment shall be provided with struts or legs and shall be supported directly on the formwork or upon the structural member without resting on the reinforcing steel.

All surfaces of forms and embedded materials shall be cleaned of any accumulated mortar or grout from previous concreting and of all other foreign material before placing fresh concrete.

Forms shall be sufficiently tight to prevent leakage of grout or cement paste. Board forms having joints opened by shrinkage of the wood shall be removed and replaced. Plywood and other wood surfaces not subject to shrinkage shall be sealed against absorption of moisture from the concrete by either (I) a field applied, approved form oil or sealer, or (2) a factory applied non-absorptive liner. When forms are coated to prevent bond with concrete, it shall be done prior to placing of the reinforcing steel. Excess coating material shall not be allowed to stand in puddles in the forms nor allowed to come in contact with the concrete against

which fresh concrete will be placed. Care shall be taken that such approved composition is kept out of contact with the reinforcement. Whereas-cast finishes are required, materials which will impart a stain to the concrete shall not be applied to the form surfaces. Where the finished surface is required to be painted, the material applied to form surfaces shall be compatible with the type of paint to be used.

For reinforced concrete, in no circumstances shall forms be struck until the concrete attains a strength of at least twice the stress to which the concrete may be exposed at the time of striking.

The strength referred to shall be that of concrete using the same cement and aggregates, with the same proportions, and cured under conditions of temperature and moisture similar to those obtaining in the work. Where possible, the formwork should be left for longer time as it would assist the curing.

In normal circumstances (generally where temperatures are above 20°C and where ordinary cement is used, forms may be struck after expiry of the following periods.

- Walls, columns and vertical sides of beams or basement retaining wall : 48 hours or as may be decided by the Engineer.

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-Side of slab (shores of props left under). : 6 days

-Beams soffits (shores or props left under). : 12 days.

-Removal of shores or props to slabs.

1. Spanning upto 4 metre 10 days.
2. Spanning over 4 metre 16 days.

-Removal of shores or props to beams.

1. Spanning upto 6 metre. 18 days
2. Spanning over 6 metre 25 days

For rapid hardening cement 3/7 of the above period will be sufficient in all cases except vertical sides of slabs, beams and columns which should be retained for a minimum of 24 hours.

The number of shores or props, their sizes and disposition shall be such as to be able to safely carry the full dead load of the slab and beams, as the case may be.

Proper allowance shall be made for the decrease in rate of hardening of concrete in cold weather and the above minimum duration must be increased when the mean daily temperature is below 20°C.

When repair of surface defects or finishing is required at an early age, forms shall be removed as soon as the concrete has hardened sufficiently to resist damage from removal operations.

Top forms on sloping surfaces of concrete shall be removed as soon as the concrete has attained sufficient stiffness to prevent sagging. Any needed repairs or treatment required on such sloping surfaces shall be performed at once and be followed by the specified curing.

Wood forms for wall openings shall be loosened as soon as this can be accomplished without damage to the concrete.

All formwork shall be removed without such shock or vibration as would damage the reinforced concrete. Before the top plank and struts are removed, the concrete surface shall be exposed where necessary in order to ascertain that the concrete has sufficiently hardened. Proper precautions shall be taken to allow for the decrease in the rate of hardening that occurs with all cement in the cold weather.

When reshoring or re-propping is permitted or required, the operations shall be planned in advance and shall be subject to approval. While reshoring is underway no live load shall be permitted on the new construction.

In no case during reshoring shall concrete in beam, slab, columns or any other structural member be subjected to combined dead and construction loads in excess of the load permitted by the Engineer for the developed concrete strength at the time of reshoring.

Re-shores shall be placed as soon as practicable after stripping operations are complete but in no case later than the end of working day on which stripping occurs.

Re-shores shall be tightened to carry their required loads without overstressing the construction. Re-shores shall remain in place at least until tests representative of the concrete being supported have reached the strength specified in sub- clause 5.23 hereof.

Floors supporting props or shores under newly placed concrete shall have their original supporting props or shores left in place or shall be re-shored. The re-shoring system shall have a capacity sufficient to resist the anticipated loads and in all cases shall have a capacity equal to at least one half the capacity of the shoring system above. The re-shores shall be located directly under a shore position above unless other locations are permitted.

The re-shoring or re-propping shall extend over a sufficient number of storeys to distribute the weight of newly placed concrete, forms, and construction live loads in such a manner that the design superimposed loads of the floors supporting shores or props are not exceeded.

It is generally desirable to give forms for reinforced concrete an upward camber to ensure that the beams or slabs (specially cantilever slabs) do not have a sag when they have taken up their deflection, but this should not be done unless permitted by the Engineer.

No loads, other than man and light plant required in connection with the actual work in hand, shall be allowed on suspended floors until 28 days after concreting where ordinary Portland Cement is used and 14 days when rapid hardening Portland Cement is used.

The formwork and shuttering for pre-stressed concrete beams shall be well and stoutly constructed from steel clad timber or steel. It shall be fully capable of supporting all the loads due to the fresh concrete and due to construction equipment and operations, including vibration, without deformation or deflection that will affect the dimensions of the concrete member beyond the tolerance stipulated hereinafter.

It is expressly stipulated that in view of precision and powerful vibration required in casting the pre-stressed concrete girders and precast members particularly in the zones of end blocks or around anchorages, specially designed formwork and supporting systems shall be required.

All details of formwork of girders and the supporting systems shall be submitted to the Engineer who shall check their safety and approve and/or amend the same, provided however that the approval of the formwork shuttering and supporting system by the Engineer, shall not in any way affect or diminish the Contractor's sole responsibility for fully satisfactory performance of the work.

All joints between formwork boards and/or panels shall be flush and tight. Internal ties shall be used as few as possible and shall, when unavoidable, be in steel, located at such positions which will not disturb the reinforcement or pre-stressing steel. The use of spacer blocks for the reinforcement shall be prohibited whenever the same effect can be achieved by properly dimensioned spacer rings mounted directly on the reinforcement. All spacer blocks and rings shall be of the same strength as the concrete in which they are embedded and shall be adequately cured before use.

Prior to placing concrete, all forms shall be inspected and all debris and extraneous matter removed. The form oil or release agent shall not react with concrete to affect the strength nor shall it give any color. It shall be applied in such a manner as not to contaminate the reinforcement and other fixtures to be embedded in concrete.

5.10.17 MEASUREMENT AND PAYMENT

No payment will be made for the works involved within the scope of this section of the specifications unless otherwise specifically stated in the Bills of Quantities or herein.

The cost thereof shall be deemed to have been included in the quoted unit rate of relevant items of the Bills of Quantities.

5.11 FINISHING OF FORMED SURFACES

5.11.1 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 imparted 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.

5.11.2 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 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 flat 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.

5.11.3 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.

5.11.4 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.

5.12 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 underside 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. P.V.C. / Swell 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.

5.13 CONCRETE FLOOR SLAB FINISHING:

5.13.1 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.

5.13.2 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 trowel led 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.

5.13.3 CONCRETE TOPPING

Where indicated on the drawings base slab under concrete topping shall receive a screened 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.

5.14 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.

5.15 WATER-PROOF 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.

5.16 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.

5.17 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, and other built-in-items as the work proceeds.

5.18 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.

5.19 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 weather 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 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	-	4500 p.s.i. (Class 'A')
	1:1 1/2:3	-	3750 p.s.i. (Class 'B')
	1:2:4	-	3000 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. No honeycombing in concrete will be acceptable.

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 intact 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 trolleys 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.

5.20 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. Defective and honey-combed work will not be measured paid and will be liable to be rejected and redone at contracts' cost.

The work under this section of the specification consists of furnishing all plant, labor, equipment, appliances and materials and performing all operations in connection with the supply and installation of plain and reinforced concrete work complete, in accordance with this section of the specifications and the applicable drawings, and subject to the terms and conditions of the Contract. The scope of this section of specification is covered with detailed specifications as laid down herein.

5.21 GENERAL

Full co-operation shall be given to trades like electrical, mechanical and other services.

Suitable templates or instructions or both shall be provided for setting out items not placed in the forms. Embedded items and other materials for mechanical and electrical operations shall have been completed, inspected, tested and approved before concrete is placed.

Shop drawings shall be prepared by the Contractor at his own cost. Approval of shop drawings as well as that of actual samples of concrete finish shall be obtained before work is commenced.

5.22 CODES AND STANDARDS

The work shall conform to the requirements of the following latest Codes and Standards, unless otherwise specified.

ACI 301-latest	Specifications for structural concrete for buildings.
ACI 304-latest	Guide measuring, mixing, transporting and placing concrete.
ACI 308-latest	Standard practice for curing concrete.
ACI 309-latest	Guide for consolidation of concrete.
ACI 325.9R	Guide for construction of concrete pavements and concrete bases.
ACI 318-latest	Building code requirements for structural concrete.
ASTM C 31-latest	Practice for making and curing concrete test specimens in the field.
ASTM C 33-latest	Standard specifications for concrete aggregates.
ASTM C 39-latest	Standard test methods for compressive strength of cylindrical concrete specimens.
ASTM C 42-latest	Standard test, method for obtaining and testing drilled cores and sawed beams of concrete.
ASTM C 78-latest	Standard test method for flexural strength of concrete (using simple beam with third point loading).
ASTM C 136-latest	Standard test method for sieve analysis of fine and coarse aggregates.
ASTM C 143-latest	Standard test method for slump of Portland cement concrete.
ASTM C 150-latest	Standard specifications for Portland cement.
ASTM C 260-latest	Standard specifications for air-entraining admixtures for concrete.
ASTM C 309-latest	Specification for liquid membrane-forming compounds for curing concrete

ASTM C 404-latest	Standard specifications for aggregate for masonry grout.
ASTM C 494-latest	Standard specifications for chemical admixtures for concrete.
ASTM C 566-latest	Standard test method for total moisture content of aggregate by drying.
ASTM C 869-latest	Standard specifications for foaming agents used in making preformed foam for cellular concrete.
ASTM D 596-latest	Reporting results of water analysis.
ASTMD1190-latest	Standard specifications for concrete joint sealer, hot-poured elastic type.
ASTM D1751-latest	Standard specifications for preformed expansion joint filler for concrete paving and structural construction (non-extruding and resilient bituminous types).
ASTM D1752-latest	Preformed sponge rubber and cork expansion joint fillers for concrete paving and structural construction.
BS 12-latest	Specifications for ordinary and rapid hardening Portland cement.
BS 3148-latest	Methods of tests for water for making concrete.
PS 232-latest	Portland cement (ordinary, rapid hardening and high strength)
PS 243-latest	Concrete coarse and fine aggregates from natural sour.
PS 279-latest	Abrasion of coarse aggregates by the use of Los Angeles machines.
PS 280-latest	Method of test for determination of aggregates crushing value
PS 281-latest	Method of test for organic impurities in sand for concrete aggregates.
PS 283-latest	Method of test for soundness of aggregates by the use of sodium sulphate or magnesium sulphate.
PS 284-latest	Sampling aggregates for concrete
PS 285-latest	Method of test for sieve or screen analysis of fine and coarse aggregates
PS 286-latest	Description and classification of mineral aggregates
PS 421-latest	Sampling of fresh concrete
PS 560-latest	Making and curing concrete compression test specimen in the field
PS 612-latest	Sulphate resisting Portland cement type 'A'
PS 716-latest	Mixing and sampling of fresh concrete in the laboratory
PS 717-latest	Test for concrete compacting factor
PS 849-latest	Making and curing concrete compression test cubes
PS 1638-latest	Fresh concrete, determination of consistency slump test.

5.23 SUBMITTALS

Delivery and Storage Record

The Contractor shall submit the following to the Engineer in such form as he may require:

- Accurate records of deliveries of cement and its use in the Works.
- Details of transport, plant, equipment for winning, transporting, manufacturing of aggregate.
- Manufacturer's literature and certification for compliance with the requirements for admixtures and other materials required for concrete work.

Details of Constructional Plants

Particulars and details of major constructional plants such as mixers, lifts, hoists and cranes, along with the general layout plans and flow diagrams for the Engineer's review and prior approval.

Shop Drawings

Shop drawings including, but not limited to lifts in concrete, formwork, jacking, shoring, architectural concrete works etc., as required by the Engineer.

Methodology

Methodology for construction along with the scheduled programme of works and the Contractor's proposed arrangements for batching, mixing, conveying, placing and curing for review and approval by the Engineer.

The method statement shall also include proposals for:

- Construction joints if not shown on the Drawings
- Installation of water stops
- Sequence of concrete placement
- Arrangement for concreting during rain, hot or cold weather and during night
- Transportation, handling and erection and/or installation of precast concrete and/or prefabricated units etc.
- Welding, etc.

Samples and Specimens

The Contractor shall submit to the Engineer for his approval:

- Samples and specimens of all constructional materials together with the supplier/manufacturer's literature containing his instructions/ recommendations. Afterwards the approved samples of aggregate, admixtures and the embedded items shall be submitted properly labelled and identified for future reference.
- Samples of precast concrete units for inspection, testing and for the Engineer's review and approval.
- A minimum of two units or portions of units of each of the architectural and In-situ concrete, of a size as required by the Engineer, shall be submitted. These specimens will be reviewed and approved on the basis of color, texture, dimensional accuracy, surface finish and general appearance.
- Samples/specimens, when accepted, will describe the allowable limits between which variation can be acceptable.
- Approved specimen/samples shall remain at Site, well protected from damage and dilapidation, as required by the Engineer.

Certificates and Mill-Test-Data

Manufacturer's or supplier's certificate of compliance with relevant standards/specifications shall be submitted for each consignment of the materials and items supplied for use in the Works including but not limited to the following:

Cement, reinforcing steel, admixtures, joint sealing compound, expansion joint material, water-proof membrane, PVC water stop and aggregates etc.

Calibration certificates in respect of scales, gauges, meters and other weighing and dispensing devices to be used on batchers and mixers shall be submitted for the first time immediately before their use in producing concrete and thereafter at every 6 week intervals or earlier if so directed by the Engineer.

Results of Routine Tests and Daily Reports

The routine shall include submission of the results of all the specified and required tests performed at the job site including, but not limited to, analysis of aggregate, slump test, compressive strength tests, etc., and detailed report of works performed on the preceding day.

Bar-Bending Schedule

Bar bending schedule shall be submitted for the Engineer's review and approval well in advance of cutting and bending of any reinforcing steel. This shall include corrections for elongations during bending.

Concreting Record

Daily returns of all concrete placed during the previous day shall be submitted in a format to be agreed with the Engineer.

The returns shall include but shall not be limited, to the following information:

For each specified grade and type of concrete

- Volume of concrete placed per batch and the total concrete.
- Volume of concrete wasted or rejected.
- Quantities of cement, aggregates, water, reinforcing steel, admixtures, embedded items used in the work.
- For each location, structure or part of structure
- The precise position or location of placement, (e.g. reference number, mark identification or element, structure, bay or lift).
- Concrete mixes placed.
- Total volume of each grade and type of concrete placed.
- Records of concrete works, detailing the date, time, humidity, temperature and weather conditions when each part of works was completed.

5.24 TOLERANCES

The Contractor is to complete all works including formwork, placement, curing, etc, and shall ensure that the concrete surfaces conform to the specified tolerance limits given in ACI 325.9R and 347. Where tolerances are not stated on the Drawings, maximum permissible deviations from established lines, grades and dimensions shall conform to the tolerances given hereinafter.

These tolerances are not cumulative.

Concrete work not meeting the tolerance requirements will be rejected unless an acceptable repair work is allowed by the Engineer.

Cast in Place Concrete

VARIATION FROM PLUMB: Variation from plumb in vertical lines and surfaces and from the batter in inclined lines and surfaces shall not exceed the limits given in the Table-A

Table-A

Columns, piers,walls and arises		**Exposed corner columns, control joint grooves and other conspicuous lines**	
In any length or height 3m	6mm	In any bay or 6m length or height 10mm	
In any storey or 6m height	6mm	Maximum for the entire length or height	6mm
Maximum for the entire length	6mm		

VARIATION FROM LEVEL OR GRADES: Variation from the Specified level and grades shall not exceed the limits given in Table-B.

Table-B

Columns, piers,walls and arises	**Exposed corner columns, control joint grooves and other conspicuous lines**
In any 3m length or height 6mm In any bay or 6m height 6mm Maximum for the entire length 6mm	In any bay or 6m Length 6mm Maximum for the entire Length 6mm

VARIATION FROM POSITION IN PLAN: Variation of the linear building lines from established position in plan and related position of columns, walls and partitions shall not exceed13mm in any bay of 6m nor a maximum of 25mm in the entire length.

VARIATION IN LOCATION OF OPENINGS: Variation in the sizes and locations of sleeves, floor openings, and wall openings shall not exceed a maximum of 13mm.

VARIATION IN DIMENSIONS: Variation in cross-sectional dimensions of columns and beams and in the thickness of slabs and walls shall not exceed minus 25mm nor plus 13mm.

VARIATION IN FOOTINGS: Variation in footings shall not exceed the limits given in Table-C

Table-C

Dimension in Plan	**Misplacement or eccentricity**	**Thickness**
Minus 13mm Plus 50mm	2% of footing width in the direction of misplacement but not more than 50mm.	decrease 5% increase No limit

(Tolerances apply to concrete dimensions only, not to positioning of vertical reinforcing steel, dowels, or embedded items.)

VARIATION IN STEPS: Variation in consecutive steps shall not be more than 2mm in rise and 3mm in tread. The maximum variation in the flight of stairs shall not be more than 3mm in rise and 2mm in treads.

Precast Concrete

Forms must be true to size and dimensions of concrete members shown on the plans and shall be so constructed that the variation in the dimensions of the finished products, at the time of placement of these units in the structure, will be within the limits shown in Table-D unless otherwise noted on structural/architectural Drawings:

Table-D

Variation in Overall dimensions of members	**per 1 m**	**2mm**
– Variation in Cross-sectional dimensions:		
* sections less than 75mm		
* sections over 75mm and less than 450mm		3mm
* sections over 450mm		6mm

– Deviations from straight line in long sections	Not more than per 3m.	3mm
– Deviation from specified camber	3m of span	2mm
– Maximum differential between adjacent units in erected position		6mm

Pavements

Departure from specified lines, levels and grades shall not exceed the following limits:

- Established alignment 6mm
- Established longitudinal grade on any line 6mm
- Transverse template contour except at transverse join 3mm
- Transverse template contour at transverse joints in width

  Of one traffic lane 6mm

5.25. QUALITY ASSURANCE

5.25.1 Cement

Cement shall be stored and sampled at Site and tested from time to time at the discretion of the Engineer in accordance with ASTM C-150 or its equivalent British or Pakistan Standards at the expense of the Contractor. If the tests prove that the cement has become unsatisfactory, it shall be removed from the Site immediately. Cement which has been in storage at the Site longer than three months, shall not be used until retesting proves it to be satisfactory.

5.25.2 Aggregate - Requirements

Aggregates shall conform to ASTM C-33. Following tests shall be carried out by the Contractor at his own cost to establish suitability of the material for the intended use.

- Mechanical properties
- Porosity
- Organic impurities
- Clay and Silt Contents
- Abrasion and Soundness tests
- Alkali Re-activity Potential
- Water soluble chloride contents

5.25.3 Sampling and Testing of Aggregate

During construction, aggregates shall be sampled and tested once for every 100 tons or part thereof as delivered to the mixer to determine compliance with the Specifications. The Contractor shall provide samples and test such samples in the presence and supervision of the Engineer using appropriate standard test methods selected by the Engineer. Testing of concrete aggregates by the Engineer shall not relieve the Contractor of his responsibility to maintain control and to ensure the production, stockpiling and handling of both fine and coarse aggregates in accordance with these Specifications. Tests shall be carried out only in laboratories approved by the Engineer.

5.25.4 Deleterious Substances

FINE AGGREGATE: The maximum percentages of deleterious substances in the fine aggregate as delivered to the mixer shall not exceed the values given in Table-E

Table-E

Item	Max.percent (by weight)
Material finer than 75 um (No. 200) sieve	3
Shale	1
Total of other deleterious substances (such as mica, chlorides, coated grains and soft flaky particles)	3

The sum of the percentages of all deleterious substances shall not exceed 5 per cent by weight.

COARSE AGGREGATE: The maximum percentages of deleterious substances in any size of coarse aggregate, as delivered to the mixer, shall not exceed the values given in Table-F

Table-F

Substances	Maximum percent by weight
Material passing 75 um (No.200) sieve	1
Shale	1
Clay lumps	1/2
Other deleterious substances	1

The sum of the percentages of all deleterious substances in any size, as delivered to the mixer, shall not exceed 3 per cent by weight.

5.25.5 Moisture Control

All fine aggregate and smallest size group of the coarse aggregate shall remain dry during storage at the Site for at least 72 hours immediately prior to use. 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, by weight of the saturated surface dry aggregates unless higher limits are allowed by the Engineer. The moisture content of the other size of the coarse aggregates shall be controlled so that the aggregates are delivered to the mixers with the least amount of free moisture and the least variation in free moisture practicable under the job conditions. The moisture content of the aggregate shall be determined in accordance with ASTM C-566. In addition to the limits on the maximum amounts of free moisture in aggregates, the moisture content shall be controlled so that for each size the variation in the percent of free moisture will not be more than 0.5 percent during any one hour of mixing plant operation and not more than 2.0 percent during any 8 hour period of mixing plant operation. Under no conditions shall the aggregate be delivered to the mixing plant dripping wet.

The Contractor may accomplish the required moisture control by use of freely-drained storage, covered transportation and storage, mechanical dewatering devices or any other means or combination of means acceptable to the Engineer.

5.25.6 Admixtures

No admixtures shall be used without the approval of the Engineer for which the following procedure shall be followed:

– Intention to use admixtures shall be submitted with reasons justifying its use supported by manufacturer's literature, past experience and applicable standards.

- If approved, trial mixes shall be prepared to arrive at a control mix design with admixtures and with suitable characteristics for the job.
- Control mix shall be used on the job only if and where approved by the Engineer.

The admixtures shall be sampled at the source of supply and tested by an approved laboratory. An admixture which has been in storage at the Site for longer than 6 months or which has been subjected to freezing shall not be used until retest proves it to be satisfactory. Additional tests shall be made by the Contractor under the supervision of the Engineer.

5.25.7 Testing Facilities

The Contractor shall make arrangement for testing of cylinders to be fixed by the Engineer from time to time shall be tested from an approved laboratory.

Concrete strength shall be determined on the basis of test cylinders, however with the approval of the Engineer compressive strength may also be controlled on the basis of test cubes. The cube strength in such case shall be multiplied by a relevant factor shown in Table-M or as agreed by the Engineer to arrive at the cylinder strength.

5.26 CONCRETE MIX DESIGN

Concrete shall be composed of Portland cement, fine and coarse aggregate, water and any admixtures as specified.

The concrete mixes for each grade of concrete shall be designed by the Contractor under the supervision of the Engineer. The proportions of concrete components for each grade of concrete once agreed by the Engineer would be changed only with the approval of the Engineer or as directed by him during progress of the Work.

5.27 INSPECTION AND TESTING

6.27.1 Inspection

Concrete batching, mixing, delivery and all other construction work shall be inspected at intervals decided by the Engineer to ensure compliance of all operations with Specifications and other provisions of the Contract.

No concrete shall be placed until all forms and all items to be embedded in concrete are inspected and approved by the Engineer in writing.

Completed concrete work which fails to meet one or more of the requirements of the Specifications and/or other Contract documents shall either be rejected or repaired to the Engineer's satisfaction.

5.27.2 Testing of Concrete

All tests shall be carried out at laboratories approved by the Engineer. The Engineer's Representative shall be present during testing if so required by the Engineer.

STRENGTH TESTS DURING THE WORK: Strength tests of the concrete placed during the course of the work shall be made by the Contractor. The Contractor shall test, for control purposes, such number of cylinders as the Engineer may direct. In general three set of three cylinders shall be taken from each 7 cubic meter or fraction thereof or from each day's pour, whichever is less, of each class of concrete placed. Test specimens shall be made and cured in accordance with the applicable requirements of ASTM C-31. Specimens shall be cured in the manner and environments as the pertinent structure.

Cylinder shall be tested in accordance with the applicable requirements of ASTM C-39 and ASTM C-78. The test result shall be based on the average of the strength of the test specimens except that if one specimen in a set of three shows manifest evidence of improper sampling, moulding or testing, the test result shall be based on the average of the remaining two specimens. If two specimens in a set of three show such

defects, the results of the set will be discarded and average strength determined from test results of the other two sets.

The standard age of test shall be 28 days, but 7-day tests may be used at the discretion of the Engineer, based on the relation between the 7-day and 28-day strengths of the concrete as established by tests for the materials and proportions used. If the average of the strength tests of the 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 Contractor may change the proportions of the constituents of the concrete, as necessary to secure the required strength for the remaining portions of the work.

TESTS OF HARDENED CONCRETE IN OR REMOVED FROM THE STRUCTURE: Where the results of the strength tests of the control specimens indicate that the concrete as placed does not meet Specification requirements, or where there is other evidence that the quality of the concrete is below Specification requirements, core-boring tests will be made by the Engineer in accordance with the applicable requirements of ASTM C-42. If the concrete in the structure will be more than superficially wet under service conditions, the cores shall be immersed in water for at least 48 hours and tested wet. In the event that the core-boring test indicates that the concrete placed does not conform to the Drawings and Specifications, measures as prescribed by the Engineer shall be taken to correct the deficiency. However, the Engineer shall have the authority to prescribe such corrective measures, and the Contractor shall take such measures if in the Engineer's opinion the results of the test specimens, without coring, warrant such action. If a strength deficiency is found and is in the opinion of the Engineer due to the Contractor's fault or negligence, the entire cost of replacing faulty concrete or carrying out prescribed corrective measures shall be borne by the Contractor who shall also reimburse the Employer for the cost of making tests. Otherwise, payment for removing and replacing faulty concrete or carrying out prescribed corrective measures will be made under applicable Items of the Bill of Quantities as determined by the Engineer.

RELATION BETWEEN ALLOWABLE STRENGTH AND CONTROL TEST CYLINDER STRENGTH: Where cylinders are made by wet screening of concrete with aggregate greater than 38mm size, such as 75mm aggregate concrete, the cylinders will be required to have a compressive test strength greater than the allowable strength shown on the Drawings, to indicate that the respective concrete in place in the work has the allowable strength shown. The mix design shall be such that the average strength of the specimens tested is greater than the allowable strength shown on the Drawings for the (75mm aggregate) concrete. Such increments over the allowable strength shown will be established by the Engineer after the mix design has been done and prior to mixing of concrete, and shall be approximately ten per cent.

5.28 DELIVERY AND STORAGE

5.28.1 Transportation of Cement

Transportation of the cement from the factory 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. Cement which has been adversely affected by moisture, as determined by the Engineer, shall be rejected. Cement in sacks shall be delivered in strong, well-made sacks, each plainly marked with the manufacturer's name, brand, type of cement and the weight of cement continued therein. Packages varying from the standard weight marked thereon may be rejected and if the average weight of packages in any consignment as shown by weighing fifty packages taken at random, is less than that marked on the packages, the entire consignment may be rejected. Packages received in broken or damaged condition shall be rejected or may be accepted only as fractional packages as determined by the Engineer.

5.28.2 Storage of Cement

Cement shall be stored at Site in dry, weather tight and properly ventilated stores. All storage facilities shall be subject to approval and shall be such as to permit easy access

for inspection and identification of each consignment. Adequate storage capacity shall be furnished to provide sufficient cement to meet the peak needs of the project.

The Contractor shall use cement in the approximate chronological order in which it is received at the Site.

Cement storage facilities shall be emptied and cleaned by the Contractor when so directed.

Suitable, accurate scales shall be provided by the Contractor to weight the cement in stores and elsewhere on the Site, if required, and he shall also furnish all necessary test weights.

5.28.3 Storage of Aggregates

Aggregate shall be stored at the Site in such a manner as to prevent its contamination. Aggregate which has deteriorated or which has been contaminated shall not be used for concrete. All methods employed by the Contractor for loading, unloading, handling and stockpiling aggregates shall be subject to the approval of the Engineer. Sufficient quantities of washed aggregate shall be maintained at the Site at all times to assure continuous placement and completion of any lift of concrete started.

5.29 MATERIALS

5.29.1 CEMENT

General

Cement shall be fresh, furnished in sacks as approved by the Engineer. 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. Cement recovered through cleaning of sacks shall not be used.

Portland cement

Portland cement shall be of Pakistan origin and manufacture unless otherwise approved by the Engineer. Portland cement shall conform to Pakistan Standard PS-232 or to British Standard BS-12 or to ASTM C 150 type-I. Portland cement conforming to ASTM C-150, Rapid hardening type-III or sulphate resistant type-V may also be used in certain parts of the Works as directed by the Engineer.

5.29.2 AGGREGATES

Requirements

The nominal maximum size of the aggregates 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's. These limitations may be waived if, in the judgment of the Engineer, workability and method of consolidation be such that the concrete can be placed without honey-combs or voids.

Composition

The use of natural sand or a combination of natural and manufactured sand may be permitted, provided that the fine aggregate meets the applicable requirements of the Specifications for the particular use intended. Coarse aggregate shall consist of gravel, crushed stone or a combination thereof.

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.

Processed Aggregates

The Contractor in procuring the processed aggregates or in planning his aggregate processing operations shall ensure that the aggregates, as delivered to the mixer, consist of clean, hard and uncoated particles; light weight elements (chalk, clay, coal) are separated by segregation under water by vibration where required and the fines

are removed from the coarse aggregate by adequate washing. The coarse aggregate shall be rescreened just prior to delivery to the concrete mixer bins. The moisture content shall conform to the provisions of sub-section 6.5 "Moisture Control". Compliance with the aggregate grading and uniformity requirements shall be determined before the material is delivered at the mixer. All aggregates shall be sieved and washed with clean water. The aggregates shall conform to the specific requirements given hereinafter.

Fine Aggregate

The grading of fine aggregate as delivered to the mixers shall conform to the requirements given in Table-G

Table-G

Sieve size Standard square mesh	*Percentage passing (by weight)*
9mm	100
No. 4	95 to 100
No. 8	80 to 100
No. 16	50 to 85
No. 30	25 to 60
No. 50	10 to 30
No.100	2 to 10

The Fineness Modulus shall range between 2.31 and 2.51

Coarse Aggregate

The grading of the coarse aggregate as delivered to the mixer shall conform to the requirements given in Table-H

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TABLE-H Grading Requirements for Coarse Aggregate

	Amounts Finer than Each Laboratory Sieve (Square openings) Weight Percentage												
Nominal Size (Sieves with Square Openings)	100mm	88mm	75mm	63mm	50mm	38mm	25mm	19mm	13mm	9mm	No.4	No.8	No.100
88mm to 38mm	100	90 to 100	------	25 to 60	------	0 to 15	------	0 to 5	------	------	------	------	------
63mm to 38mm	------	------	100	90 to 100	35 to 70	0 to 15	------	0 to 5	------	------	------	------	------
5omm to 25mm	------	------	------	100	90 to 100	35 to 70	0 to 15	------	0 to 5	------	------	------	------
50mm to No.4.	------	------	------	100	95 to 100	------	35 to 70	------	10 to 30	------	0 to 5	------	------
38mm to 19mm	------	------	------	------	100	90 to 100	20 to 55	0 to 15	------	0 to 5	-----	------	------
38mm to 19mm	------	------	------	------	100	95 to 100	------	35 to 70	------	10 to 30	0 to 5	------	------
25mm to 13mm	------	------	------	------	------	100	90 to 100	20 to 55	0 to 10	0 to 5	-----	------	------
25mm to 19mm	------	------	------	------	------	100	90 to 100	40 to 85	10 to 40	0 to 15	0 to 5	------	------
25mm to No.4.	------	------	------	------	------	100	95 to 100	------	25 to 60	-----	0 to 10	0 to 5	------
19mm to 9mm	------	------	------	------	------	------	100	90 to 100	20 to 55	0 to 15	0 to 5	-----	------
19mm to No.4.	------	------	------	------	------	------	100	90 to 100	-----	20 to 55	0 to 10	0 to 5	------
13mm to No.4.	------	------	------	------	------	------	------	100	90 to 100	40 to 70	0 to 15	0 to 5	------
9mm to No.8.	------	------	------	------	------	------	------	-----	100	85 t100	0 to 30	0 to 10	0 to 5

Particle Shape

The shape of the particles in fine and coarse aggregate shall generally be spherical or cubical. 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 per cent by weight in any size group. 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.

Soft Particles

The Contractor in procuring processed aggregates or in planning his aggregate processing operations shall make whatever provisions are necessary, as regards methods and equipment, to ensure effective elimination of soft particles from all aggregates to the degree that the percentage of soft particles present in the processed coarse aggregate does not exceed 3 per cent by weight when determined in accordance with the applicable requirements of ASTM C-851, or other standard test methods selected by the Engineer. Test samples shall be representative of each size group of processed aggregate specified in Table-H, obtained according to ASTM C-851. Weight of samples for each size group shall be as given in Table-I

Table-I

Size No.	Nominal Size	Weight of Sample in Kilograms
8.	9mm to No.8	0.6
7.	13mm to No.4	1.0
6.	19mm to 9mm	1.5
5.	25mm to 13mm	3.0
4.	38mm to 25mm	4.5
3.	50mm to 25mm	7.0
2.	63mm to 38mm	16.0

5.29.3 WATER

Water for washing aggregates and for mixing and curing concrete shall be fresh, clean and free from injurious amounts of oil, acid, alkali, salt, organic matter, or other deleterious substances as determined by ASTM D-596.

The water for curing concrete should have a PH value between 6 to 8 and shall not contain impurities which cause discoloration of concrete.

5.29.4 ADMIXTURES

Approval Required

Admixtures, including air-entraining admixtures, foaming chemicals and water-reducing admixtures, shall not be used, except with the prior approval of the Engineer. All tests for the evaluation and approval of an admixture shall be made by the Contractor as specified in sub-section 6.6 of these Specifications.

Air-Entraining Admixtures

The source and brand of air-entraining admixture, if required, shall be proposed by the Contractor and approved by the Engineer. The air-entraining admixture will be an approved substance or compound conforming to the requirements of ASTM C-260, which will produce entrained air in the concrete as hereinafter specified. The air-entraining admixture shall be added to the batch in solution in a portion of the mixing water. This solution shall be batched by means of a mechanical batcher capable of accurate measurement and in such a manner as to ensure uniform distribution of the admixture throughout the batch during the specified mixing period.

Water-Reducing Admixtures

The source, brand, types of suitable water reducing cement dispersing admixtures, if required, shall be proposed by the Contractor and approved by the Engineer. The water-entraining admixture will be compatible with the air-entraining admixture specified above and shall be batched and added to the concrete in the manner specified for the adding of air-entraining admixture but separate from the portion of the mixing water containing the air-entraining admixture. The quantities of water-reducing, cement-dispersing admixture to be used shall be in accordance with the instructions of the manufacturers as approved by the Engineer. Water reducing admixture shall conform to the requirements of ASTM C-494.

5.29.5 WATERSTOPS

PVC or Swell bar Water stops

PVC (Polyvinylchloride) water stops shall be extruded from an elastomeric plastic compound, the basic resin of which shall be polyvinylchloride. The compound shall contain such additional resins, plasticizers, stabilizers or other materials needed to ensure that when the material is compounded and extruded to the shapes and dimensions shown and tested it shall have the physical characteristics when tested by the U.S Corps. Of Engineer test method as shown in Table-J.

Table-J

Corps of Engrs.Tests Method No.	No. of Specimens Tested	Physical characteristics	Requirement
1	2	3	4
568	5	Tensile strength using die III, not less than	12 MPa
573	5	Ultimate elongation using die III, not less than	350%
570	3	Low temperature brittleness, no sign of failure such as cracking or chipping at	-37º C
571	3	Stiffness in flexure 1/2 inch span, not less than	28 MPa

5.29.6 JOINT SEALING COMPOUND

Sealing compound shall be either of the cold application type conforming to ASTM D-1850 or of the single or multiple component type or of the hot poured type conforming to the requirements of ASTM D-1190 or their equivalents.

5.29.7 EXPANSION JOINT FILLER

Expansion Joint filler material shall be pre-molded asphalt impregnated fiber board, to be applied over the full joint-width, except as otherwise indicated on the Drawings, and shall conform to ASTM D-1751 where non-extruding and resilient bituminous type is indicated but where non-extruding and resilient non-bituminous is required the expansion joint filler shall

consist of sponge rubber, self-expanding cork or any other material and type as directed by the Engineer, meeting the requirements of ASTM D-1752.

5.29.8 NON-SHRINK GROUT

Non-shrink grout of a thickness less than one inch shall consist of one part cement, one part clean sharp sand and 1:22000 to 1:15000 part of grained aluminum powder containing non-polishing agent. Non-shrink grout one inch or more in thickness shall be proportioned as above except that 1.5 parts of 9mm to 6mm (pea-size) gravel shall be added to the mix. The above composition may be varied if so required by the Engineer. In each case, however, the Contractor shall, at his own cost, prepare optimum mix design and conduct testing of the grout composition for strength and non- shrink performance. Pre-mix non-shrink grout from approved manufacturers may also be used as required by the Engineer.

5.29.9 EPOXY CONCRETE AND MORTAR

General

Epoxy concrete for installation adjacent to embedded metal and epoxy concrete and/or mortar for the replacement of faulty concrete or for other special purposes as ordered or approved by the Engineer shall conform to the requirements specified hereunder. Epoxy concrete and epoxy mortar shall be mixed in the proportions by such methods and with such equipment as are recommended by the manufacturer of the epoxy resin and approved by the Engineer. The proportions of epoxy mortar and epoxy concrete and the methods of mixing and placing will be subject to change to meet field requirements. The individual batch size of epoxy concrete and mortar which may be prepared at one time shall not exceed the amount that may be mixed, placed and finished in accordance with the manufacturer's instructions as approved by the Engineer.

Materials

EPOXY RESIN: Epoxy resin shall be subject to approval by the Engineer.

AGGREGATES FOR EPOXY CONCRETE: The aggregates used for epoxy concrete shall be clean, dry, crushed river cobble gravel ¾ inch maximum size. Except for gradation, fine and coarse aggregates shall meet the requirements of ASTM C-33. Gradation of fine aggregate shall be the same as specified in sub-section 4.2.5, except that the percentage passing a No. 100 sieve shall be held to the lower limit specified to the greatest extent practicable. The fine and coarse aggregates used in preparation of epoxy resin concrete shall be oven dry and shall be conditioned to a temperature of 15°C to 21°C prior to mixing the epoxy resin binder. Gradation of the coarse aggregate shall conform to the requirements of Table-K when tested in accordance with ASTM C-136.

Table-K

Sieve Size Standard Sq. Mesh	Per cent passing (by weight)
19mm	100
13mm	90 - 100
9mm	40 - 70
No.4	0 - 15
No.8	0 - 5

The aggregates shall be well graded from coarse to fine.

AGGREGATES FOR EPOXY MORTAR: Except for gradation, fine aggregates for use in epoxy mortar shall conform to the requirements of ASTM C-404. The aggregate used in the preparation of the epoxy resin mortar shall be oven dry and shall be conditioned to a temperature of 15°C to 21°C prior to mixing the epoxy resin binder. Gradation of the fine aggregate shall conform approximately to the requirements of Table-L when tested in accordance with ASTM C-136.

Table L

Sieve Size Standard Sq.mesh	Percentage Passing (by weight)
No. 4	100
No. 8	95 - 100
No. 16	60 - 100
No. 30	35 - 70
No. 50	15 - 35
No. 100	2 - 5
No. 200	0 - 2

The aggregates shall be well graded from course to fine and the material passing the No. 100 sieve shall be held to a minimum.

5.29.10 VAPOR BARRIER

Vapor barrier shall be polyethylene building film, visqueen standard or approved equal. The film shall be 100 gauge thick. The quality of material shall be approved by the Engineer prior to use in the works.

Vapor barrier shall be laid in position wherever shown on the Drawings.

The material shall be supplied in rolls and laid by rolling over the prepared surface at the levels and position in the areas shown on the Drawings. Where joint is necessary at the side or end of a sheet, this shall be a double weld folded joint made by placing the edges together and folding over twice continuously taking the top edge prior to concreting. The Contractor shall protect the film sheets from damages during laying and subsequent operations and shall replace at his own cost all damaged film sheets to the satisfaction of the Engineer.

Manufacturer's recommendations and instructions alongwith the sample of material shall be submitted to the Engineer for his approval.

5.30 EXECUTION

5.30.1 PROPORTIONING OF CONCRETE

General

Trial mixes and tests shall be made by the Contractor for the purpose of designing the mixes and for quality control with regard to the required strength, density and durability. The proportions shall be changed whenever such change is necessary to maintain the standard of quality required for the structures and to meet the varying conditions encountered during construction.

All materials composing the concrete shall invariably be measured by weight or if approved by the Engineer as an exception by volume.

Cement Content

The cement content of concrete for various grades shall be established by trial mixes and shall depend on the size, type and gradation of aggregate used, water cement ratio required for the structure and on the requirements of concrete strength, durability and workability.

Aggregate Content

The maximum size of aggregate (MSA) to be used in the various parts of the structure shall be as shown on the Drawings and where not shown, shall be as directed by the Engineer. Concrete mixes shall be designed to use the largest size and maximum amount of coarse aggregate practicable keeping in view the requirements of sub-section 10.2.1

Water Content

The amount of water to be used shall be governed by the following considerations:

WATER CEMENT RATIO: In general, the mix design shall provide for water cement ratios by weight with aggregate at saturated surface dry condition, which will be determined on the basis of producing concrete having suitable workability, density, impermeability, durability and the required strength without the use of excessive amount of cement.

It is expected that water cement ratio by weight will vary from 0.45 for concrete in thin sections to 0.65 for mass concrete in severe weather conditions. Maximum permissible water cement ratio will also vary from 0.67 for low strength concrete to 0.38 for concrete for higher strength concrete.

CONSISTENCY: The amount of water used in the concrete shall be regulated as required to produce concrete of proper consistency taking into account the effect of any variation in either or both the moisture contents or grading of the aggregates as they enter the mixer. Addition of water to compensate for stiffening of concrete before placing shall not be permitted. Uniformity in concrete consistency from batch to batch shall be ensured.

Concrete Strength

Various classes of concrete shall have 28 day compressive strength of 6 inch x 12 inch test cylinders at least equal to the values given in Table-M except as otherwise indicated on the Drawings or directed by the Engineer.

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Table -M

Cylinder Strength (kg/cm²)	Cylinder Strength MPa (Psi)
70	7 Mpa (1000 Psi)
103	10 Mpa (1500 Psi)
140	14 Mpa (2000 Psi)
210	21 Mpa (3000 Psi)
250	25 Mpa (3625 Psi)
280	28 Mpa (4000 Psi)
315	31.03 Mpa (4500 Psi)
350	34.48 Mpa (5000 Psi)
420	41.37 Mpa (6000 Psi)
455	45 Mpa (6500 Psi)
492	48 Mpa (7000 Psi)
560	55 Mpa (8000 Psi)
630	62 Mpa (9000 Psi)
700	69 Mpa (10000 Psi)

Slump

In general, the slump of the concrete, after concrete has been deposited but before it has been consolidated, shall not exceed the values specified below for the structures and/or parts thereof unless otherwise directed by the Engineer. Check slumps shall be taken at the mixer and at locations of placement and or as directed by the Engineer. The Engineer may order the placement of concrete having lesser slump, wherever concrete of such lesser slumps can be consolidated readily into place by means of the specified vibrations. The use of buckets, chutes, hoppers, or other equipment of types that will not readily handle and place concrete of such lesser slumps will not be permitted. The slump will be determined in accordance with ASTM C-143.

The minimum slump shall be 19mm inch in all cases, except when plasticizers are used with the Engineer's approval. The maximum slump shall not exceed the undermentioned limits:

Mass concrete 50mm

Slabs, floors and foundations 50mm

Columns, beams, walls, parapets etc. 100mm

Other parts 75mm

5.30.2 BATCHING AND MIXING

Type and Capacity

All concrete shall be produced in a batching and mixing plant or by means of a mechanical mixer as approved by the Engineer.

The capacity of the plant shall be such that the proposed arrangement will produce adequate quantity of concrete to meet with all the other requirements of these Specifications and the construction schedule. The batched materials shall be thoroughly combined into a uniform mixture before the addition of water and admixtures. The water shall be added gradually and the mixer operated for specified duration of time so as to obtain a thoroughly mixed concrete of uniform color and quality.

Mixers

Hand mixed concrete shall not be used; however, the Engineer may allow concrete to be mixed in small mixers. The mixers provided by the Contractor shall be capable of combining the materials into a uniform mixture and of discharging without segregation. Mixers shall not be charged in excess of the capacity recommended by the manufacturer and shall not be recharged before completely discharging the previous batches. Overmixing requiring additions of water will not be permitted. The mixers shall be operated at a drum speed designated by the manufacturer. The mixers shall be cleaned frequently and maintained in satisfactory operating condition, and mixer drums shall be replaced when worn down more than 10 per cent of their length and or thickness.

Water Batcher

A suitable water measuring device shall be provided by the Contractor which shall be capable of measuring water within the specified requirements for each batch. The mechanism for delivering water to the mixer shall be such that no leakage will occur when the valves are closed.

Locations

The concrete plant/mixer shall be installed at the Site at locations selected by the Contractor and approved by the Engineer.

Arrangement

Separate bins and compartments shall be provided for each size or type of aggregate and Portland cement. The compartments shall be of adequate size and so constructed that the materials will be maintained separated under all conditions. Batching equipment/ arrangement shall be capable of delivering concrete within the following limits of accuracy as shown in Table-N

Table-N

Material	Per cent by weight
Cement +1%	
Water +1%	
Aggregate smaller than ¾ inch	+2%
Aggregate larger than ¾ inch	+3%

Cooling

Adequate cooling facilities shall be provided to ensure that the temperature of concrete when discharged from the mixers is sufficiently low to meet the temperature requirements as specified in sub-section 11.4.2. Cool mixing water, ice, precooled aggregate, shading the

stockpiles with roofing or any other arrangements may be used to ensure the pre-cooling of the concrete, subject to the approval of the Engineer, but approval shall not in any way relieve the Contractor of his responsibility of placing concrete at temperatures at or below the specified limits.

Scales

Adequate weight and volume batching facilities, as approved by the Engineer, shall be provided by the Contractor for the accurate measurement and control of each of the materials entering each batch of concrete. The accuracy of the weighing equipment shall conform to the requirements of applicable standards. The weighing equipment shall be arranged so that the concrete plant operator and Engineer can observe the dials or indicators. Volumetric measurements, if approved by the Engineer, shall be made by means of accurate measuring boxes.

Mixing Time

The mixing periods specified in Table-O are based on proper control of the speed of rotation of the mixer and of the proper introduction of the materials into the mixer. The mixing time will be increased when such increase is necessary to secure the required uniformity and consistency of the concrete. The mixing time for each batch after solid materials are in the mixer drum, provided that all the mixing water is introduced before one fourth of the mixing time has elapsed, shall be as follows:

Table -O

Capacity of	Mixer Mixing Time
Up to 2.0 cubic yards	2.0 minutes
From 2.0 to 3.25 cubic yards	2.5 minutes

5.30.3 CONVEYING

Concrete shall be conveyed from mixer to the place of final deposit as rapidly as practicable, by methods which will prevent segregation or loss of ingredients and in accordance with ACI-304. Any wet batch hopper through which the concrete passes shall be conical in shape. There shall be no vertical drop greater than three feet except where the use of such equipment is approved in writing by the Engineer, in advance of any use. Each type or class of concrete shall be visually identified by placing a colored tag or marker on the bucket as it leaves the mixing plant so that the concrete may be positively identified and placed in the structure forms in the desired position.

5.30.4 PLACING

General

No concrete is to be placed until all the preparatory works have been satisfactorily completed and the reinforcement and embedded items have been checked and approved by the Engineer. Concrete placing shall follow the practice given in ACI-304.

No concrete shall be placed until all formwork, reinforcement, installation of parts to be embedded, bracing of forms and preparation of surfaces involved in the placing and the method of placement have been approved by the Engineer. Approval of the method of placement proposed will not relieve the Contractor of his responsibility for its adequacy and he shall remain solely responsible for the satisfactory construction of all work under the Contract. Before concrete is placed, all surface upon or against which concrete is to be placed shall be free from standing water, mud, debris or any loose material. All surfaces of forms and embedded material that have become encrusted with dried mortar or grout from concrete previously placed shall be cleaned of all such mortar or grout before the surrounding or adjacent concrete is placed. The surfaces of absorptive materials against or upon which concrete is to be placed shall be moistened thoroughly so that the moisture will not be drawn

from the freshly placed concrete. Concrete shall be worked into the corners and angles of the forms and around all reinforcement and embedded items without permitting the material to segregate. Concrete shall be deposited as close as possible to its final position in the forms. The depositing of concrete shall be regulated so that the concrete may be effectively compacted with a minimum of lateral movement into horizontal layers approximately 450mm in thickness. No concrete that has partially hardened or been contaminated by foreign materials shall be deposited in the structure, nor shall retampered concrete be used unless approved by the Engineer. The surfaces of construction joints shall be kept continuously wet for at least eighteen hours during the twenty-four hour period prior to placing concrete except as otherwise directed by the Engineer. All free water shall be removed and the construction joint shall be completely surface dry prior to placement of concrete. All concrete placing equipment and methods shall be subject to approval of the Engineer. Concrete placement will not be permitted, if in the opinion of the Engineer, weather conditions prevent proper placement and consolidation.

Time Interval between Mixing and Placing

Concrete mixed in stationary mixers and transported by non- agitating equipment shall be placed within thirty minutes after it has been mixed, unless otherwise authorized. In any case, concrete shall be placed and compacted well within the initial setting time.

Placing Temperature

Placing temperature shall conform to the requirements herein specified for thin and moderate sections. The Engineer's determination as to the type of section and applicable placing temperatures shall govern. Concrete shall be placed at temperatures as follows:

THIN SECTIONS: Concrete for thin sections shall be delivered to the forms at the coolest temperature which is practicable to produce under current conditions but in no case at a temperature in excess of 30°C. Except as otherwise determined by the Engineer, sections to which this provision shall apply shall be less than 450mm in thickness.

MODERATE SECTIONS: Concrete for moderate sections shall have a temperature of not more than 21°C when placed. A moderate section will be one that is greater than 450mm but less than 900mm in thickness.

Blinding Concrete

Where concrete is to be placed on a flat excavated surface or on an excavated surface inclined at not more than 1V: 1.75 H, a 75mm layer of blinding concrete, if not otherwise shown on the Drawings, shall be placed immediately after completion of excavation and cleaning. The upper surface of the blinding concrete shall not be higher than the required cover below the lowest layer of the reinforcing steel. The final excavated level shall be calculated to allow for the 75mm thickness of the blinding layer.

Lifts in Concrete

Concrete shall be placed in lifts or depths as directed by the Engineer. The placement of concrete shall be carried on at such a rate and in such a manner that formation of cold joints is prevented. Slabs shall be placed in one lift, unless otherwise authorized or directed. In walls, lifts shall terminate at such levels as shall conform to structural details. Where slabs and beams are placed continuously with walls and columns, the concrete in walls and columns shall have been in place for at least two hours, or for a longer period when directed by the Engineer, before placing concrete in the slabs and beams. The top surface of vertically formed lifts shall be generally levelled. The concrete in columns shall be placed in one continuous operation, unless otherwise authorized. In general, the construction joints in beams and slabs shall be located as shown on the Drawings and concrete shall be placed in the sequence indicated on the Drawings or as authorized by the Engineer. The maximum differential in height between the various pours of the structure shall be as shown on the Drawings or as directed by the Engineer.

Elapsed Time between Placements of Lifts

Except as otherwise approved on the basis of lift drawings submitted by the Contractor, a minimum of 72 hours shall elapse between the placing of successive lifts of walls and thin

sections and 120 hours shall elapse between placing lifts of moderate sections. Thin and moderate sections are defined in sub-section 4.4.3.

Time between Adjacent Pours

The time between adjacent pours shall be defined as the time elapsing from the end of the striking off of one pour to the start of placing the next pour. The minimum time elapsing between adjacent pours shall be five days for thin and moderate sections and fourteen days for mass section.

Concrete for Block outs

Block outs for equipment and fittings and for such other work as indicated or directed shall be provided as indicated on the Drawings. After the said equipment and fitting have been installed and adjusted in their final location, the blackout recesses shall be filled with concrete. Before installing the components to be embedded in blackout concrete and before depositing any block out concrete, the concrete surfaces of the block out shall be cleaned in the manner specified for cleaning construction joints.

Placing Concrete through Reinforcement

In placing concrete through reinforcement, care shall be taken that no segregation of the coarse aggregate occurs.

In certain cases, like the bottom of beams and slabs, the congestion of steel near the forms may make placing difficult. In such cases, as decided by the Engineer, a layer of mortar of a composition compatible with the required concrete strength shall be first deposited to cover the surface to a depth of 16mm.

Vibration of Concrete

Recommended Practice given in ACI-309 shall be followed for concrete consolidation. Concrete shall be compacted with mechanical vibrating equipment supplemented by hand spading and tamping. In no case shall vibrators be used to transport concrete inside the forms. The vibrating equipment shall be of internal type and shall at all times be adequate in number of units and power of each unit to properly consolidate all the concrete. Form or surface vibrators shall not be used unless specifically approved. The intensity (amplitude) of vibration shall be sufficient (frequency not less than 6,000 impulses per minute) to produce satisfactory consolidation. The duration of vibrations shall be limited to that necessary to produce satisfactory consolidation. Excessive Vibration will not be permitted.

Precast Cement Concrete

The work to be done under this item consists of manufacturing, storing, handling, transporting and laying precast concrete members as may be required. Materials and methods for precast concrete work shall conform to the applicable requirements of these Specifications - Plain and Reinforced Concrete. Except as otherwise shown or specified, maximum size of coarse aggregate shall be 19mm. Concrete shall be mechanically vibrated in placing. Slump shall be limited to 38mm. Precast concrete shall be water cured for 14 days. Precast units shall not be removed until they have attained at least 75% of their required 28 days strength and shall be picked up only by their lifting hooks. The precast members which are subjected to overstress or otherwise injured during curing or handling shall be removed from the Site by the Contractor.

5.30.5 EXPANSION, CONTRACTION AND CONSTRUCTION JOINTS

Construction Joints

GENERAL: As soon as a lift is completed, the top surface of concrete and reinforcing dowels shall be immediately and carefully protected from any condition that may damage the concrete surface and the dowels. The construction joints shall be prepared as per satisfaction of the Engineer.

CLEANING: Horizontal construction joints on lifts with relatively open and accessible surfaces shall be prepared for receiving the next lift by cleaning with either wet sandblasting or by air-water cutting. Approved wet sandblasting equipment shall be provided. If the surface of a lift is congested with reinforcing steel and is relatively inaccessible or if for any other reason it is considered undesirable to disturb the surface of a lift before it has hardened, surface cutting

by means of air-water jets will not be permitted and the use of wet sandblasting will be required.

AIR WATER CUTTING: Air-water cutting of a construction joint shall be performed when approved by the Engineer. The surface shall be cut with a high-pressure air-water jet to remove all laitance and to expose clean, sound aggregate, but not so as to undercut the edges of the larger particles of the aggregate. The air pressure used in the jet shall be 0.7 MPa plus or minus 10% (0.7 MPa) and the water pressure shall be just sufficient to bring the water into effective influence of the air pressure. After cutting, the surface shall be washed and rinsed as long as there is any trace of cloudiness of the wash water. The surface shall again be washed with an air-water jet while the concrete is still green, say well within 6 hours of concreting, (depending upon the atmospheric conditions of humidity and temperature) prior to placing the succeeding lift. Where necessary to remove accumulated laitance, coatings, stains, debris and other foreign material, wet sandblasting will be required immediately before placing the next lift to supplement air-water cutting. When approved by the Engineer, a retarder may be applied to the surface of the lift in order to prolong the period of time during which air-water cutting is effective. Prior to receiving approval, the Contractor shall furnish technical data and samples of the retarder to be used and shall demonstrate the method to be used in its application.

WET SANDBLASTING: When employed in the preparation of construction joints, wet sandblasting shall be performed immediately before placing the following lift. The operation shall be continued until all laitance, coating, stains, debris and other foreign materials are removed. The surface of the concrete shall then be washed thoroughly to remove all loose material.

JOINTS: Vertical construction joints shall be prepared similar to the horizontal construction joints. Where allowed by the Engineer, the inner surface of the formwork may be coated with an approved set-retarder to facilitate the preparation of the vertical construction joint.

WATER DISPOSAL: The method used in disposing of water employed in cutting, washing and rinsing of concrete surfaces shall be such that the waste water does not stain, discolour, or effect exposed surfaces of the structure. Methods of disposal shall be subject to approval by the Engineer.

5.30.6 INSTALLATION OF WATER STOPS

General

Except as otherwise shown on the Drawings, water stops shall be installed with an approximately equal width of material embedded in concrete on each side of the joint. Water stops shall be sealed to other cut off systems as shown on the Drawings or as directed by the Engineer. All water stops shall be installed and carefully positioned so as to form a continuous water tight diaphragm in each joint. All splices shall be neat with the ends of the joined materials in true alignment.

Concrete shall be carefully placed and vibrated around water stops to ensure maximum concrete imperviousness and density, the complete filling of the forms in the vicinity of the water stop and complete contact between the concrete and all surfaces of water stop.

PVC Water stops

Splices in the continuity or at the intersections of run of PVC water stops shall be performed by heat sealing the adjacent surfaces in accordance with the manufacturer's recommendations or as directed by the Engineer. 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. After splicing, a re-moulding iron with ribs and corrugations to match the pattern of the water stop shall be used to reform the ribs at the splices. The continuity of the characteristic components of the cross-section of the water stop design (ribs, tubular center axis, protrusions, and the like) shall be maintained across the splice. The splices joints shall be tested in accordance with the applicable standards and as directed by the Engineer.

5.30.7 CURING

General

All concrete including concrete repair work shall be cured by an approved method or combination of methods in accordance with ACI-308. The Contractor shall have all equipment and materials needed for adequate curing and protection of the concrete on hand and ready to use before actual concrete placement begins. Means shall be provided for the protection of concrete from the sun, drying winds and traffic until the specified curing has been completed.

The curing medium shall be applied so as to prevent loss of moisture from the concrete. Concrete shall be protected from heavy rains for 24 hours. All concrete shall be adequately protected from damage. No fire or excessive heat, including the heat resulting from welding, shall be permitted near or in direct contact with the concrete at any time. All galleries, conduits and other formed openings through the concrete shall be closed during the curing period.

If during the specified minimum period of curing, the surface temperature of the concrete falls below 10°C, the period of curing shall be extended to allow the concrete to reach sufficient maturity. The period of extension shall be as approved by the Engineer.

Moist Curing

Concrete shall be moist-cured maintaining all surfaces continuously (not periodically) wet for 14 days immediately following the placing or until covered with fresh concrete. Precast elements shall also be water-cured for 14 days. Curing water shall be removed without allowing stagnant pools of water to form on the exposed lift surface. Water for curing shall comply with the applicable requirements of sub-section of “Water”. Where forms of tongue- and groove or shiplap sheathing are used and are left in place during curing, the sheathing shall be kept wet at all times. When in contact with concrete, steel forms shall be kept wet. Horizontal construction joints and finished horizontal surfaces cured with sand shall be covered with a minimum uniform thickness of 50mm of sand and kept continuously saturated with water.

Liquid Curing Membrane

An approved curing compound conforming to ASTM C 309 shall be applied in accordance with the manufacturer's recommendations immediately after any water sheen which may develop after finishing has disappeared from the concrete surface. It shall not be used on any surface against which additional concrete or other material is to be bonded unless it is proven that the curing compound will not prevent bond or unless positive measures are taken to remove it completely from such areas.

5.30.8 REPAIR OF CONCRETE

General

Concrete that is damaged from any cause; concrete that is honeycombed, fractured, or otherwise defective; and concrete which, because of excessive surface depressions, must be excavated and built up to bring the surface to the prescribed lines; shall be removed and replaced with dry pack mortar, or concrete, as hereinafter specified. Repair of concrete shall be performed only by skilled workmen and within 24 hours of removal of forms. The Contractor shall keep the Engineer advised as to when repair of concrete will be performed. Unless an inspection is waived in each specific case, repair of concrete shall be performed only in the presence of the Engineer. Repairs shall be made in accordance with the procedures approved by the Engineer.

Materials

All materials used in the repair of concrete shall conform to the applicable requirements of the Specifications.

Protrusions

Where bulges and abrupt irregularities protrude outside the specified limits on formed surfaces not to be concealed permanently, the protrusions shall be reduced by bush-hammering and grinding so that the surface irregularities are within the specified limits.

Depressions

GENERAL: All fillings for depressions shall be bonded tightly to the surfaces of holes and shall be sound and free from shrinkage cracks and dummy areas after the fillings have been cured and have dried. All fillings in surfaces of structures prominently exposed to public view shall contain sufficient white Portland cement to produce the same colour as that of the adjoining concrete. Repairs shall be made with non-shrink grout, guniting or dry pack filling except where repairs with epoxy concrete and/or epoxy mortar are directed to be made by the Engineer. Concrete, mortar, grouting, guniting or dry pack mortar filling as the case may be shall each be mixed in proportions approved by the Engineer to produce a repair at least equivalent in strength density and durability to the concrete in which the repair is required and shall match with the adjacent surfaces in texture, colour and shade.

CONCRETE FILLING: Concrete filling shall be used for holes extending entirely through concrete sections; for holes in which no reinforcement is encountered and which are greater in area than 0.1 square meter and deeper than 100mm; and for holes in reinforced concrete which are greater than 0.05 square meter in area and which extend beyond the reinforcement.

MORTAR FILLING: Mortar filling, placed under impact by use of a mortar gun, may be used for repairing defects on surfaces, not exposed to public view where the defects are too wide for dry pack filling and too shallow for concrete filling and no deeper than the far side of the reinforcement that is nearest to the surface.

DRYPACK MORTAR FILLING: Dry pack mortar fillings shall be used for filling holes having a depth nearly equal to, or greater than, the least surface dimension; for narrow slots cut for repair of cracks; for grout pipes recesses; and for tie rod fastener recesses as specified. Dry pack mortar shall not be used for filling behind reinforcement or for filling holes that extend completely through a concrete section. If removal of the ends of form ties results in recesses, the recesses shall be filled with dry pack mortar provided that filling of recesses in surfaces upon or against which fill material or concrete is to be placed will be required only where the recesses are deeper than 1 inch in walls less than 300mm thick.

SURFACE FINISHES OF REPAIRED AREAS: The Contractor shall correct all imperfections on the concrete surface as necessary to produce surfaces that conform to the requirements specified for the adjacent area. Fins and encrustations shall be neatly removed from the surfaces.

5.30.9 EPOXY CONCRETE AND MORTAR

Mixing and Batching

EPOXY BINDER: Prior to mixing, the two components of the epoxy resin binder shall be conditioned to 15°C to 21°C. The two components shall be combined with constant stirring, and the stirring shall be continued until a uniform mixture is obtained. The rate of mixing should be such that entrained air is held to a minimum. A power-driven (air or spark proof) mixer with propeller-type blade operating at a maximum of 500 rpm shall be used for mixing the two components of the epoxy resin binder and a hemispherical bottomed polyethylene or metal container shall be used for the mixing.

EPOXY CONCRETE: Epoxy binder shall be prepared as specified above, and after the two components have been thoroughly mixed, shall be transferred to large metal pans and the aggregates added in recommended and approved proportion as specified in sub- section 10.2.6.

The fine aggregate shall be added to the epoxy resin binder and the material shall be mixed until a rich mortar consistency is attained. The coarse aggregate shall then be added and the epoxy concrete thoroughly mixed.

MORTAR: Epoxy binder shall be prepared as specified above in para - Epoxy Binder. After the two components have been thoroughly mixed, the binder shall be transferred to large metal pans and the fine aggregate added in recommended and approved proportions as specified in sub-section 10.2.5. The fine aggregate shall be added to the binder gradually and mixing continued until all particles are coated.

Temperature, Moisture and Protection for Epoxy Mortars and Concrete

Epoxy concrete and mortar shall be placed and repairs shall be made when the atmospheric and concrete temperature are above 5°C and less than 38°C and remain in this range for a period of at least 24 hours. If the work is required to be done at temperatures lower or higher than those specified; approved means as recommended by the manufacturer of the epoxy binder and approved by Engineer shall be provided to raise or lower the ambient and concrete temperatures as required for satisfactory work. Such means will include heating or cooling equipment and necessary shelters. If temperatures below 5°C are anticipated during the cure-out or hardening period of the epoxy concrete or mortar, heated enclosures shall be maintained over the repair area with care taken to avoid localized heating or hot-spots. Circulating air shall be used to ensure that surface temperatures do not exceed 35°C during curing. Epoxy resin concrete and mortar shall be placed only on sound, clean and dry surfaces. Suitable methods shall be used to dry and to maintain dry the contact surfaces of the concrete to which the epoxy concrete or mortar is to be applied. All repairs shall be protected from rain or seepage water for at least 24 hours and from all types of traffic for a period of 72 hours.

Preparation and Placing

EPOXY CONCRETE: All fines, dust, and other loose material on the contact surface shall be removed by scrubbing with a stiff bristle brush followed by washing. The dry, cleaned surfaces shall receive a prime coat of epoxy resin. The prime coat shall be applied in a thin coat and briskly scrubbed into the dry concrete surface with a stiff bristle brush. Placement of the epoxy resin concrete shall be delayed until the prime coat becomes tacky. The epoxy resin concrete shall be placed in layers not over 100mm in thickness. The thickness of courses and time interval between courses, shall be such that the temperature of the epoxy concrete does not exceed 60°C at any time during hardening. Mechanical plate, screed or float vibrators or hand tampers shall be used to consolidate the epoxy concrete. Excess epoxy concrete which becomes spread on the adjacent surfaces of hardened concrete shall be removed before it hardens.

EPOXY MORTAR: Defective concrete in areas as determined by the Engineer, shall be repaired with the aid of a saw cut at least 25mm outside the faulty area. The concrete between the saw cut and the edge of the faulty area and the concrete throughout the area shall be chipped out to solid concrete. The cavity thus formed shall be thoroughly cleaned with compressed air, sand blasting or other method to remove all loose material. The dry, cleaned surfaces of the cavity shall receive a prime coat of epoxy resin binder of composition as recommended by the manufacturer of the epoxy. The prime coat shall be applied in a thin coating and scrubbed into the surface with a stiff bristle brush. Placement of epoxy resin mortar shall be delayed until the prime coat becomes tacky. The epoxy mortar shall then be placed in the cavity in layers not exceeding 25mm in thickness. The time interval between placements of additional layers shall be such that the temperature of the epoxy resin mortar does not exceed 60°C at any time during hardening. Mechanical plate, screed or float vibrators or hand tampers shall be used to consolidate the epoxy resin mortar. Excess epoxy resin mortar, which becomes spread on the adjacent surfaces of the hardened concrete, shall be removed before it hardens.

5.30.10 Health and Safety Precautions

- Full face shields shall be used during all mixing and blending operations and for placing operations as required.
- Protective skin creams of a suitable nature for the operations shall be used.
- Portable eye washing facilities shall be maintained at mixing, batching and placing operations.
- Adequate fire protection shall be maintained at all mixing and placing operations.
- Smoking or the use of spark or flame producing devices is prohibited within 50 feet of mixing and placing operations.
- The mixing, placing, or storage of solvent is prohibited within 4.5m of any vehicle, equipment or machinery which could be damaged from fire or could ignite vapors from the material.

- Contaminated clothing which cannot be decontaminated shall be burned at an approved burning area at the end of each working day.
- Facilities shall be provided for decontamination of clothing and equipment at the job site.
- Care should be taken in handling solvent for cleaning equipment to avoid problems of toxicity, fires and possible explosions.
- Adequate ventilations shall be provided.

5.31 FINISHES AND FINISHING

General

Allowable deviations from plumb or level and from the alignment, profile grades and dimensions shown on the Drawings or specified in sub-section 5 "Tolerances" are defined as tolerances and are to be distinguished from irregularities in finish as described herein. The classes of finish and the requirements for finishing of concrete surfaces shall generally be as specified herein or as indicated on the Drawings. Finishing of concrete surfaces shall be performed only by workmen who are skilled concrete finishers.

The Contractor shall keep the Engineer informed as to when finishing of concrete will be performed. Unless inspection is waived in each specific case, finishing of concrete shall be performed only in the presence of the Engineer. Concrete surfaces will be tested by the Engineer where necessary to determine whether surface irregularities are within the limits hereinafter specified. Surface irregularities are classified as abrupt or gradual. Offsets caused by displaced or misplaced form sheathing or lining or form sections or otherwise defective form lumber will be considered as abrupt irregularities, and will be tested by direct measurements. All other irregularities will be considered as gradual irregularities and will be tested by the use of a template, consisting of a straight edge or the equivalent thereof for curved surfaces. The length of the template will be 4 feet 6 inch.

The classes of finish for concrete surfaces shall be as shown on the Drawings or as directed by the Engineer. No grinding will be required on formed surfaces other than that necessary for repair of surface imperfections as specified herein.

Ordinary Finish (OF)

Ordinary finish (OF) applies to surfaces upon or against which fill material or concrete is to be placed. If unformed, the finishing operation shall consist of sufficient levelling and screeding to produce even uniform surfaces. When formed, the surfaces require no treatment after form removal except for repair of defective concrete and filling of holes left by the removal of fasteners from the end of the tie rods as required under sub-section 11.8 –"Repair of Concrete". Correction of surface irregularities shall be required for depressions only and only for those which exceed 25mm when measured as described in sub-section 11.11.1.

Rough Concrete Finish (RC)

Rough concrete finish (RC) applies to surfaces which are intended to receive tiles, metallic lining or other applications as indicted on the Drawings. After consolidation and levelling of the concrete to the specified tolerances, the surface shall be roughened with stiff brushes or rakes before final set. Where rough concrete finish is specified for wall surfaces, the same shall be obtained by use of formwork suitable to produce the required finish. Surface irregularities measured as described in sub-section 11.11.1 General, shall not exceed 6mm for floors and 3mm for walls.

Ordinary Slab Finish (OS)

Ordinary slab finish (OS) applies to floor surfaces which are not intended to receive any floor coverings. After the concrete has been placed, consolidated, struck-off and levelled, and its surface has stiffened sufficiently, floating shall be performed by use of hand or power driven equipment, and shall be the minimum necessary to produce a surface that is free from screed marks and is uniform in texture. Floating shall be continued until a small amount of mortar without excess water is brought to the surface so as to permit effective trowelling. Steel trowelling shall be started when the surface has hardened sufficiently to prevent excess of fine material from being drawn to the surface. Steel trowelling shall be performed with firm

pressure such as will flatten the sandy texture of the floated surface and produce a dense uniform surface, free from blemishes and trowel marks. Surface irregularities measured as described in sub-section 11.11.1 General, shall not exceed 6mm for abrupt irregularities and 13mm for gradual irregularities.

Fair Faced Finish (FF)

Fair Finish (FF) shall be applied to all exposed surfaces of walls and ceilings which are not to be covered by any other finish. Surface irregularities shall not exceed 3mm for abrupt irregularities and 6mm for gradual irregularities, when measured as described in sub-section all abrupt irregularities and all gradual irregularities in excess of 6 mm shall be reduced by grinding to conform to the specified limit for gradual irregularities.

5.32 MEASUREMENT AND PAYMENT

General

Except as otherwise specified hereunder, measurement of concrete shall be made on the basis of the actual volume of concrete in place within the neat lines of the structure, as indicated on the Drawings. Measurement for payment shall not be made of concrete, nor any ingredients including cement in concrete, which is placed outside of the pay lines shown on the Drawings. Measurement of concrete placed against the sides of any excavation without the use of intervening forms shall be made only within the pay lines of the structure. Unless otherwise specified, payment for concrete shall be made at the respective contract unit price per cubic feet for the various items of the Bill of Quantities, which price shall include the cost of all labour, materials and the use of all equipment and tools required to complete the batching, mixing, transporting, placing, protecting, curing and other concrete work; except the reinforcement, waterproofing and embedded parts which are specified to be paid for separately. The Contract unit prices per cubic metre for concrete will include the cost of formworks, form oils, aggregates, water, preparation of all type of joints, bond breaking and curing compounds, handling and incorporating the cement admixture into the work, mixing, cooling, specified cleaning and other preparation of surface to receive concrete, placing, finishing, curing and all other work required to complete the concrete structures. No measurement or payment shall be made for removal and replacement of rejected concrete with Portland cement mortar, epoxy concrete, epoxy mortar or by any other method.

No measurement and payment shall be made for testing of cement; sampling and testing of aggregates; providing and testing concrete for slump and compressive strengths on the basis of test cylinders as specified or cubes if approved by the Engineer; providing and designing the trial mixes and testing for each grade of concrete as required by the Engineer and other tests as specified to be made in the laboratory at Site and/or in a laboratory approved by the Engineer.

No measurement and payment shall be made for providing samples and testing precast concrete units manufactured outside the Site;

No. measurement and payment shall be made for providing any type of admixtures; water stops; embedded items; expansion/ contraction joint, expansion joint/ contraction joint filler materials, Aluminium, G.I, Copper, stainless steel strip cover (any size) etc. cost of which shall be deemed to be included in the cost of respective item.

Measurement

Concrete shall be measured as per approved execution, and no deduction shall be made for the following:

- Volume of any reinforcing steel embedded in the concrete.
- Volume occupied by water pipes and conduits etc, not exceeding 25 sq. cm each in cross-sectional area.
- Voids not exceeding 900 sq. cm. If any void exceeds 900 sq. cm total area of void shall be deducted.

Voids, which are not to be deducted as specified above, refer only to openings or vents which are wholly within the boundaries of measured areas. Openings or vents which

are at the boundaries of measured areas shall always be subject to deduction irrespective of their size.

Concrete work shall be classified and measured separately as listed under the Items of BOQ.

Junction between straight and curved works shall in all cases be deemed to be included with the work in which they occur.

Measurement of walls shall be taken between attached columns, piers or pillar. The thickness of attached columns, piers or pillar shall be taken as the combined thickness of the wall and columns, pier or pillar. Attached or isolated columns, piers, pillar and the like (except where caused by openings) having a length on plan not exceeding four times the thickness shall be classified as columns. Those having a length over four times the thickness and caused by openings in wall shall be classified as walls.

Columns shall be measured from the top of footing/footing beams or floor surfaces to the underside of beams or slabs as the case may be. Where the width of beams is less than the width of columns, the extra width at the junction shall be included in the beams.

The depth of the beams shall be measured from bottom of the slab to the bottom of the beams except in case of inverted beams where it shall be measured from top of slab to the top of beam. The cross-section of the beam shall be the actual cross- section below or above the slab.

Measurement of acceptably completed works of plain and reinforced cement concrete shall be made on the basis of the number of cubic meter of concrete placed and compacted in position within the neat lines of the structure as shown on the Drawings or as directed by the Engineer.

Measurement of non-shrink cement grout shall be made on the basis of number of cubic meter of grout acceptably placed in positions as shown on the Drawings or as directed by the Engineer.

PUBLIC PROCUREMENT REGULATORY AUTHORITY (PPRA) EPADS

SECTION – 6

6.0 STEEL REINFORCEMENT

6.1 SCOPE OF WORK:

The work covered by the section of the specification consists of furnishing all materials, tools, labor 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.

6.2 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 51 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-615-60

a) Tensile Strength – 414 Mpa.

b) Yield Strength – 630 Mpa.

c) Elongation - 11 %

Tensile Strength

C. All steel to be true to the Standard Specifications with regard to bendability 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.

6.3 TESTING:

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.

6.4 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.

6.5 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 dis9placement 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 day's 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.

6.6 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 tor steel shall have laps of 50 time 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.

6.7 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 mm.	Weight in kgs/m.	Size mm.	Weight in Kgs/m.
10	0.617	25	3.853
12	0.888	32	6.313
16	1.578	40	9.865
20	2.466	28	4.834

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, labor, equipment and incidentals necessary to complete the item.

The work under this section of specifications consists of furnishing, cutting, fabricating, bending and placing steel reinforcement and Welded wire fabric in concrete structures or elsewhere as shown on the drawings or as directed by the Engineer. The scope of this section of specification is covered with detailed specifications as laid down herein.

6.8 APPLICABLE STANDARDS

Latest editions of the following Pakistan, British and ASTM Standards are relevant to these specifications wherever applicable.

Pakistan Standard

PS 2674 Tensile Testing of Metals.

PS 2031 Bend test for Metallic Materials.

PS 607 General technical delivery requirement for steel.

PS 1612 Cold worked steel deformed bars for reinforcement of Concrete.

PS 1879 Deformed and Plain billet steel bars for concrete reinforcement (Metric)

British Standard

BS 4482 Specifications for cold reinforced steel wire for the reinforcement of concrete.

BS 5135 Specification for arc welding of carbon and carbon manganese steel.

BS 4449 Hot rolled steel bars for reinforcement of concrete

B.S 4461 Cold worked steel bars for reinforcement of concrete.

BS 4466 Bending dimensions, cutting and scheduling of steel reinforcement for concrete.

BS 4483 Steel fabric for the reinforcement of concrete.

A 305 Minimum requirement for the deformations of deformed steel bars for concrete reinforcement.

A 615 Deformed billet steel bars for concrete reinforcement.

ACI 301 Specification for structural concrete for buildings.

ACI 315 Manual of standard practice for detailing reinforced concrete structures.

In addition to the above, the latest editions of other Pakistan Standards, British Standards, American Concrete Institute Standards, American Society for Testing and Materials Standards and other standard as may be specified by the Engineer for Special Material and construction are also relevant.

6.9 MATERIAL AND SIZE OF BARS

6.9.1 Reinforcement for concrete shall conform to the respective Pakistan, British, ASTM, or other Standards as specified in the Drawings and in the Contract Documents or as may be specified by the Engineer.

6.9.2 Unless otherwise specified, all grade 40 reinforcing bars shall comply with the requirements of ASTM-A 615 Deformed Billet steel bars and shall have a minimum yield strength of 40,000 Psi.

6.9.3 Unless otherwise specified, all grade 60 reinforcing bars shall comply with the requirements of ASTM-A 615M for Deformed steel bars and shall have a minimum yield strength of 60,000 Psi.

6.9.4 Steel wire mesh reinforcement shall conform to requirements of ASTM Designation A 185-64 or BS. 4482 and 4483, Standard Specifications for Welded Steel Wire Fabric for concrete reinforcement. It shall be used where shown on the Drawings.

6.9.5 Binding wire shall be 16 gauge Soft iron wire.

6.9.6 Reinforcement shall be obtained only from manufacturers approved by the Engineer. Each consignment of reinforcement steel shall be accompanied by the manufacturer's certificate or shall refer to a previous certificate, if the consignment is from the same batch, showing that the reinforcement steel complies with the specified requirement. If such certificate is not made available or if the Engineer considers that the manufacturer's tests are inadequate, samples shall be taken for acceptance test from different consignments as the Engineer may direct and shall be tested at the contractor's cost. Should the result of such tests show that the sample does not meet with the specifications the whole consignment shall be rejected and removed from the site at the Contractor's cost?

6.9.7 Reinforcement shall be free from all loose or flaky rust and mill scale, or coating, and any other substance that would reduce or destroy the bend. Reduced section steel reinforcement shall not be used.

DELIVERY & STORAGE

6.10 **Delivery**

Steel reinforcement bars shall be kept in bundles firmly secured and tagged. Each bar or bundle of bars shall be identified by marks stamped on hot or cold or painted on or by any other means. The identifying marks shall contain the following information:

- Name of the producer or his trade.
- Standard to which the bars have been manufactured.
- The class type and strength.
- The diameter.
- The number of the test certificate.

6.11 **Storage**

The method of storage shall be approved by the Engineer. Reinforcing bars shall be stored and shall be protected from mud, scaling, rusting, oiling, coatings, damage, contamination and structural defects prior to placement in works. Bars of different diameters and grades of steel reinforcement shall be kept separately.

6.12 BAR BENDING SCHEDULES

The Contractor shall prepare bar bending schedules of all the reinforcing steel bars and these bar bending schedules shall be submitted to the Engineer for his approval. The Contractor shall obtain approval of the bar bending schedules before starting actual bar bending works.

6.13 CUTTING, BENDING AND PLACING

The Contractor shall furnish, cut bend and place all reinforcement.

Reinforcement is to be accurately placed as shown in the drawings, and secured against displacement by using 16 gauge G.I wire ties or suitable slips at intersections and supported from the formwork by using concrete, or metal chairs and spacers or hangers of an approved pattern. Where concrete blocks are used for ensuring the cover, they shall be made of mortar not less than 1 part of cement to 2 parts of sand. All reinforcement including dowels, remaing exposed in the work shall be suitable protected against corrosion by a thick coat of cement slurry until embedded in concrete.

Bars used for concrete reinforcement shall be fabricated in accordance with the dimensions shown in the bar bending schedule approved by the Engineer.

The cutting tolerance for all bars shall be ± 25mm.

Where an overall or an internal dimension of a bent bar is specified in the schedule, the bending tolerance, unless otherwise stated, shall be as in Table-1.

Table-1

Bending Tolerances

Description	Tolerance	
	Plus	Minus
	mm	mm
Bars up to 1m. long	6	6
Bars 0.5m to 1m long	6	6
Bars over 1.8m. long	6	6

- Bars shall be placed to the following tolerances:

  Concrete cover to formed surfaces : ±6mm.
  Minimum spacing between bars : ±6mm

- Top bars in slabs and beams : ± 50mm

  Members 20cm deep or less : ±25mm

  Members more than 20cm but Not over 60cm deep : ±6mm

  Members more than 60mm Deep. : ±6mm

Bars may be moved as necessary to avoid interference with other reinforcing steel, conduits, or embedded items. If bars are moved more than one bar diameter or enough to exceed the above tolerances, the resulting arrangement of bars shall be subject to approval of the Engineer.

Vertical bars in columns shall be offset at least one bar diameter at lapped splices. To ensure proper placement, templates shall be furnished for all column dowels.

Reinforcement shall not be bent or straightened in a manner that will injure the material.

No bars shall be bent twice in the same place, nor shall they be straightened after bending.

Unless permitted by the Engineer, reinforcement shall not be bent after being partially embedded in hardened concrete.

No splice of reinforcement shall be made except as shown on the working drawings unless approved by the Engineer.

Welding shall be permitted for bars only under suitable conditions and with suitable safeguards in accordance with BS 693, BS 1856, or AWS D12.1, provided the type of reinforcement bar has the required welding properties. Tack welding may be used to fix in position bars that cross each other, only with prior approval of the Engineer.

Exposed reinforcement intended for bonding with future extensions is to be effectively protected from corrosion. Protection is also to be provided to reinforcement partly built into concrete where the exposed part is to be built into later concrete.

No concreting is to be carried out until the reinforcement has been checked and approved by the Engineer.

All detailing shall be done as per American Concrete institute standards ACI-315 and ACI-318.

6.14 CONCRETE COVER

All reinforcing steel shall be held firmly in place before and during the placing of concrete by means of wires and supports adequate to prevent displacement during the course of construction.

6.15 SUPPORTS

All reinforcement shall be secured in place by use of concrete supports. Chairs, spacers, or ties may be of metal or as approved by the Engineer. Such supports shall be of sufficient strength to maintain the

reinforcement in place throughout the concreting operations. Concrete supports shall be manufactured of the same concrete strength as used in the structure to be concerted.

6.16 EMBEDDED ITEMS

Before placing concrete, care shall be taken to determine that all embedded items are properly placed as required under the Specifications and are firmly and securely fastened in place as indicated on the Drawings or as directed by the Engineer. Embedded items shall be free from oil and other foreign matter such as loose coatings of rust, paint and scale. The embedding of wood or other perishable materials in concrete is prohibited unless specifically authorized or directed.

6.17 MEASUREMENT AND PAYMENT

6.17.1 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 Bills of Quantities.

6.17.1.1 Providing and installing chairs, supports, hooks, spacers, binding wires, and laps not shown on Drawings including wastage and rolling margin.

6.17.1.2 Furnishing , delivering , storing, handling bending, cutting and cleaning of reinforcement

6.17.1.3 Plants, tools , labor and equipment required for the completion of the works at any elevation

6.17.1.4 Welded splices done by the Contractor for his convenience.

6.18 Furnish and install reinforcing Steel

6.18.1 Measurement

Measurement for acceptably completed works of steel reinforcement shall be made on the basis of number of M.Tonne of reinforcing steel placed on the basis of the lengths of bars installed in accordance with the approved Drawings or bar schedules or as directed by the Engineer. Length of each size of bars shall be converted to weights use of the unit weights per linear metre for each size as stated below. Steel laps indicated on the Drawings and as required by the Engineer will be measured for payment.

Nominal Bar Diameter (Metric)	Weight Kg/m.
10	0.617
12	0.888
16	1.578
20	2.466
25	3.853
32	6.313
40	9.865

2204.6 lbs. = 1.00 M.Tonne (1000 Kg)

6.19 Payment

Payment will be made for acceptable measured quantity of reinforcement as provide above on the basis of unit rate per Kg or M. Ton quoted in the Bill of Quantities and shall constitute full compensation for all the works related to the item.

SECTION – 7

7.0 DISMANTLING AND DEMOLITION

7.1 SCOPE OF WORK

The scope of work of this section covers dismantling and demolishing of existing works.

7.2 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 of 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.

7.3 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.

PUBLIC PROCUREMENT REGULATORY AUTHORITY PPRA EPADS

SECTION – 8

8.0 STRUCTURAL STEEL WORKS

8.1 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.

8.2 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, labor, 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.

8.3 DRAWINGS

8.3.1 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.

8.3.2 Shop Drawings

a) Before proceeding with the manufacture, or fabrication, Shop 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) Shop 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 1:5O, 1:100, 1:200, for joints 1:5, 1:1O or 1:2O.

- 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 de-rusting process.

- Recommended scale for assembly drawings are preferably 1:1O or 1:2O 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.

8.4 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-3O7-65 (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-3O7-65, except that the tolerance of the unthreaded portion of the bolt body shall be +0.O - O.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, primers, wax, varnishes etc., shall be standard best or top brands produced for each particular kind of material required.

8.5 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.

8.6 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 localized 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 of 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	**Upto 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.

8.7 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 labor, plant and material for this work in the price as mentioned in the Bill of Quantities.

8.8 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.

8.9 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.

8.10 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.

8.11 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 / Shop 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 Shop 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.

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SECTION – 9

9.0 CONCRETE REPAIRS AND RETROFITTING WORKS

9.1 General Description.

The Work shall consist of:

9.1.1 Removing the deteriorated concrete as shown and described on the Drawings and in this Specification

9.1.2 Preparing the surface of the concrete for the repair, including abrasive cleaning, cleaning of existing reinforcement, and applying bonding agent to the surface; and

9.1.3 Supplying materials and the mixing and placing of concrete repair mortar or concrete as shown and described on the Drawings and in this Specification including vibrating, finishing and curing; and

9.1.4 Supplying, fabricating, constructing, maintaining and removing temporary works, including false work and formwork; and

9.1.5 The quality control (QC) testing of all materials.

9.1.6 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.

9.2 References

All reference standards shall be current issue or the latest revision at the date of tender advertisement.

9.2.1 ASTM - the published standards of the American Society for Testing and Materials, West Conshohocken, PA.

9.2.2 CSA A23.1, Concrete Materials and Methods of Concrete Construction

9.2.3 ASTM D4541 - Pull-off Strength of Coatings Using a Portable Adhesion Tester.

9.2.4 International Concrete Repair Institute (ICRI) Technical Guideline No. 310.1R, Guide for Surface Preparation for the Repair of Deteriorated Concrete Resulting from Reinforcing Steel Corrosion.

9.2.5 D638 - Tensile Properties of Plastics.

9.2.6 ASTM D790 - Flexural Properties of Unreinforced and Reinforced Plastics.

9.2.7 ASTM D695 - Compressive Properties of Rigid Plastics.

9.2.8 ASTM D2584 - Volatile Matter Content.

9.2.9 ASTM D2240 - Durometer Hardness, Type D.

9.2.10 Reinforcing steel (when required) shall conform to the requirements of ASTM A-615 (Fy = 60 ksi) deformed steel bars of Grade 60 U.N.O

9.2.11 ACI 117, Standard Tolerances for Concrete Construction and Materials

9.2.12 Structural steel to be used for falsework shall comply with the requirements of Standard Specifications for Structural Steel ASTM.

9.2.13 Approved Products List

9.3 Submittals

The Contractor shall submit the following to the Engineer, in accordance with this Specification and the Special Provisions:

9.3.1 Technical data sheet on each product used, including ASTM test results indicating the product conforms to and is suitable for its intended use per these specifications.

9.3.2 Product data sheets and installation procedures for proposed concrete repair mortar(s).

9.3.3 Project specific guidelines and recommendations

9.3.4 Detailed design notes, calculations and Shop Drawings for any temporary works, including formwork and false work shall be submitted to the Engineer prior to the Contractor proceeding with the work.

9.4 Materials

The Contractor shall supply all materials necessary for the repair and restoration of

deteriorated concrete areas as follows:

9.4.1 Concrete repair mortar from the most recent Approved Products List most closely matching the exposure class and properties of the existing concrete and meeting the anticipated placement requirements.

9.4.2 Sacrificial galvanic anodes (when required) shall be puck-shaped, pre-manufactured, and consist of electrolytic high grade zinc in compliance with ASTM B418-95a Type 1 cast around a pair of steel electric lead wire in compliance with bright annealed ASTM A82-97a and encased in a highly alkaline cementitious shell with a pH of 14 or greater. The cementitious shell shall contain no chlorides or other corrosive constituents as per ACI Guideline No. 222.

9.4.3 Reinforcing steel (when required) shall conform to the requirements of ASTM A-615 (Fy = 60 ksi) deformed steel bars of grade 60 unless indicated otherwise on the Drawings.

9.5 Construction Methods

9.5.1 Surface Preparation

9.5.2 Each portion of concrete to be removed shall be clearly identified, outlined and catalogued. The area marked shall be such that the polygon defining the boundary does not have any internal angle less than135. The engineer shall approve the extents and locations of these pockets to be removed prior to commencement of works by the contractor.

9.5.3 The contractor shall apply shallow cuts of 20 mm depth at the defined periphery of the area marked for removal before commencing with the required removal of concrete. The contractor shall use approved means to remove concrete up to limits defined above. Care shall be exercised that sound concrete to be left intact at the boundary is not damaged or compromised. In the event such damage is inadvertently caused, the damage shall be immediately notified to the engineer and the extent of concrete removal area shall be enhanced to include the newly damaged concrete in consultation with the engineer.

9.5.4 Although the contractor may use any mechanized means of removing existing concrete, use of small chisels with light to medium hammer blows shall be encouraged. Any method of removal of concrete proposed by the contractor shall ensure that the chances of any possible damage to the embedded reinforcement and surrounding sound concrete remain minimized. Use of jackhammers and similar vibratory equipment shall not be allowed.

9.5.5 The engineer may instruct practical demonstration of some or all of the equipment proposed to be used by the contractor to satisfy him of the adequacy/suitability of the same. Upon receiving such instructions from the engineer, the contractor shall arrange trials of his proposed equipment in mock conditions duplicating the actual working conditions as far as reasonably possible. Only equipment approved by the consultants shall be used for the works.

9.6 Removal of Existing Concrete

9.6.1 Each portion of concrete to be removed shall be clearly identified, outlined and catalogued. The area marked shall be such that the polygon defining the boundary does not have any internal angle less than 135. The engineer shall approve the extents and locations of these pockets to be removed prior to commencement of works by the contractor.

9.6.2 The contractor shall apply shallow cuts of 20 mm depth at the defined periphery of the area marked for removal before commencing with the required removal of concrete. The contractor shall use approved means to remove concrete up to limits defined above. Care shall be exercised that sound concrete to be left intact at the boundary is not damaged or compromised. In the event such damage is inadvertently caused, the damage shall be immediately notified to the engineer and the extent of concrete removal area shall be enhanced to include the newly damaged concrete in consultation with the engineer.

9.6.3 Utmost care shall also be exercised to prevent any damage to the existing reinforcement within portions of the concrete to be removed. Any damage caused to the existing reinforcement shall be recorded and reported to the engineer immediately.

9.6.4 Prior to pouring fresh concrete, the surrounding edges of existing concrete shall be

coated with an approved epoxy mix as per the supplier's recommendations.

9.7 Cleaning of Reinforcement

9.7.1 The intended concrete having been removed to the extents desire d/instructed by the engineer, the exposed reinforcement shall now be cleaned of all debris etc still adhering to the surface of the bars. This debris shall be removed using wire brushes and small chisels where required. Utmost care shall be exercised that the existing reinforcement is not damaged during this operation. Undue flexing, bending or hammering of the reinforcement shall not be allowed. The use of chemicals to remove or otherwise dissolve material sticking the exposed reinforcement shall not be allowed. The cleaned up reinforcement shall be inspected and approved by the engineer before proceeding further with the work at each location.

9.7.2 The reinforcement having been cleaned, the edges of sound concrete defining the extents of removed portions shall be cleaned with wire brushes and water/air jets. The objective shall be to dislodge and remove any loose material from these edges.

9.7.3 Areas so worked and prepared shall be cordoned off to prevent contamination or further damage due to any reason.

9.8 Drilling of Dowel Holes

9.8.1 After locations of all dowels have been marked and identified, work shall proceed to drilling of dowel holes. Approved drilling equipment shall be used to drill holes of the required depth and diameter. The drill bits shall be marked so that drill hole depths achieved can be easily established during the drilling operations. Care shall be exercised that concrete surrounding the drill hole is not shattered or damaged in any way.

9.8.2 In case such damage does occur, the damaged portions shall be immediately removed using small chisels and light hammer blows. After removing such damaged concrete, the worked surfaces shall be cleaned using wire brushes and air jets to dislodge and remove any loose particles at the surface.

9.8.3 While drilling in the vicinity of reinforcement components embedded within the girder, extreme care shall be exercised to ensure that none of the reinforcement components are damaged in any way due to the drilling operation. Each drill hole in such areas shall be advanced 5 mm at a time. After each advance, the drill shall be removed and the hole shall be carefully examined to ensure that any reinforcement element has not been encountered inadvertently. In the event that a reinforcement element has been encountered, the hole shall be immediately abandoned and filled up with epoxy as outlined in the drawings. An alternate location, in lieu of the abandoned hole shall be decided and approval for the same sought from the designers before drilling at the new location.

9.8.4 Immediately after each hole is drilled, it shall be cleaned using air jets and the drilled depth recorded. The mouth of the drill hole shall then be plugged to prevent any debris or contamination from entering the hole.

9.8.5 The engineer shall inspect works for quality and accuracy before giving approval for the drilling operation. Work shall proceed to the next stage after the engineer's approval for this stage of work. The concerned work areas shall be kept clean and free of contamination at all times.

9.9 Installing dowels.

9.9.1 The drill holes made and approved, work shall proceed to installation of dowels. Each drill hole shall be unplugged just prior to installation of the dowel within. The hole shall be re-cleaned using air jets and prepared as per recommendations of the epoxy suppliers. Usually epoxy applications require the intended surfaces to be saturated but without any free surface moisture. To achieve this, water jets followed by air jets may be used to get the desired results. The supplier's recommendations for preparing the intended concrete surfaces shall however be followed in all detail. A group of drill holes having been so primed; the concerned area shall be cleaned again to remove any debris or loose particles.

9.9.2 Epoxy, premixed as per the supplier's recommendations, shall be introduced into the drill holes–followed by the steel dowels of the required length, grade and diameter. While introducing epoxy into the drill holes, care shall be exercised that air pockets or bubbles are not formed within the drill hole. Towards this end it is recommended that an epoxy gun with an extended nozzle be used for introducing epoxy into the drill hole–filling the hole from the bottom towards the top. Pouring the epoxy using funnels

is not advised.

9.9.3 Dowels shall be inserted into the holes immediately after the epoxy has been introduced. Any epoxy that overflows the holes upon introduction of dowels shall be removed immediately using suitable bladed instruments and disposed-off. Such overflow epoxy shall not be reused in any of the other drill holes.

9.9.4 After introduction of dowels into the holes, the concerned area shall be cordoned-off so as to prevent any disturbance to the dowels until the epoxy has set and gained strength. Similarly, any drilling operations or similar works that may cause vibrations in areas where fresh epoxy has been applied shall be suspended for sufficient amount of time.

9.9.5 The epoxy shall be given sufficient time to set and gain strength as per the supplier's recommendations before subsequent operations are performed in the area. During the curing period for the epoxy compound, the area shall be protected from extreme variations of temperature and moisture as per the supplier's recommendations.

9.10 Concrete Patch Repair

9.10.1 The contractor shall apply shallow cuts of 20 mm depth at the defined periphery of the area marked for removal before commencing with the required removal of defective concrete. The contractor shall use small chisels and light hammer blows to remove defective concrete up to limits defined and/or up to a minimum of 25 mm behind the surface reinforcement. Care shall be exercised that sound concrete to be left intact at the boundaries is not damaged or compromised. In the event such damage is inadvertently caused, the damage shall be immediately notified to the engineer and the extent of concrete removal area shall be enhanced to include the newly damaged concrete in consultation with the engineer.

9.10.2 Utmost care shall also be exercised to prevent any damage to the existing reinforcement within portions of the concrete to be removed. Any damage caused to the existing reinforcement shall be recorded and reported to the engineer immediately.

9.10.3 The defective concrete having been removed to the extents desired/instructed by the engineer, the exposed reinforcement shall now be cleaned of all debris, rust etc still adhering to the surface of the bars as specified in the drawings.

9.10.4 The reinforcement having been cleaned, the edges of sound concrete defining the extents of removed portions shall be cleaned with wire brushes and water/air jets. The objective shall be to dislodge and remove any loose material from these edges.

9.10.5 Prior to pouring fresh concrete, the surrounding edges of existing concrete shall be coated with an approved epoxy mix as per the supplier's recommendations. In case the existing reinforcement was discovered to be corroded, it shall be coated with an approved epoxy protection.

9.10.6 Depending upon the situation, the contractor may, after previous declaration and approval, use guniting, shotcreting, dry packing or simple concrete to replace the damaged concrete removed. In the case of concreting, a mix containing 20 mm and down aggregate with a slump of 150 mm minimum is advisable. The mix shall be so proportioned that shrinkage tendencies are minimized. In all instances the material used by the contractor shall be pre-approved by the engineer.

9.10.7 The outer/exposed surface of the new concrete shall be worked to a smooth and uniform finish in line with the original profiles to complete the job.

9.11 Concrete Mix Design

9.11.1 Concrete shall be class "A" (refer general notes drawing as given in appendix d for concrete classes). Since early strength is required, an accelerator like corn plast 430 or equivalent shall be used. Recommended dosage for corn plast 430 is between 0.5 liters and 1.0 liters for each bag of concrete used. Recommended water/cement ratio is 0.32.

9.12 Curing

9.12.1 Curing shall be in accordance with the manufacturer's instructions or as otherwise directed by the Engineer.

9.13 Quality Management

9.14 General.

9.14.1 Concrete repair mortar that is not stored, handled, prepared, placed, or cured in accordance with the manufacturer's instructions will be rejected by the Engineer and his/her decision shall be considered final. The Engineer reserves the right to require immediate removal of any concrete from rejected batches that may have already been placed in the structure.

9.14.2 Quality assurance testing will be carried out by the Engineer and all associated costs will be paid for by the Department. There shall be no charge to the Department for materials taken by the Engineer for testing purposes.

9.15 Delivery, Storage, and Handling

9.16 Materials are to be kept dry, protected from weather and stored under cover.

9.17 Materials such as protective coating are to be stored between 50 and 90 degree Fahrenheit. Do not store near flame, heat or strong oxidants.

9.18 Materials are to be handled according to their material safety data sheets.

9.19 Warranty

9.19.1 Applicator shall warrant all work against defects in materials and workmanship for a period of ten (10) years, unless otherwise noted, from the date of final acceptance of the project. Applicator shall, within a reasonable time after receipt of written notice thereof, make good defects in materials or workmanship which may develop during said ten (10) years period, and any damage to other work caused by such defects or the repairing of same, at his own expense and without cost to the Owner.

9.20 Payment.

Payment will be made for acceptable measured quantity of this section 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. 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.

PUBLIC PROCUREMENT REGULATORY AUTHORITY (PPRA) EPADS

SECTION - 10

10.0 BLOCK MASONRY

10.1 SCOPE

The work under this section of the specifications consists of furnishing all plant, labour, equipment, appliances and materials and performing all operations in any floor and at any height in connection with the supply and installation of ordinary cement concrete solid and hollow block masonry work including wall ties, anchors, damp-proof courses, complete in strict accordance with this section of the Specifications and applicable drawings, and subject to the terms and conditions of the Contract.

10.2 APPLICABLE STANDARDS

Latest editions of following Pakistan, British and ASTM Standards are relevant to these specifications wherever applicable.

10.2.1 Pakistan Standards

232 Ordinary Portland Cement.

419 Properties & Specifications of blocks

10.2.2 ISO (International Standardisation Organization

R.679 Method of testing strength of cement compressive and flexural strengths of plastic mortar.

R.680 Chemical analysis of cements - Main constituents of Portland Cement.

R.681 Chemical analysis of cement - Main constituents of Portland Cement.

10.2.3 ASTM (American Society for Testing and Material)

C.144 Aggregate for Masonry Mortar.

C.331 Light weight Aggregate for Concrete Masonry Units.

C.404 Aggregates for Masonry Grout.

C.426 Drying Shrinkage of Concrete Block.

C.476 Mortar and Grout for Reinforcement Masonry.

C.149 Bond Strength of Mortar to Masonry Units.

10.2.4 BSI (British Standards Institution)

743 Materials for Damp-proof Courses.

1243 Specification for Metal Ties for Cavity wall Construction.

4887 Mortar Plasticizer

121 Pt-1 Brick and Block Masonry

122 Pt-2 Walls and Partitions of Blocks and Slabs.

10.3 **MATERIALS**

10.3.1 **For Block**

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

10.3.2 **For Mortar**

10.3.3 **Sand**

Sand for mortar shall comply with the requirements for BS-1200. It shall be graded in accordance with the following table and the various sizes of particles shall be uniformly distributed.

Sieve Size (No.)	Percent Passing by weight min.	max.
# 4	100	-
# 8	95	-
# 16	70	100
# 30	40	75
# 50	10	35
#100	2	15
#200	0	0

Sand upto 0 .0025 inch shall not be more than 8% by weight of the total.

10.3.4 **Cement:**

Cement shall be Ordinary Portland Cement conforming to BS-12.

10.3.5 **Water:**

Water shall be clean and free from any harmful impurity. Where the quality of the water is doubtful, it shall be tested in accordance with BS- 3148.

10.3.6 **Additives:**

Additives where used, shall be proprietary products used in the proportions and manner recommended by the manufacturer. The additives shall in no way adversely affect the mortar strength or contain chemicals, which may be harmful to other building materials. To add gypsum to cement is strictly forbidden.

10.3.7 **Mortars and Grout:**

Materials for mortar, sand binding agent and water, shall be mixed by volume or by weight for at least 3 minutes with the minimum amount of water to produce a correctly mixed mortar or grout of workable consistency in a mechanical batch mixer. For small jobs, hand mixing may be permitted, the ingredients being mixed with sufficient water to produce a correctly mixed workable mortar.

Mortar shall be as strong, but no stronger than the materials it bonds together: Mortars shall be mixed in batches, which can be used within a period before the setting process commences. Once a mix begins drying off, it shall be rejected. No ingredients shall be added to it once the setting process has begun.

10.3.8 **Reinforcement:**

For reinforcement refer specification section no. 2200.

10.4 **CONCRETE BLOCK MAKING**

10.4.1 The Solid and Hollow blocks shall be factory manufactured/fabricated and be machine moulded. The block making machines shall be of the standard approved by the Engineer. They shall be operated according to the instructions laid down by the manufacturers. The contractor shall submit samples/literature of various manufacturers for Engineer's approval. The contractror should note that only blocks supplied by the approved manufacturer(s) shall be allowed to be used in this project.

10.4.2 The blocks shall be continuously water cured by sprinkling water for a minimum of 10 days and covered between sprinkling operations with 4 mils thick polyethelene sheeting. After 10 days water curing period the blocks shall be air-dried. Under no circumstances will blocks be used in the work until they are completely dry. During curing period no surfaces of the block will be allowed to dry.

10.4.3 Cured concrete blocks shall be stored off the ground, stacked on level platforms which allow air circulation under stacked units. Units shall be covered and protected against wetting.

10.4.4 Care shall be exercised in the handling of all concrete blocks. No damaged blocks shall be used in the work.

10.4.5 The hollow blocks shall be manufactured as per pattern shown on the drawing. These block units shall be provided by the Contractor for use where required in building structures from approved type of materials. Units shall have uniformly fine smooth surfaces of uniform colour. These shall be free of any honey combing or other imperfections or deformations, all edges true and straight, and at right angles with each other and without any chipped or otherwise broken edges.

10.4.6 The blocks cast on different dates shall be stacked separately and must be labelled showing the date on which they were cast.

10.4.7 Reinforced cement concrete hollow block masonry shall be provided where shown on the drawings. Hollow block manufactured by moulding machine shall have well formed cavities, sharp and well defined edges and corners, smooth surfaces without any imperfections or deformations.

10.5 PROPERTIES **OF BLOCKS**

10.5.1 All blocks shall be of the size and shape required to complete the work shown in the Drawings or as instructed by the Engineer.

10.5.2 The cement, sand and coarse aggregate shall be volume batched and their proportion may be adjusted so as to provide the concrete of the required strength when tested and shall be mixed in a concrete mixer in accordance with clause 5.4 of the section 'Plain and Reinforced Concrete'.

10.5.3 All blocks shall comply with ASTM 1988 edition. The comppressive strength of various solid and hollow blocks shall be as follows:

S.No.	Type of Concrete Masonry ASTM 1988 Edition	Compressive Strength Psi Average of 3 Units	Individual Unit (MPa)	Location
1.	Solid load bearing Masonry units (ASTM-C-145-85)	1800 (12.4) 1200 (8.30)	1500 (10.4) 1000 (6.90)	Exposed to frost action
2.	Solid/Hollow non load bearing	600(4.14)	500 (3.45)	Not exposed to moisture

	Masonry units			& weather
3.	Hollow load bearing masonry	1000 (6.90)	800 (5.50)	Exposed to moisture & weather
	(ASTM-C-90-85)	700 (4.80)	600 (4.10)	Not exposed to moisture & weather

10.5.4 The Contractor shall provide test certificates providing the average minimum crushing strength of the blocks prior to the commencement of the construction. Further test certificates shall be provided as required by the Engineer, to ensure that all batches of blocks have the minimum specified crushing strength.

10.5.5 A laboratory approved by the Engineer shall carry out the test. Evidence shall be produced that the block manufacturer has an efficient method of quality control. The Engineer will require to test samples of blocks periodically and the Contractor shall make necessary arrangements accordingly. The method of sampling for all tests shall be in accordance with.

10.5.6 All properties or specifications of blocks, not explained in these Specifications shall comply with the requirements of ASTM 1988 edition as directed by the Engineer.

10.6 **SUCTION RATE**

The Contractor shall, at his own cost, satisfy the Engineer that the suction rate of the block when determined in accordance with Appendix "A" of BS 3921 does not exceed 20 g/dm^2/ min. or that the Contractor is able to adjust it so that it does not exceed this value on site.

10.7 **SOLUBLE SALT CONTENT**

For exposed blockwork, the contents by weight percent of soluble sulphate, calcium, magnesium, potassium and sodium radicals, shall not exceed 0.30, 0.10, 0.30, 0.03 and0.03, percent respectively when ascertained in accordance with BS 3921, at the cost of the Contractor.

10.8 **REINFORCING AND ANCHORS OF BLOCK MASONRY**

Unless otherwise stated reinforcing and anchors shall conform to undermentioned sizes:

10.8.1 Joint reinforcing shall be 1.32mm (0.05-inch) diameter mild steel wire mesh design, galvanised after fabrication. Steel wire woven into 12mm mesh 75mm wide. Reinforcing bar anchors shall be 250mm dia. Deformed bar minimum 10 inch long.

10.8.2 Two 6mm dia bar shall be provided at every fourth course for anchoring of block masonry to columns. Two 10 mm bars at every fourth horizontal course shall be provided for anchoring masonry walls to plinth beam/floor beam, as shown on the drawings.

10.8.3 Dovetail anchors and slots (if used as an alternate anchorage) shall be not less than 18 gauge galvanized steel.

10.9 **ERECTION**

10.9.1 Blocks shall be laid true to line, level and laid in accurately spaced courses in stretcher bond with vertical joints of each course located at centre of units in alternate courses below. Vertical joints shall be buttered in the entire height of blocks. Each course shall be bonded at corners and at intersections of walls and shall be properly bonded. Courses of block shall be kept plumb throughout and corner reveals shall be true and in plumb.

Standard width of mortar joints for both horizontal and vertical joints shall be 10mm (maximum). Mortar joints in walls shall have full mortar coverage on vertical and horizontal faces between the blocks. Mortar joints on wall including struck joints, shall be thoroughly compacted and pressed tight against the edges of the blocks with proper tools. Blocks terminating against

soffits of beam or slab construction shall be wedged tight with wedges and the joints shall be packed solidly with mortar between the top of the block and the bottom of slab or beam. Control expansion joints shall be kept free from mortar or other debris.

Unless otherwise shown on the drawings or specified by the Engineer, the spaces around doorframes and other material or built in items shall be solidly filled with mortar. Spaces around the door and window holdfasts shall be filled in with Class `C' concrete. Work required to be built in with masonry including doorframe anchors, wall plugs, and dovetail anchors and accessories shall be built in as the erection progresses.

10.9.2 The block work shall be carried up in a uniform manner and no portion shall be carried more than one metre above the adjoining one at any time. All masonry shall be kept strictly true and square and the whole properly bonded together and levelled round each floor.

10.9.3 Sleeves, Chases, holes, sinking and mortices for other trades shall be correctly located and formed to the sizes as required by the relevant trades. Chiselling of completed walls or the formation of holes shall only be carried out with the approval of the Engineer.

10.9.4 Walls of blocks indicated, as being non-load bearing shall be constructed on the insitu concrete floor slab unit after the floor formwork is struck and the concrete has obtained sufficient strength to support theirweight. Toothing into load-bearing walls shall not be permitted.

10.9.5 All bolts, anchors, ties, pipe sleeves, flushing metal attachments, lintels and the like required to be built into the work shall be correctly inserted and executed as the work proceeds.

Walls or partitions abutting concrete columns or walls shall be securely anchored and tied with metal anchors or ties at not more than 450mm vertical centres. Wall ties cast in with concrete shall be bent down after the removal of formwork and shall be securely jointed into the mortar beds of walling.

10.9.6 Care shall be taken during construction of cavity walls so as to avoid the filling up of cavity with mortar. G.I. flashing and weep holes shall be provided whereever specified on the drawings or as per the instructions of the Engineer. Wheep holes will be formed by oiled rods, removed after the mortar is set, at specified locations.

10.10 **SCAFFOLDING**

Contractor shall provide safe scaffolding of adequate strength for use of workmen at all levels and heights at his own expense. Scaffolding which is unsafe in the opinion of the Engineer shall not be used until it has been strengthened and made safe for use of workmen. Cost of scaffolding etc., shall be included by the Contractor in the unit rate for masonry items.

Damage to masonry from scaffolding or from any other object shall be repaired by the Contractor at his own cost.

10.11 **JOINTING**

Jointing is the forming of joints as work proceeds. Joints shall be as follows:

8.11.1 Exterior exposed joints shall be tightly formed to a weather joint with the point of the trowel.

8.11.2 Interiorexposed joints shall be tightly formed to a concave joint.

8.11.3 Joints which are subsequently covered with plaster or other finish materials shall be struck flush.

10.12 TOLERANCES

All block work shall be erected plumb and true to line and level with the maximum variation in any storey height or any length of wall being one mm in one metre. The maximum tolerance in the length, height or width of any single masonry unit shall be ± 3mm.

10.13 **DAMP PROOF COURSE**

Damp-proof course shall be laid on an even mortar bed, free from projections, which may puncture the material. Where the damp-proof course is to be stepped, only flexible membrane shall be used. All damp proof course, unless otherwise specified, shall consist of class 'C' cement concrete 50mm thick, mixed with 2.5 kg. of pudlo per bag of cement or other approved quality water proofing compound as per manufacturer's specifications and shall be laid at required levels as per drawings and instructions of the Engineer. The D.P.C shall be tamped consolidated, levelled, edges and corners made to the requirements of concerned drawings including finishing and curing complete.

10.14 **SOLID BLOCK WORK AROUND OPENING OF HOLLOW MASONRY**

Around all openings in hollow block masonry, the Contractor shall provide solid block work of same thickness as that of hollow block masonry wall and of width as indicated on the Drawings. Solid block shall be laid around openings in such a manner that these are bonded integrally with hollow block masonry.

10.15 **REINFORCED HOLLOW BLOCK MASONRY**

Where specified on the Drawings, reinforced hollow block masonry shall be provided. Horizontal and vertical reinforcement shall be cold worked deformed bar. Two bars of (8mm) diameter shall be provided at every third horizontal course at 600mm centers, while the vertical reinforcement shall be two bars of (12mm) diameter at 800mm centers. Bars shall be anchored and held firmly vertical in respective beams and columns in the manner shown in shop Drawings. The reinforced hollow part of the block wall shall be solidly filled with Class 'D' concrete at intervals of one meter maximum height as the laying of block masonry work proceeds. The filled concrete shall be consolidated thoroughly by rodding to avoid formation of voids. Contractor shall submit shop drawings of anchoring and placing of reinforcement in hollow block masonry for approval of the Engineer.

10.16 **CURING AND REPAIRS**

10.16.1 All block masonry shall be water cured and shall be kept wet for at least seven days, by an approved method, which will keep all surfaces to be cured continuously wet. Water used for curing shall meet the requirements of the specifications for water used in the manufacture of blocks.

10.16.2 If, after the completion of any block masonry, the work is not in alignment or level, or does not, conform to the lines and grades shown on the Drawings or shows a defective surface, it shall be removed and replaced by the Contractor at his expense unless the Engineer grants permission, in writing, to patch or replace the defective area.

10.17 **MASONRY SHORT OF HEIGHT**

In case of different thickness of slab in different areas or rooms or for any other reasons, whatsoever if chiselling of masonry is required, the Contractor shall do so at his own cost. Where for any reason whatsoever, the height of the wall is short of ceiling height, the actual height shall be made good with Class 'C' nominal mix concrete. This concrete shall neither be measured nor be paid under item of concrete but wil be paid for under the item of wall masonry. Similarly where the lintel heights are such that the Contractor has to chisel the masonry or provide cast-in-place concrete to make up the height of the course, no payment will be made for chiselling, but where such cast-in-place concrete is provided, payment for the same will be made at the unit rate of masonry.

10.18 **MEASUREMENT AND PAYMENT**

10.18.1 **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 Bills of Quantities.

10.1.1 Chiselling of masonry, wherever required.

10.1.2 Cement sand mortar used in laying blocks, curing of masonry works and making of weep holes.

10.1.3 Providing and filling Class 'D' Concrete in the cavity of hollow block masonry.

10.1.4 Providing and laying damp proof courses including damp proof materials and GI sheet flashing within cavity wall.

10.18.2 **Solid Block Masonry**

10.18.2.1 **Measurement:**

Measurement for acceptably completed works of respective type of solid block masonry will be made on the basis of number of sq meters provided and installed in position as shown on the drawings or as directed by the Engineer. Each measurement shall be taken to the nearest cm. All openings left in the masonry wall shall be deducted. Steel reinforcing bars, joint reinforcing bars, dovetail anchors on any horizontal/vertical reinforcement in hollow/solid block masonary shall be measured separately under relevant Section of Specifications i.e. 2200 and 3000.

10.18.2.2 **Payment:**

Payment will be made for acceptable measured quantity of respective type of solid block / Hollow Block masonry work on the basis of unit rate quoted in the Bills of Quantities and shall constitute full compensation for all the works related to the item. Steel reinforcing bars, joint reinforcing bars, dovetail anchors on any horizontal/vertical reinforcement in hollow/solid block masonry and Including DPC shall not paid separately.

SECTION - 11

11.0 PLASTERING

11.01 Scope of Work:

The work covered by this section of the Specifications consists of furnishing all plant, labour, appliances, and materials and in performing all operations in connection with the installation of plastering complete in strict accordance with this section of the Contract.

11.02 General

Except as may be otherwise shown or surfaces specified all plaster surface shall include walls, partitions jambs, returns, reveals, backs of recesses and jambs and heads of windows and doors and all the sofits, alcoves unless otherwise specified or shown on the drawings.

11.03 Materials:

a) "WATER" as specified in respective section.

b) CEMENT" shall be ordinarily Portland Cement and shall conform to B.S.S.12.

c) "SAND" shall be from approved source and free from dust and salt as specified in Section on concrete.

d) "METAL LATH" shall be expanded metal not less than 9" wide strips, and weighing at least 2.5 lbs, per square yard or as directed by the Engineer.

e) "CORNER LATH" shall be strips 6" wide bent to form two 3-inches wings.

f) **Lime:** (To be used for putty)

i. Hydrated lime shall conform to British Standard BS-890 Class A, with the further requirement that the total free (unhy drated) calcium oxide (CaO) and magnesium Oxide (MgO) shall not exceed 8 percent by weight, calculated on the "as received" basis.

ii. Quicklime (pulverized) shall conform to British Standard B.S.890 A. Pulverized quicklime shall pass a No.20 sieve, and at least 90 percent shall be used throughout the work. After slaking to a putty, the pulverized quicklime shall have a plasticity figure of not less than 200 when tested in accordance with ASTM Standard `methods of Test C 110, and at the end of 72 hours the total free (unhy drated) calcium oxide (CaO) and magnesium oxide (MgO) in the hydrated product shall not exceed 8 percent by weight, calculated on the basis of the lime solids in putty.

g. **Lime Putty** shall be made from hydrated lime, except that quicklime may be used when adequate time and facilities are available for aging. Suitable precautions shall be taken to protect the putty from exposure to the sun and to prevent excessive evaporation when stored. Lime putty prepared from quicklime shall be allowed to cool completely before using. Lime putty shall be prepared as follows:

i) Quick lime (pulverized) shall be slaked in suitable large batches, and with enough water to form a thick cream. During cold weather, precautions shall be taken to maintain the heat and prevent premature cooling during the process of hydration. The slaked quicklime shall be passed through a No.10 sieve and stored for at least 72 hours before using. When the use of lump quicklime, slaked on the job, in lieu of pulverized quicklime, is specifically approved for plastering, the cooling and aging period shall be not less than 14 days.

ii. Hydrated lime shall be machine-mixed with water to form putty and shall be allowed to stand for at least 15 minutes before using.

11.04 MIXING OF MORTAR

Except where hand-mixing of small batches is approved by the Engineer, mechanical mixers of an approved type shall be used for the mixing of mortar. Frozen, caked, or lumped materials shall not be used. Mechanical mixers, mixing boxes, and tools shall be cleaned after mixing each batch and kept free of mortar from previous mixes. Plaster mortar shall be thoroughly mixed with the proper amount of water until uniform in colour and consistency. Retempering will not be permitted and all mortar, which has begun to stiffen, shall be discarded. Mortar for scratch coats over metal lath shall be fibered by the addition of a pound of hair or fibre per bag of cement.

11.05 **PROPORTIONING OF PLASTER**

a) All plaster shall be Portland cement plaster, all coats of which shall be mixed in the following proportions by volume or otherwise specified.
One part cement
4 parts sand
1/4 part lime putty, if required or specified.

b) All coats of plaster in liquid retaining structures shall be water proofed by the addition of an approved compound in liquid or solid form used at the approved rate. The water proofing compound shall be commercially pure with no grease or oils or other ingredients detrimental to the cement.

11.06 **APPLICATION OF PLASTER:**

i) Strips of metal lath shall be provided between ceiling beams, lintels walls, columns and near by partitions of masonry parallel to the beams if required. The lath shall be laced with the wire at joints between sheets and screwed to the concrete and masonry with galvanized offset head or hood head lath nails. Also lath not less than 3" wide shall be installed over joints between dissimilar base materials where the surface to be plastered by in the same plane and where the base materials can not be effectively bonded or tied together.

ii) Before the plaster work is commenced it shall be seen that all electric conduits, drainage and sanitary pipes inlets, outlets to tanks, brackets, clamps doors and windows frames and all sorts of inserts are fixed in position. It shall be the responsibility of the Contractor to bring to the notice of the Engineer if such work is not carried out by the other Contractors. Chiseling and repairing of cement plaster shall not be permitted under any circumstances.

iii) The walls shall be washed with fresh water and shall be kept damp for 2 hours before the plaster is applied. All masonry joints and concrete surfaces shall be properly roughened before plaster work is commenced. The proportion of cement plaster shall be as per drawings or as specified. The ingredient shall be properly mixed. The sand used for mix shall be only sufficient for one bag of cement. The mixtures shall be turned over and over till the ingredients are thoroughly mixed. Cement slurry shall be applied to the surface to be plastered and allowed to dry before plaster work is commenced.

iv) The plaster shall be from 1/2" to 3/4" thick and shall not be less than 1/2" thick at any surface. If the plaster is more than 3/4" thick it shall be done in two coats, the first coat shall be made rough. The plaster on all surfaces shall be perfectly in plumb. The edges and corners shall represent a straight line. The plaster shall be kept wet for at least 10 days. No extra payment shall be allowed for jambs, junctions, corners, edges, round surfaces, cement slurry base and for thicker plaster required due to any un-evenness in the work done by the Contractor. At edge of every horizontal projection on external faces of the building if directed by Engineer a drip course of 3/4" is to be provided for trickling of water without any extra cost. Plaster on lath shall be done in three coats. Finish coat shall have a reasonably uniform thickness of approximately 3 mm (1/8"), and the minimum thickness at any point shall not be less than 1.5 mm (1/16") and shall be applied in one continuous operation without staging breaks.

a) The Scratch Coat: shall be full and thick and shall be applied with sufficient force to form good keys. The scratch coat shall be cross-scratched upon attaining its initial set and shall be kept damp with a fog spray.

b) Brown Coat: shall be applied after the scratch coat has set, but not earlier than 24 hours after the application of the scratch coat. When applied directly to masonry, the brown coat similar to the scratch coat shall be applied with sufficient pressure to fill the raked-out joints in brickwork to prevent air pockets and secure a good bond. The brown coat shall be lightly scratched and broomed after attaining its initial set and shall be kept moist with a fog spray for 2 days and then be allowed to dry out.

c) Finish Coat: shall not be applied until the brown coat has seasoned for 7 days. Just before the application of the finish coat, the brown coat shall be wetted evenly with a fog spray. All plaster shall be given a sand float finish of a uniform texture as approved or directed otherwise by the Engineer or his Representative. The finish coat shall be kept moist with a fog spray for at least 7 days and thereafter shall be protected against rapid drying until properly and thoroughly cured and dried.

11.07 **SAMPLING OF PLASTER**

Samples may be taken by the Engineer at any time from plaster work in place. Areas where over sanding is observed shall be rejected and shall have to be done again at the cost of contractor.

11.08 **DRIPS AND GROOVES:**

The Contractor shall make drips for rainwater protection and Architectural grooves shall also be made as shown on the drawings or directed by the Engineer.

11.09 **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 or his Representative.

11.10 **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 or his representative.

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

Protect finished plaster from injury by any source.

Prior to plastering all Aluminium windows and finished metals should be covered by sheet of plastic or tarpaulin to protect it from damage.

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

11.11 **PAYMENT**

Plaster work will be measured and paid for the net area over which it is laid. All openings shall be deducted. The cost for drips and architectural grooves shall be included in the unit rate of plaster and no separate payment shall be made for drips and grooves.

SECTION - 12

12.0 **FLOORING**

12.01 **Scope of Work:**
The work covered under this section of the Specifications consists of furnishing all plant, labour, equipment, appliances and materials and in performing all operations in connection with the construction of floors complete as details of floors in strict accordance with this specification and the schedule of finishing, the applicable drawings and subject to the terms and conditions of the contract.

12.02 Before commencing any work under this section the Contractor shall study applicable drawings, schedule of finishing, details of floors, all levels etc. the Contractor shall also ascertain before starting of flooring that all pipes, trench etc. to pass under flooring have been placed in position and tested. Other concerned trades shall be consulted for completion of all required utilities prior to commencement of the work.

12.03 **Sub-Grade**
All sub-grade shall be prepared to the lines, levels and falls as indicated on the drawings, all subgrade should be compacted mechanically to obtain a density as specified. All sub-grade shall be inspected and approved by the Engineer before any subbase is placed on it.

12.04 **Material:**

i) Water
As specified in the relevant Section of the Specifications.

ii) Cement
a) The grey cement shall be ordinary normal setting cement of any brand complying in all respects with B.S. No.12.

b) White cement shall be complying in all respects with British Standard.

iii) Concreting**:**
All classes of concreting, "B", "C", "D" or "E" shall conform to their respective specifications as laid down in Section on "Concrete".

iv) Terrazzo Cast-in-Situ:
a) The Contractor shall lay 1/2" thick terrazzo topping with white cement or grey as specified and use marble chips No.1 to 4 of approved colour and quality and shall have an abrasive hardness of not less than 16 as determined by the test of wear resistance in national bureau of Standard Report BMS-98. The various sizes of chips shall conform to following:

Chips size No.	Passing through Screen inches	Retained in Screen inches
1	1/4	1/8
2	3/8	1/4
3	2	3/8
4	5/8	½

Chips shall be crushed so that all the dimensions are close to the limits of the specified sizes. Flats or flaky chips shall be kept to a minimum. Colour of the chips shall be selected by the Engineer if the chips are not clean, the Engineer's Representative reserves the right to have them washed at the cost of the Contractor. Terrazzo topping shall be laid over concrete surface as given on the drawings and the ratio shall be 2 part of chips and one part of cement by volume.

b) **Division Strips**

Division strips shall be 1 1/2" wide strips of 5mm thick plate glass and will be suitably embedded and anchored. Division strips shall be fixed on the terrazzo in situ pavements on 4' x 4' grid, unless otherwise shown on the drawings or directed by the Engineer.

vi) **White/Black Glazed Tiles:** (Skid or non-skid)
6"x6"x1/4" or any other size as directed by the Engineer shall be best quality glazed tiles of manufacturer as approved by the Engineer.

12.05 **Method of Application:**

i) Terrazzo Cast-in-Situ:
The terrazzo shall be machine grinded to a true even surface using a No.24 grit followed by a No.80 grit or finer abrasive stone. After the first grinding, the floors shall be thoroughly grouted with the same cement and colour composition as specified for the martix of the terrazzo mix. The grout shall be of the consistency of thick cream, and shall be brushed over the floor to eliminate all cavities and thoroughly fill the surface for final grinding.
Not less than 72 hours after application, the grouting coat shall be removed by grinding. In the later stages of grinding the grit stones or other abrasive used in the grinding machine shall be of a grain or fineness that will give the surface a honed finish. Small areas, inaccessible portions and corners, which cannot be reached by the grinding machine, shall be ground and rubbed manually. After all grinding is completed the surface shall be polished to the entire satisfaction of Engineer or his Representative.

12.06 **Terrazzo Tile Flooring:**

a. General:
Terrazzo tiles of specified size and thickness made to the best local standard with best quality marble chips '0' to maximum of 3 No. size with white/grey cement and colour and pattern as approved by the Engineer on his. Rep. shall be used for all floors except otherwise specified. Tiles shall be laid on a bed of cement-sand mortar of ratio not less than 1:6 and the mortar shall be covered with neat cement slurry and the joints of the tiles shall be kept perfectly tight and grouted with the cement of same colour as that of the matrix of the terrazzo tiles. Tiles shall be laid evenly and to the perfect level and shall be set between the walls of the room so as to cause minimum cutting of the full size tiles and where the tiles do not "Corner-out-even" the excess space area, joints pattern shall be continued throughout the floor.

Tiles shall be cured for a minimum of seven days after casting Terrazzo tiles shall be made of grey cement, white cement or a combination of two and to match sample for tiles available in the office of the Engineer. The joints shall not exceed 1/16 inch in any case and shall be rendered invisible as far as possible in colour with cement to match the tile colour. The joints shall be perfectly straight and shall meet perfectly with the lines of adjoining rooms. All terrazzo tiles shall be the product of reputable tile manufacturers and shall be cast and pressed Hydraulically in machines especially made for the manufacture of Terrazzo tiles. The machines used and method of manufacture shall be subject to the approval of the Engineer or his Representative. The minimum thickness of Terrazzo Matrix on top shall not be less than 1/2 inch thick in any part of the tiles. Tiles with Terrazzo Matrix less than the thickness stated above shall be rejected and the Contractor shall have to replace the tiles at his own cost and risk. Contractor shall, before bringing the tiles ensure that these conform to the specifications with regard to their colour and size of Marble Chips. All rejected tiles shall be immediately removed by the Contractor from the site. All Terrazzo tiles shall be wax polished before acceptance.

b) Chequerred Tiles:

Chequerred Terrazzo tiles for staircase and other specified locations shall be made to the same specifications as terrazzo tiles as specified in this Section. The exposed edges of Terrazzo tiles on steps shall have a Terrazzo Matrix on one edge of the tiles. The exposed edge shall project 1" from the finished face of the riser as shown on the drawing. Chequerred tiles shall be subject to the approval of the Engineer or his Representative. The tiles shall be 1" thick and the Terrazzo Matrix shall not be less than 1/2 inch.

c) Polishing & Finishing:
Complete curing, initial grinding or cutting and finishing of the tiles shall be done prior to the delivery on the site. All Terrazzo floor tiles shall remain in place after setting for not less than 1 (one) week unless otherwise approved. Final grinding, cleaning and polishing shall be done to the best standard and upto the satisfaction of the Engineer or his Representative.

d) Curing:
All Terrazzo floors and finishes shall be cured for a minimum of 7 days after laying by means of wet bags or sand or other approved methods.

e) Defects in Tiles and Tile laying:
The surface of all tiled floors shall be perfectly as per level and grade as shown in drawings or as directed and shall be executed by experienced workers in the field of Tile laying. A sample Panel of laid Tiles of each type shall be got approved by the Engineer or his Representative before commencement of the laying. All chipped or damage tiles installed by the Contractor shall be rejected and shall have to be replaced by the Contractor at his own cost and risk.

f) Wall Bases: (Skirting)
Wall bases where specified in all areas with Terrazzo shall be as shown on drawings. All wall bases shall be made with cast-in-situ Terrazzo and the colour and size of marble chips used shall be such as to match with the terrazzo tile floors in each room or area. The minimum thickness of Terrazzo Matrix shall not be less than 1/2" thick. The height of wall bases shall be as shown on the finish schedule and the relevant drawings. The surface shall be perfectly smooth and polished to a high degree of finish. The top edge of wall base shall be perfectly straight. Sample of each type of wall bases shall have to be approved by the Engineer or his Representative before commencement of work of wall bases by the Contractor. All applicable Specifications pertaining to Terrazzo cast-in-situ as laid in this Section shall be applicable for cast-in-situ wall bases. All tiles shall be laid before the work of wall bases is started and no cast-in-situ Terrazzo of wall bases shall be allowed on the flooring to overcome defect in tile laying.

12.07 **Glazed Ceramic Tiles:**
Glazed tiles will be of size 6 inch x 6 inch or as directed by the Engineer and of best quality of local manufacturer white/colored shall be supplied by the Contractor. All sanitary and water supply pipes shall be in place before start of glazed tiles work.

The walls and floors on which the glazed tiles are required to be fixed shall be plastered with 1:4 cement mortar 1/2"-3/4" thick as base for the tiles and surface shall be thoroughly roughened. Before starting to fix the tiles the plaster shall be thoroughly wetted and cement slurry spread on the surface. Neat cement mixed with water in the form of thick paste shall be uniformly applied on the tiles-back and the tiles pressed on the wall so as to spread the cement paste uniformly under the tiles. The squeezed out slurry shall be wiped out of the edges. The tiles shall be laid course after course starting from bottom. No joint shall be more than 1/16" and all joints shall be uniform and continuous. The slurry shall be gently raked out from the joints when it is green. White or coloured cement of the same shade as tiles shall be applied in the raked out joint and finished slightly sunk with the tiles surfaces.

12.08 **Marble Tiles in Flooring, Skirting, Dado and Steps**

a. Material
Marble for use on the building shall be selected first quality marbles of type and colour as specified by the Engineer or his Representative marble shall be the best quality China Verona marble free from discolorations.

Anchors and Cramps shall be made of non-ferrous metal as detailed on the drawings and specified and directed.

Cement shall be white Portland cement meeting with the requisite British Standard Specifications.

Coloured marble shall be other than dark Green onyx marble.

Green Onyx: Where specified best quality of dark green marble shall be used meeting with the approval of the Engineer.

b. Samples:

Samples of all types of marble for various areas shall be got approved by the Engineer or his Representative. Contractor shall have to match the marble brought to site as close to the approved samples as possible. The Engineer or his Representative has the right to reject marble pieces, which have unduly dark patches, or large unsightly veins which do not conform to the overall pattern and effect on the marble wall. Contractor shall also construct a Panel for each of the marble areas for the approval of the Engineer or his Representative before commencement of work. Engineer's discretion with regard to quality of marble shall be final and binding on the contractor.

c. Workmanship:

The size of marble slabs and the jointing pattern shall be as shown on the drawings or as directed by the Engineer or his Representative. Joints between the marble slabs shall be filled smooth with white cement paste of the required shade of the marble slabs. The marble slabs before being laid shall be machine cut, dressed smooth and mirror polished and shall be free from cracks or any other discolorations, which in the opinion of the Engineer or his Representative is objectionable. All such defective and rejected marble slabs shall have to be replaced by the Contractor at his own cost and risk. The thickness of marble slabs shall be as specified.

d. Selection of Marble:

The marble slabs shall be selected by the Contractor in the factory before these are brought to site for installation purposes which match the samples in the office of the Engineer. Marble pieces which do not meet with the approval of the Engineer or his Representative shall be removed and replaced by the Contractor at his own cost and risk, whether they have been installed or not.

e. Installation:

Marble for floors, walls, shall be laid on a bed of mortar by workmen specialized in the marble work. All floors shall be perfectly level and joints rigidly conforming to the joint pattern. Any leveling of concrete floor or filling in of low spots by mortar for levelling shall be done by the Contractor at no extra cost to the owner. Wherever slope for drainage purposes is required the bed shall be pitched to slope. Marble slabs in walls and columns shall be properly anchored to the wall or column as well as between the slabs themselves by means of anchors and cramps as detailed on the drawings or as directed. Non-ferrous metal anchors and cramps shall be used. Anchors shall be rigidly bolted to the wall.

f. Even Panels:

In each surface marble panels both horizontally and vertically shall be so divided that the sizes of all panels are equal. The sizes of panels in the pattern shown on drawings may be adjusted in each room with the approval of the Engineer or his Representative in order to have all equal sized panels of marble.

Before cutting the marble pieces for each space the Contractor shall take actual physical measurements of the constructed portion so that even sized marble panels can be fitted at all places. Unequal panel sizes shall not be acceptable and shall be replaced at the cost of the Contractor. Joints between marble panels shall not be more that 1/16" and shall be filled in with white cement slurry as specified.

g. Kitchen Cabinet Tops:

Specially selected marble slab shall be used for counter tops as specified and directed. These marble slabs shall first be approved by the Engineer or his Representative before actual cutting and installation of marble slabs is undertaken. Counter tops upto 3'- 0" length shall be one piece marble slabs and for over 3'-0" long counters two marble pieces shall be used to obtain the required length of the counter. The cutting of holes in slab for sink and water taps where required shall be accurately done according to the actual size of sink and piping. The Contractor shall coordinate this work with the sanitary contractor. Marble slabs wherever indicated to be installed shall be mirror polished and finished before installation duly cut to the required size.

h. Finishing and Polishing:

All marble before being laid in the final position shall be finished and polished to a high degree of mirror finish by means of machine grinders in the factory. Where machine grinders cannot be used grinding and polishing by hand may be permitted by the Engineer or his Representative. All polished surfaces shall meet the approval of the Engineer or his Representative before acceptance.

12.09 **Cement Concrete Flooring:**

The materials for C.C. flooring shall be the same as already specified under other clauses of these specifications.

a. Composition of Concrete

Concrete shall be composed of Portland cement, sand, coarse aggregate and water, all well mixed and brought to the proper consistency. The Contractor shall mix the ingredients as shown on the drawings or as specified. The proportions of the various ingredients shall be determined from time to time during the progress of the work and tests shall be made of samples of the aggregates and the resulting concrete. The mix proportions and appropriate water cement ratio shall be determined on the basis of the production of concrete having required workability, density, impermeability, durability and required strength.

b. Mixing Concrete

The concrete ingredients shall be mixed in batch mixer for not less than 1 1/2 minutes after all ingredients, except the full amount of water, are in the mixer. The Engineer reserves the right to increase the mixing time when the charging and mixing operations fail to produce a concrete batch in which the ingredients are not uniformly distributed and the consistency is not uniform. The concrete shall be uniform in composition or consistency from batch to batch except when changes in composition or consistency are required. Water shall be added prior to, during and following the mixer charging operations. Excessive over-mixing requiring the addition of water to preserve the required concrete consistency shall not be permitted. The concrete ingredients shall be mixed by volume in boxes made for this purpose and approved by the Engineer.

c. Construction

The base course of the floor shall comprise of stone in case of Car park garages and road pavement. The base course shall be thoroughly compacted by suitable power rammers to the total consolidated thickness as shown on the drawings and as approved by the Engineer. The interstices shall be filled with smaller size stones screened material with finer particles. The base course shall be blinded with sand and the whole surface watered. Over the well

compacted base course, a layer of 1:2:4 concrete of the required class and thickness shall be laid in panels of the sizes as indicated on the drawings and as approved by the Engineer.

At places other than mentioned above, base course of required thickness and class of concrete shall be laid over a sub-grade compacted to 95% AASHTO density.

After the C.C. bed has been cured, as directed by the Engineer, it shall be roughened and well-watered before floor finishing is laid. The floor finish shall comprise of cement concrete 1:2:4 nominal mix or of such proportion as specified or directed by the Engineer and of the required thickness shall be laid in alternate panels with butt joints to the required thickness as shown on the drawings and/or as directed by the Engineer. The concrete after laying will be thoroughly rammed and mortar worked up to the top and smoothed with a steel trowel. The edge of each section into which the floor is divided should be defined by wooden screeds of the approved width and of a depth equal to the depth of floor concrete.

Freshly placed concrete floor portions as finished shall be protected to prevent loss of water by covering with damp hessian, waterproof paper, or other approved material, and shall be kept constantly damp for a period of 10 days or longer after concreting, as directed by the Engineer. The concrete shall be allowed to dry out slowly over a period of a few days after wet curing is completed.

12.10 **Measurement and Payment:**

All the items of work covered by this Section of the Specifications shall be measured by the Standard Method of measurements. The quantity of flooring will be ascertained by measuring length and breadth of actual area laid deducting any section of columns and other structures penetrating throughout the floor and shall be paid for at the individual item rates entered in the Bill of Quantities and in accordance with the applicable terms and conditions of the Contract.

PUBLIC PROCUREMENT REGULATORY AUTHORITY (PPRA) EPADS

SECTION - 13

13.0 PAINTING

13.01 SCOPE OF WORK:

The work covered by this section of the specifications consists of furnishing all materials, plant, labour, equipment, appliances and performing all operations in connection with surface preparation, mixing, painting concrete works, gates, frames steel works, steel and wooden doors, windows, ventilators, walls ceilings and all such surfaces as shown on the Drawings and/or as directed by the Engineer. The scope of this section of specifications is covered with detailed specifications as laid down herein.

13.02 GENERAL:

Except as otherwise specified, all painting shall be applied in conformity with BS CP 231 "Painting of Building as applicable to the work".

The Contractor shall repair at his own expense all damaged or defective areas of shop-painted metal work. Metal surfaces against which concrete is to be placed will be furnished shop-painted and shall be cleaned prior to being embedded in concrete.

Except as otherwise specified, all concrete and plastered surfaces are to be painted.

13.03 MATERIALS:

All materials shall be acceptable, proven, top-grade products and shall meet or exceed the minimum standards of reputable manufacturers as approved by the Engineer.

Colors shall be pure, non-fading pigments, mildew-proof, sun-proof, finely ground in approved medium. Colors used on plaster and concrete surfaces shall be lime-proof. All materials shall be subject to Engineer's approval.

All enamel paints and primers for wood and metal work will be the best available of its type and shall be approved by the Engineer prior to its procurement.

Unslaked lime, gum and marine blue shall be used for white washing.

DUROCEM a cement base heavy duty water proof coating manufactured by ICI or any equivalent approved by the Engineer shall be used for painting on the surface specified. The cement base water proof coating for concrete shall conform to ASTM C-109,C-67, D-822 and G-23.

All materials shall be delivered to site in their original unbroken containers or packages and bear the manufacturer's name, label, brand and formula and shall be mixed and applied in accordance with his directions.

13.04 SURFACE PREPARATION:

All oil, grease, dirt, dust, loose mill, scale and any other foreign substance shall be removed from the surface to be painted, polished and white washed by the use of a solvent and clean wiping material. Following the solvent cleaning, the surfaces shall be cleaned by scraping, chipping, blasting, wire brushing or other effective means as approved by the Engineer.

In the event the surface becomes otherwise contaminated in the interval between cleaning and painting, recleaning will be done by the Contractor at no additional cost.

Surfaces of stainless steel, aluminium, bronze and machined surfaces adjacent to metal work being cleaned or painted shall be protected by effective masking or other suitable means, during the cleaning and painting operations.

No work in this Section shall be allowed until all surfaces or conditions have been inspected and approved by the Engineer.

13.05 **APPLICATION:**

All paint and coating materials shall be in a thoroughly mixed condition at the time of application. All work shall be done in a workmanlike manner, leaving the finished surface free from drips, ridges, waves, laps and brush marks. All paints shall be applied under dry and dust free conditions. Unless approved by the Engineer paint shall not be applied when the temperature of the surrounding air is below 10 Deg.C. Surfaces shall be free from moisture at the time of painting.

All primary paint shall be applied by brushing. The first coat of paint shall be applied immediately after cleaning. When paint is applied by spraying, suitable measures shall be taken to prevent segregation of the paint in the container during painting operations.

Effective means shall be adopted for removing all free oil and moisture from the air supply lines of the spraying equipment.

Each coat of paint shall be allowed to dry or harden thoroughly before the succeeding coat is applied. Surfaces to be painted that will be inaccessible after installation shall be completely painted prior to installation shall be completely painted prior to installation.

Only as much material should be mixed as can be used up in one hour. Over-thinning will not be permitted. After the first coat, the surfaces will be soaked evenly four or five times and the second coat shall be applied after leaving for at least overnight.

All steel doors, windows and ventilators shall be painted with two coats of approved enamel paint over one coat of a redoxide primer as directed by the Engineer.

Oil bound distemper shall be applied to internal wall surfaces and white wash on ceilings as specified herein after.

For applying Durocem the surface shall be dampened with clean water immediately ahead of application. Durocem and clean water shall be mixed as per directions of the manufacturer. A heavy first coat at 20 lbs/100 sft (1 kg per sq.m) shall be applied. This shall be followed by a second brush coat at 10 lbs/100 sft (0.5 kg per sq.m) after the first coat has set. When finish coat has set, it shall be floated to uniform texture with a sponge float. The work shall include cleaning the surface, sand papering and smooth finishing, scaffolding, curing etc. complete as per the approval of the Engineer.

13.06 **WHITE AND COLOUR WASHING:**

The surfaces shall be well cleaned and brushed before white washing. The white washing material shall be prepared from un-slaked lime. The lime shall be dissolved in a tub with sufficient quantity of water and then well mixed and strained through a clean cloth. 4 kg clean gum boiled with 12 kg of rice for each cu.m of lime shall be added to the liquid lime along with a small quantity of marine blue as directed by the Engineer.

The mixture shall be in thoroughly mixed condition and shall be applied in three coats with a brush.

Each coat of white wash shall be allowed to dry, so that no sign of cracking shall appear on the surface and also white wash shall not come off readily on fingers when rubbed. The white wash when completed, shall form an opaque coat of uniform white colour, through which the old work does not

show and shall present a smooth regular surface free from Powderly matter. For colour washing approved quality of coloring matter shall be added to the liquid and thoroughly mixed by stirring.

13.07 **DISTEMPERING:**

Oil bound distemper of approved quality and shade shall be applied on internal wall surfaces where shown in drawing or directed by the Engineer.

13.08 **EXECUTIONS:**

13.09 **SUBMITTALS**

Colour samples shall be submitted on 6"x6" (150x150 mm) asbestos cement boards, showing each type of paint for Engineer's approval.

13.10 **PRODUCT DELIVERY**

Deliver materials in manufacturer's original unopened containers with labels intact and legible identifying brand names and contents.

13.11 **JOB CONDITION**

Observe manufacturer's recommended minimum and maximum temperature but do not apply paint or finish to any surface unless ambient temperature is 10 deg.C or above and less than 43 deg.C. No painting shall be done above 90% relative humidity.

Place drop cloths to adequately protect all finished work.

Remove and replace all items of finished hardware, device plates, accessories, including fixtures or other removable items.

The surface shall be prepared first before applying distemper by filling depressions with putty, rubbing, sand papering and cleaning. A priming coat shall first be applied of petrifying liquid of approved manufacture. Distemper shall be applied with broad stiff brush of approved make. Distemper shall be applied quickly and boldly. Each coat of distemper should first be got approved by the Engineer before applying the next coat.

13.12 **MEASUREMENT AND PAYMENT**:

Measurement of the work acceptably completed and specified herein as painting, distempering, and white/colour washing etc. will be made on the basis of actual area in square feet of the respective job including all preparatory work like scraping, scratching, sand papering, filling depressions with putty, priming and scaffolding etc. complete in all respect as directed by the Engineer. Payment under covered in this section shall be made as per unit rates entered in the BOQ. No payment shall be made for painting work on doors, windows, ventilators, steel grills, cabinets and cup boards steel ladders etc. for which the contractor shall make necessary allowance in his rates for such items.

Contractor's Representative and Key Personnel

MINIMUM MANDATORY STAFF: The Contractor shall arrange all requisite resources for timely completion of project as per provisions given in the Bidding Documents.

Following is the list of Minimum Mandatory Staff Requirement & Equipment to be deployed at site by the Contractor as and when required by the Engineer till completion of the Project. In case Contractor fails to deploy any of the following personnel, the Engineer will deduct the amount mentioned at column (E) for the respective personnel. However, the deduction of the amount does not relieve the Contractor to deploy the minimum staff at site and shall not prejudice Engineer / Employer from any other remedy defined in the Contract.

Designation	***Nos.***	***Minimum Qualification***	***Min. Relevant Working Experience***	***Minimum Amount to be deducted per month per person in case the personnel is not deployed at site (Rs.)***
(A)	***(B)***	***(C)***	***(D)***	***(E)***
Engineer (Electrical)	01	B.E/ BSC (Registered with PEC)	03 years	250,000/-
Site Supervisors (Electrical)	01	DAE Electrical/ B-Tech	08 years	120,000/-

Authorized Signature and official Seal: _____

Name: _____

Date: _____

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