HOME DEPARTMENT
GOVERNMENT OF SINDH

ESTABLISHMENT OF
FORENSIC SCIENCE LABORATORY IN SINDH AT KARACHI

CONSTRUCTION OF RECEPTION & EVIDENCE COLLECTION BLOCKS
(ARCHITECTURAL FINISHES & MEP WORKS ONLY)

BIDDING & CONTRACT DOCUMENTS

VOLUME - I

INVITATION FOR BIDS
INSTRUCTIONS TO BIDDERS & BIDDING DATA
SCHEDULES TO BID
BILL OF QUANTITIES
CONDITIONS OF CONTRACT
STANDARD FORMS

APRIL 2023

National Engineering Services Pakistan (Pvt.) Ltd.
A&P DIVISION
Karachi.

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National Engineering Services Pakistan Ltd. A&P DIVISION Karachi.

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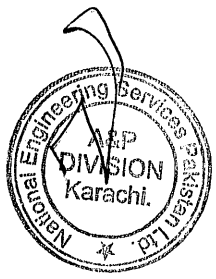
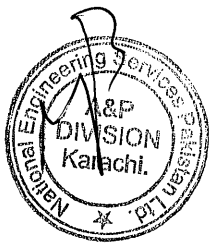
National Engineering Services Pakistan Ltd. A&P DIVISION Karachi.

NOTICE INVITING TENDER



NOTICE INVITING TENDER

Construction of Reception & Evidence Blocks (Architectural & MEP Works Only)



No/SFSL/(HD)/Recp & Evidence Blk Finishing tender/2022-23

GOVERNMENT OF SINDH
PROJECT IMPLEMENTATION UNIT
ESTABLISHMENT OF SINDH FORENSIC LABORATORY
HOME DEPARTMENT

Karachi dated, 13th April, 2023

M/s Yawar Builders,
Office # 240, 2nd Floor,
Glass Tower, Teen Talwarm Clifton. Karachi
Tel: +92-300-2001211

ESTABLISHMENT OF SINDH FORENSIC SCIENCE LABORATORY AT KARACHI
CONSTRUCTION OF RECEPTION & EVIDENCE COLLECTION BLOCKS
(ARCHITECTURAL FINISHES & MEP WORKS ONLY)

- Letter Inviting Bid

Project Director Sindh Forensic Science Laboratory, Karachi is pleased to invite bids from prequalified bidders.

You are requested to submit the bid as per following guidelines.

1. The Bidding documents can be obtained from the office of **Project Implementation Unit Office – Sindh Forensic Science Laboratory, Mezzanine Floor, Fayaz Centre, Shah re Faisal, Karachi, Phone No. 021-99211415** from **April 14, 2023** on submission of pay Order/ cash in favour of Project Director, Sindh Forensic Science Laboratory for Rs. 20,000/= (Rupees Twenty Thousand only) per set non refundable.

2. Bidding Documents and Bidding Drawings including all addendum and corrigendum (if any) duly filled in, signed and enclosed in a sealed envelope addressed to **Project Director, Sindh Forensic Science Laboratory, Office no. 314, Planning & Development Department, 2nd Floor, Tughlaq House, Sindh Secretariat Karachi, Phone No. 021-99211926** be submitted on **May 2, 2023 on or before 11:30 am** and will be opened on same date i.e. **May 02, 2023 at 12:00 Noon** in the presence of those bidders who wish to attend.

4. Bid must be accompanied with Bid Security in the form of Pay Order/ Bank Draft from a Scheduled Bank of Pakistan in favour of Project Director, Sindh Forensic Science Laboratory, Karachi, for 2% of Bid amount. Bid Security shall be submitted separately in a sealed envelop along with the Bid.

5. The bidders are advised to study the instructions to Bidders, Conditions of Contract, and Bidding Drawings and strictly comply with the stipulated instructions and conditions in submitting their bid.

6. Bidders should note that incomplete bids and bids without the requisite amount of earnest money in the prescribed form shall not be entertained.

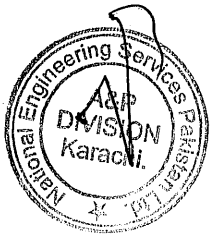
7. The procuring agency will reject outright any bid containing stipulations and conditions of any kind and nature not complying with the provisions of the Bidding Documents and if found any other procedural flaw(s) as per SPP Rule 41(7) under SPPRA Rules 2010 (Amended up to date).

8. The Procuring Agency is not bound to accept any or the lowest bid and may cancel the procurement process at any time prior to the acceptance under SPP Rule 25 of SPPRA Rules 2010 (Amended up to date).

PROJECT DIRECTOR
Sindh Forensic Science Laboratory at Karachi
Office no. 314 , P&D Department, 2nd Floor, Tughlaq House, Sindh Secretariat Karachi,
Phone No. 021-99211926

Copy for Information to:
1. The PS to Secretary, Home Department, Government of Sindh
2. Office Copy

INSTRUCTIONS TO BIDDERS



INSTRUCTIONS TO BIDDERS

(Note: These Instructions to Bidders along with Bidding Data will not be part of the Contract and will cease to have effect once the contract is signed.)

A. GENERAL

IB.1 Scope of Bid

1.1 The Procuring Agency as defined in the Bidding Data hereinafter called "the Procuring Agency" wishes to receive bids for the construction and completion of works as described in these Bidding Documents, and summarized in the Bidding Data hereinafter referred to as the "Works".

1.2 The successful bidder will be expected to complete the Works within the time specified in Appendix-A to Bid.

IB.2 Source of Funds

2.1 The Procuring Agency has received a grant from the source(s) indicated in the bidding data towards the cost of the project /scheme specified in the bidding data, and it is intended that part of the proceeds of this grant/funds will be applied to eligible payments under the Contract for which these Bidding Documents are issued.

IB.3 Eligible Bidders

3.1 This Invitation for Bids is open to all interested bidders who are eligible under provision of Sindh Public Procurement Rules as mentioned below and the Criteria given in the Notice Inviting Tender / Bidding.

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

a) Bidders may be excluded if;

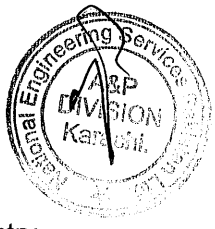
(i) as a matter of law or official regulations, commercial relations are prohibited with the bidder's country by the federal government in case of ICB, or

(ii) a firm is blacklisted/ debarred by the procuring agency and the matter has been reported to the Authority, subject to Rule 30 of Sindh Public Procurement Rules 2010.

b) Government-owned enterprises or institutions may participate only if they can establish that they are:

(i) legally and financially autonomous, and

(ii) operate under commercial law.



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

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

IB.4 One Bid per Bidder

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

IB.5 Cost of Bidding

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

IB.6 Site Visit

6.1 The bidders are advised to visit and examine the Site of Works and its surroundings and obtain for themselves on their own responsibility all information that may be necessary for preparing the bid and entering into a contract for construction of the Works. All cost in this respect shall be at the bidder's own expense.

6.2 The bidders and any of their personnel or agents will be granted permission by the Procuring Agency to enter upon his premises and lands for the purpose of such inspection, but only upon the express condition that the bidders, their personnel and agents, will release and indemnify the Procuring Agency, his personnel and agents from and against all liability in respect thereof and will be responsible for death or personal injury, loss of or damage to property and any other loss, damage, costs and expenses incurred as a result of such inspection.

B. BIDDING DOCUMENTS

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

7.1 The Bidding Documents, in addition to invitation for bids, are those stated below and should be read in conjunction with any Addenda issued in accordance with Clause IB.9:

a. Instructions to Bidders
b. Bidding Data.
c. General Conditions of Contract, Part-I (GCC).
d. Special Conditions of Contract, Part-II (SCC).
e. Specifications.
f. Form of Bid & Appendices to Bid.
g. Bill of Quantities (Appendix-D to Bid).
h. Form of Bid Security
i. Form of Contract Agreement
j. Forms of Performance Security, Mobilization Advance Guarantee, Integrity Pact and Indenture Bond for Secured Advance
k. Drawings.

National Engineering Services Pakistan (Pvt.) Ltd. A&P DIVISION Karachi.

7.2 The bidders are expected to examine carefully the contents of all the above documents. Failure to comply with the requirements of bid submission will be at the Bidder's own risk. Pursuant to Clause IB.26, bids which are not substantially responsive to the requirements of the Bidding Documents will be rejected.

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

8.1 Any interested bidder requiring any clarification (s) in respect of the Bidding Documents may notify the Procuring Agency in writing at the Procuring Agency's address indicated in the Invitation for Bids/NIT and no. of days before Pre-Bid meeting as indicated in Bidding Data. The Procuring Agency will respond to any request for clarification provided they are received at least five calendar days prior to the date of opening of bids.

Provided that any clarification in response to query by any bidder; shall be communicated to all parties who have obtained bidding documents, but without identifying its source.

IB.9 Amendment of Bidding Documents

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

9.2 Any addendum thus issued shall be part of the Bidding Documents pursuant to Sub-Clause 7.1 hereof and shall be communicated in writing to all the bidders. Interested bidders shall acknowledge receipt of each addendum in writing to the Procuring Agency.

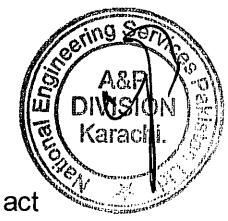
9.3 To afford bidders reasonable time in which to take an addendum into account in preparing their bids, the Procuring Agency may extend the deadline for submission of bids in accordance with Clause IB.20

C. PREPARATION OF BIDS

IB.10 Language of Bid

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

IB.11 Documents Accompanying the Bid



11.1 All bidders shall:

(a) submit a written power of attorney authorizing the signatory of the bid to act for and on behalf of the bidder;

(b) updated information as indicated/ or listed in Bidding Data & previously submitted along with the application for prequalification (if applicable), in order to continue meeting with the minimum criteria set out in the prequalification documents.

(c) Furnish & submit their updated Company Profile taking into account the various Appendices to Bid specially the following:

Appendix-E to Bid	Proposed Construction Schedule
Appendix-F to Bid	Method of Performing the Work
Appendix-G to Bid	List of Major Equipment
Appendix-K to Bid	Organization Chart for Supervisory Staff and

other pertinent information such as mobilization program etc;

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

(a) one of the joint venture partners shall be nominated as being in charge; and this authorization shall be evidenced by submitting a power of attorney signed by legally authorized signatories of all the joint venture partners;

(b) the bid and in case of a successful bid, the Form of Contract Agreement shall be signed so as to be legally binding on all partners;

(c) the partner-in-charge shall always be duly authorized to deal with the Procuring Agency regarding all matters related with and/or incidental to the execution of Works as per the terms and Conditions of Contract and in this regard to incur any and all liabilities, receive instructions, give binding undertakings and receive payments on behalf of the joint venture;

(d) all partners of the joint venture shall at all times and under all circumstances be liable jointly and severally for the execution of the Contract in accordance with the Contract terms and a statement to this effect shall be included in the authorization mentioned under Sub-Para (a) above as well as in the Form of Bid and in the Form of Contract Agreement (in case of a successful bid); and

(e) a copy of the agreement entered into by the joint venture partners shall be submitted with the bid stating the conditions under which it will function, its period of duration, the persons authorized to represent and obligate it and which persons will be directly responsible for due performance of the Contract and can give valid receipts on behalf of the joint venture, the proportionate participation of the several firms forming the joint venture, and any other information necessary to permit a full appraisal of its functioning. No amendments / modifications whatsoever in the joint venture agreement shall be agreed to between the joint venture partners without prior written consent of the Procuring Agency.

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

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

IB.12 Bid Prices

12.1 Unless stated otherwise in the Bidding Documents, the Contract shall be for the whole of the Works as described in Sub-Clause 1.1 hereof, based on the unit rates and / or prices submitted by the bidder or percentage quoted above or below on the rates of Composite Schedule of Rates (CSR), as the case may be.

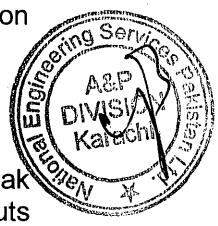
12.2 The bidders shall fill in rates and prices for all items of the works described in the Bill of Quantities. Items against which no rate or price is entered by a bidder will not be paid for by the Procuring Agency when executed and shall be deemed covered by rates and prices for other items in the Bill of Quantities. In case of Composite Schedule of Rates, if the bidder fails to mention the percentage above or below, it shall be deemed to be at par with the rates of Composite Schedule of Rates.

12.3 Bidders are required to submit, Rate Analysis of all the major items of works described in the Bill of Quantities. All government taxes including GST should also be mentioned & highlighted separately in Rate Analysis.

12.4 The bid price submitted by the contractor shall include all rates and prices including taxes. All duties, taxes and other levies payable by the contractor under the contract, or for any other cause during the currency of the execution of the work or otherwise specified in the contract as on the date seven days prior to the deadline for submission of bids.

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

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



IB.13 Currencies of Bid and Payment

13.1 The unit rates and the prices shall be quoted by the bidder entirely in Pak rupees. A bidder expecting to incur expenditures in other currencies for inputs to the Works supplied from outside the Procuring Agency's country (referred to as the "Foreign Currency Requirements") shall indicate the same in Appendix-B to Bid. The proportion of the Bid Price (excluding Provisional Sums) needed by him for the payment of such Foreign Currency Requirements either (i) entirely in the currency of the Bidder's home country or, (ii) at the bidder's option, entirely in Pak rupees provided always that a bidder expecting to incur expenditures in a currency or currencies other than those stated in (i) and (ii) above for a portion of the foreign currency requirements, and wishing to be paid accordingly, shall indicate the respective portions in the bid.

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

IB.14 Bid Validity

14.1 Bids shall remain valid for the period stipulated in the Bidding Data after the Date of Bid Opening specified in Clause IB.23.

14.2 In exceptional circumstances, prior to expiry of the original bid validity period, the Procuring Agency may request that the bidders extend the period of validity for a specified additional period which shall in no case be more than the original bid validity period. The request and the responses thereto shall be made in writing. A bidder may refuse the request without forfeiting his Bid Security. A bidder agreeing to the request will not be required or permitted to modify his bid, but will be required to extend the validity of his Bid Security for the period of the extension, and in compliance with Clause IB.15 in all respects.

IB.15 Bid Security

15.1 Each bidder shall furnish, as part of his bid, a Bid Security in the amount stipulated in the Bidding Data in Pak Rupees or an equivalent amount in a freely convertible currency.

15.2 The Bid Security shall be, at the option of the bidder, in the form of Pay Order, Demand Draft, Deposit at Call or a Bank Guarantee issued by a Scheduled Bank in Pakistan or from a foreign bank duly counter guaranteed by a Scheduled Bank in Pakistan in favour of the Procuring Agency which should commensurate with the bid validity period. The bank guarantee for bid security shall be acceptable in the manner as provided at Annexure BS-1.

15.3 Any bid not accompanied by an acceptable Bid Security shall be rejected by the Procuring Agency as non-responsive.

15.4 Bid security shall be released to the unsuccessful bidders once the contract has been signed with the successful bidder or the validity period has expired.

15.5 The Bid Security of the successful bidder will be returned when the bidder has furnished the required Performance Security and signed the Contract Agreement.

15.6 The Bid Security may be forfeited:

(a) if the bidder withdraws his bid except as provided in Sub-Clause 22.1;

(b) if the bidder does not accept the correction of his Bid Price pursuant to Sub- Clause 27.2 hereof; or

(c) In the case of successful bidder, if he fails within the specified time limit to:

(i) furnish the required Performance Security; or
(ii) sign the Contract Agreement.

IB.16 Alternate Proposals by Bidder

16.1 Each bidder shall submit only one bid either by himself, or as a member of a joint venture, until and unless they have been requested or permitted for alternative bid, then he has to purchase separate bidding documents and alternate bid shall be treated as separate bid.

16.2 Alternate proposals are allowed only for procurement of works where technical complexity is involved and more than one designs or technical solutions are being offered. Two stage two envelope bidding procedure will be appropriate when alternate proposal is required.

16.3 Alternate bid(s) shall contain (a) relevant design calculations; (b) technical specifications; (c) proposed construction methodology; and (d) any other relevant details / conditions, provided that the total sum entered on the Form of Bid shall be that which represents complete compliance with the bidding documents.

IB.17 Pre-Bid Meeting

17.1 The Procuring Agency may, on his own motion or at the request of any bidder(s), hold a pre-bid meeting to clarify issues and to answer any questions on matters related to the Bidding Documents. The date, time and venue of pre-bid meeting, if convened, shall be communicated to all bidders. All bidders or their authorized representatives shall be invited to attend such a pre-bid meeting at their own expense.

17.2 The bidders are requested to submit questions, if any, in writing so as to reach the Procuring Agency not later than three (03) days before the date of proposed pre-bid meeting.

17.3 Minutes of the pre-bid meeting, including the text of the questions raised and the replies given, will be transmitted without delay to all purchasers of the Bidding Documents. Any modification of the Bidding Documents listed in Sub-Clause 7.1 hereof which may become necessary as a result of the pre-bid meeting shall be made by the Procuring Agency exclusively through the issue of an Addendum pursuant to Clause IB.9 and not only through the minutes of the pre-bid meeting.

17.4 Absence at the pre-bid meeting will not be a cause for disqualification of a bidder.

IB.18 Format and Signing of Bid

18.1 Bidders are particularly directed that the amount entered on the Form of Bid shall be for performing the Contract strictly in accordance with the Bidding Documents.

18.2 All appendices to Bid are to be properly completed and signed.

18.3 Alteration is not to be made in the Form of Bid nor in the Appendices thereto except in filling up the blanks as directed. If any such alterations be made or if these instructions be not fully complied with, the bid may be rejected.

National Engineering Services Pakistan (Pvt.) Ltd. A&P DIVISION Karachi.

18.4 Each bidder shall prepare by filling out the forms without alterations and shall provide an original copy along with photocopies as per the requirement of the procuring agency specified in the bidding data. The original as well as copies of the document shall be clearly marked as "ORIGINAL" and "COPY", as the case may be. If there is any discrepancy between original and copy / copies then the original shall prevail.

18.5 The original and all copies of the bid shall be typed or written in indelible ink (in the case of copies, Photostats are also acceptable) and shall be signed by a person or persons duly authorized to sign on behalf of the bidder pursuant to Sub- Clause 11.1(a) hereof. All pages of the bid shall be initialed and stamped by the person or persons signing the bid.

18.6 The bid shall contain no alterations, omissions or additions, except to comply with instructions issued by the Procuring Agency, or as are necessary to correct errors made by the bidder. Such corrections shall be initialed by the person (s) signing the bid.

18.7 Bidders shall indicate in the space provided in the Form of Bid their full and proper addresses at which notices may be legally served on them and to which all correspondence in connection with their bids and the Contract is to be sent.

18.8 Bidders should retain a copy of the Bidding Documents as their file copy.

D. SUBMISSION OF BIDS

IB.19 Sealing and Marking of Bids

19.1 Each bidder shall submit his bid as under:

(a) ORIGINAL and __*copies of the Bid shall be separately sealed and put in separate envelopes and marked as such.

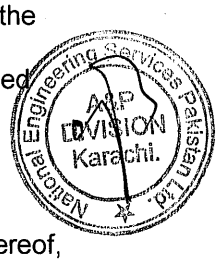
(b) The envelopes containing the ORIGINAL and COPIES shall be put in one sealed envelope and addressed as given in Sub- Clause 19.2 hereof.

19.2 The inner and outer envelopes shall:

(a) be addressed to the Procuring Agency at the address provided in the Bidding Data;

(b) bear the name and identification number of the contract as defined in the Bidding Data; and

(c) provide a warning not to open before the time and date for bid opening, as specified in the Bidding Data.



19.3 In addition to the identification required in Sub- Clause 19.2 hereof, the inner envelope shall indicate the name and address of the bidder to enable the bid to be returned unopened in case it is declared "late" pursuant to Clause IB.21

19.4 If the outer envelope is not sealed and marked as above, the Procuring Agency will assume no responsibility for the misplacement or premature opening of the Bid (Technical & Financial including all attachments)

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* Note: See Bidding Data

IB.20 Deadline for Submission of Bids

20.1 (a) Bids must be received by the Procuring Agency at the address specified no later than the time and date stipulated in the Bidding Data.

(b) Bids with charges payable will not be accepted, nor will arrangements be undertaken to collect the bids from any delivery point other than that specified above. Bidders shall bear all expenses incurred in the preparation and delivery of bids. No claims will be entertained for refund of such expenses.

(c) Where delivery of a bid is by mail and the bidder wishes to receive an acknowledgment of receipt of such bid, he shall make a request for such acknowledgment in a separate letter attached to but not included in the sealed bid package.

(d) Upon request, acknowledgment of receipt of bids will be provided to those making delivery in person or by messenger.

20.2 The Procuring Agency may, at his discretion, extend the deadline for submission of bids by issuing an amendment in accordance with Clause IB.9, in which case all rights and obligations of the Procuring Agency and the bidders previously subject to the original deadline will thereafter be subject to the deadline as extended.

IB.21 Late Bids

(a) Any bid received by the Procuring Agency after the deadline for submission of bids prescribed in Clause IB.20 will be returned unopened to such bidder.

(b) Delays in the mail, delays of person in transit, or delivery of a bid to the wrong office shall not be accepted as an excuse for failure to deliver a bid at the proper place and time. It shall be the bidder's responsibility to submit the bid in time.

IB.22 Modification, Substitution and Withdrawal of Bids

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

22.2 The modification, substitution, or notice for withdrawal of any bid shall be prepared, sealed, marked and delivered in accordance with the provisions of Clause IB.19 with the outer and inner envelopes additionally marked "MODIFICATION", "SUBSTITUTION" or "WITHDRAWAL" as appropriate.

22.3 No bid may be modified by a bidder after the deadline for submission of bids except in accordance with Sub-Clauses 22.1 and 27.2.

22.4 Withdrawal of a bid during the interval between the deadline for submission of bids and the expiration of the period of bid validity specified in the Form of Bid may result in forfeiture of the Bid Security in pursuance to Clause IB.15.

National Engineering Services Pakistan (Pvt.) Ltd. APP DIVISION Karachi.

E. BID OPENING AND EVALUATION

IB.23 Bid Opening

23.1 The Procuring Agency will open the bids, including withdrawals, substitution and modifications made pursuant to Clause IB.22, in the presence of bidders' representatives who choose to attend, at the time, date and location stipulated in the Bidding Data. The bidders or their representatives who are present shall sign an attendance sheet.

23.2 Envelopes marked "MODIFICATION", "SUBSTITUTION" or "WITHDRAWAL" shall be opened and read out first. Bids for which an acceptable notice of withdrawal has been submitted pursuant to Clause IB.22 shall not be opened.

23.3 Procuring agency shall read aloud the name of the bidder, total bid price and price of any alternate proposal(s), if any, discounts, bid modifications, substitution and withdrawals, the presence or absence of bid security, and such other details as the procuring agency may consider appropriate, and total amount of each bid, and of any alternative bids if they have been requested or permitted, shall be read aloud and recorded when opened.

23.4 Procuring Agency shall prepare minutes of the bid opening, including the information disclosed to those present in accordance with the sub-clause IB.23.3.

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

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

IB.25 Clarification of Bids (SPP Rule 43)

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

National Engineering Services Pakistan (Pvt.) Ltd. A&P DIVISION Karachi.

IB.26 Examination of Bids and Determination of Responsiveness

26.1 Prior to the detailed evaluation of bids, the procuring agency will determine whether the bidder fulfills all codal requirements of eligibility criteria given in bidding documents such as registration with tax authorities, registration with PEC (where applicable), turnover statement, experience statement, and any other condition mentioned in the NIT and bidding documents. If the bidder does not fulfill any of these conditions, it shall not be evaluated further.

26.2 Once found to be fulfilling the eligibility criteria, as mentioned in sub- clause 26.1, the bids of eligible bidders will be evaluated for technical responsiveness as per specification and criteria given in the bidding documents. Technical and financial evaluations may be carried out in accordance with single stage-single one envelope, single stage-two envelopes, two stage or two stage-two envelopes bidding procedures, depending on the selection procedure adopted by the procuring agency.

26.3 A bid will be considered technically responsive if it (i) has been properly signed; (ii) is accompanied by the required bid security; and (iii) conforms to all the terms, conditions and specifications of the bidding documents, without material deviation or reservation. A material deviation or reservation is one (i) which affect in any substantial way the scope, quality or performance of the works; (ii) which limits in any substantial way, inconsistent with the bidding documents, the procuring agency's rights or the bidder's obligations under the contract; or (iii) adoption/rectification whereof would affect unfairly the competitive position of other bidders presenting substantially responsive bids.

26.4 If a bid has major deviations to the commercial requirements and technical specifications will be considered technically non responsive. As a general rule, major deviations are those that if accepted, would not fulfill the purposes for which the bid is requested, or would prevent a fair comparison or affect the ranking of the bids that are compliant with the bidding documents.

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

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

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

National Engineering Services Pak. Ltd. Karachi.

(B) Minor Deviations

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

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

IB.27 Correction of Errors

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

(a) where there is a discrepancy between the amounts in figures and in words, the amount in words will govern; and

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

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

IB.28 Evaluation and Comparison of Bids

28.1 The Procuring Agency will evaluate and compare only the Bids determined to be substantially responsive in accordance with Clause IB.26.

28.2 In evaluating the Bids, the Procuring Agency will determine for each Bid the evaluated Bid Price by adjusting the Bid Price as follows:

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

National Engineering Services Pakistan (Pvt.) Ltd. DIVISION Karachi

28.3 The estimated effect of the price adjustment provisions of the Conditions of Contract, applied over the period of execution of the Contract, shall not be taken into account in bid evaluation.

28.4 If the bid of the successful bidder is seriously unbalanced in relation to the procuring agency's estimate of the cost of work to be performed under the contract, the procuring agency may require the bidder to produce detailed price analyses for any or all items of the Bill of Quantities to demonstrate the internal consistency of those prices with the construction methods and schedule proposed. After evaluation of the price analyses, the procuring agency may require that the amount of the Performance Security set forth in clause IB.32 be increased at the expense of the successful bidder to a level sufficient to protect the procuring agency against financial loss in the event of default of the successful bidder under the contract.

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

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

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

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

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

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

National Engineering Services Pakistan Ltd. AM DIVISION Karachi.

28.6 Evaluation Report (SPP Rule 45)

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

F. AWARD OF CONTRACT

IB.29 Award (SPP Rule 49)

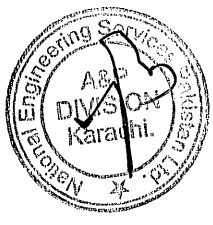
29.1 Subject to Clauses IB.30 and IB.34, the Procuring Agency shall award the Contract to the bidder whose bid has been determined to be substantially responsive to the Bidding Documents and who has offered the lowest evaluated Bid Price, but not necessarily the lowest submitted price, within the original or extended period of bid validity. Provided that such bidder has been determined to be eligible in accordance with the provisions of clause IB 03 and qualify pursuant to sub-clause IB 29.2.

29.2 The Procuring Agency, at any stage of the bid evaluation, having credible reasons for or *prima facie* evidence of any deficiency/ies in supplier's or contractor's capacities, may require the suppliers or contractors to provide information concerning their professional, technical, financial, legal or managerial competence whether already pre-qualified or not for the said project.

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

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

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



IB.31 Notification of Award (SPP Rule 25)

31.1 Prior to expiry of the period of bid validity, including extension, prescribed by the procuring agency, the procuring agency shall notify the successful bidder in writing ("Letter of Acceptance") that his bid has been accepted. This letter shall mention the sum which the procuring agency will pay to the contractor in consideration of the execution and completion of the works by the contractor as prescribed by the contract (hereinafter and in the conditions of contract called the "Contract Price").

31.2 No negotiation with the bidder having evaluated as lowest responsive or any other bidder shall be permitted, however, procuring agency may hold meetings to clarify any item in the bid evaluation report.

31.3 The notification of award and its acceptance by the bidder will constitute the formation of the contract, binding the procuring agency and the bidder till signing of the formal Contract Agreement.

31.4 Upon furnishing by the successful bidder of a Performance Security and signing of the contract, the procuring agency will promptly notify the name of the successful bidder to all bidders and return their bid securities accordingly.

31.5 Within seven days of the award of contract, procuring agency shall publish on the website of the Authority and on its own website, if such a website exists, the results of the bidding process, identify the bid through procurement identifying numbers, and the following information:
(1) Evaluation report;
(2) Form of Contract and letter of Award;
(3) Bill of Quantities or Schedule of Requirement.

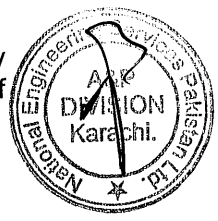
31.6 Debriefing (SPP Rule 51).

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

(b) The requesting bidder shall bear all the costs of attending such a debriefing.

31.7 Redressal of Grievances (SPP Rule 31)

A bidder may being aggrieved by the decision of the procuring agency regarding disqualification may seek relief through the mechanism of grievance redressal as provided under SPP Rule 31 (Refer SPP Rules 2010)



IB.32 Performance Security (SPP Rule 39)

32.1 The successful bidder shall furnish to the Procuring Agency a Performance Security in the form pay order or demand draft or bank guarantee, and the amount stipulated in the Bidding Data and the Conditions of Contract within a period of 14 days after the receipt of Letter of Acceptance.

32.2 Failure of the successful bidder to comply with the requirements of Sub-clause IB.32.1 or Clauses IB.33 or IB.35 shall constitute sufficient grounds for the annulment of the award and forfeiture of the Bid Security.

32.3 Validity of performance security shall extend at least ninety days beyond the date of completion of contract, or as mentioned in the bidding data to cover defects liability period or maintenance period subject to final acceptance by the procuring agency.

IB.33 Signing of Contract Agreement (SPP Rule 55)

33.1 Within 14 days from the date of furnishing of acceptable Performance Security under the Conditions of Contract, the Procuring Agency will send the successful bidder the Contract Agreement in the form provided in the Bidding Documents, incorporating all agreements between the parties.

33.2 The formal Agreement between the Procuring Agency and the successful bidder shall be executed within 14 days of receipt of Contract Agreement by successful bidder from the Procuring Agency.

33.3 A procurement contract shall come into force when the signatures of both the procuring agency and the successful bidder are affixed to the written Contract Agreement. Such affixing of signatures shall take place within the time specified in the Bidding Data.

Provided that the procuring agency may reduce the maximum time limit for signing of contract, as and when required, and shall be notified to successful bidder.

33.4 **Stamp Duty:**

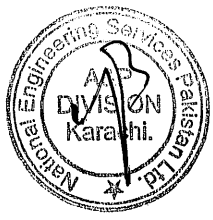
The formal Agreement between the Procuring Agency and the successful bidder shall be duly stamped at rate of 0.35% *of bid price (updated from time to time) stated in Letter of Acceptance

IB.34 General Performance of the Bidders

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

IB.35 Integrity Pact (SPP Rule 89)

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



IB.36 Instructions not Part of Contract

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

IB.37 Arbitration (SPP Rule 34)

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

BIDDING DATA

BD-1

Bidding Data

1.1 Name and Address of the Procuring Agency:

The Project Director,
Sindh Forensic Science Laboratory, Karachi
P&D Department
2nd Floor, Tughluq House, Sindh Secretariat, Karachi
Tel: +92 21 99211415

1.1 Name of the Project & Summary of the Works:

Establishment of Sindh Forensic Science Laboratory in Sindh at Karachi

Construction of Reception & Evidence Blocks

Complete Architectural, Mechanical, Electrical & Plumbing works as described in the drawings and Bill of Quantities in detail.

2.1 Name of the Borrower/Source of Financing/Funding Agency:

ADP Scheme No. 1225/2022-23

2.1 Amount and type of financing: Not Applicable

3.1 Eligible Bidders

This Invitation for Bids is open to only bidders already prequalified in prequalification process earlier.

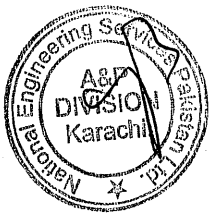
7.1 The Bidding Documents, in addition to invitation for bids, are those stated below and should be read in conjunction with any Addenda issued in accordance with Clause IB.9:

1) Volume-I : Bidding & Contract Documents

- Instructions to Bidders & Bidding Data.
- Appendices to Bid [App A to K].
- Form of Bid & Appendix-D to Bid
- Bill of Quantities
- Sample Forms:
  - Bid Security (Bank Guarantee)
  - Performance Security (Bank Guarantee)
  - Contract Agreement
  - Mobilization Advance Guarantee/Bond
  - Indenture Bond for Secured Advance
- General Conditions of Contract, Part-I (GCC).
- Particular Conditions of Contract, Part-II (PCC).

2) Volume-II : Specifications – Special & Technical Provisions.

3) Volume-III: Tender Drawings.



8.1 Time limit for clarification:

Bidders may seek clarification regarding Bidding Documents by sending their queries in writing at least three (03) days before Pre-Bid Meeting.

10.1 Bid language:

English

13.1 *Bidders to quote entirely in Pak. Rupees only.*

14.1 Period of Bid Validity:

90 days from the date of Bid Opening.

15.1 Amount of Bid Security:

Bid Security for the lump sum amount of ***@ 2.0% of Bid Price*** *in the form of Pay Order / Demand Draft / Deposit at Call issued by a Scheduled Bank in Pakistan in favor of the Procuring Agency.*

Bid Security of the successful bidder shall be retained / adjusted as Performance Security.

17.1 Venue, time, and date of the pre-Bid meeting:

Venue: *As notified in Letter of Invitation.*

Time and date: *As notified in Letter of Invitation*

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

One (01) Original plus One (01) Copy

19.1 Sealing and Marking of Bids

Bidding Process is carrying out under Single stage – One Envelope Procedure (SPP Rule 46 (1)) as under

(a) Each bid shall comprise one single envelope containing financial proposal.

(b) All bids received shall be opened and evaluated in the manner/criteria prescribed in the NIT or bidding document.

(c) Verification and up-to-date information: Procuring agency can verify the previous working, experience and financial statements made by the bidders in their bids;

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

The Project Director,
Sindh Forensic Science Laboratory, Karachi
Office No. 314, Section Officer-I, P&D Department
2nd Floor, Tughluq House, Sindh Secretariat, Karachi
Tel: +92 21 99211926

National Engineering Services Pakistan Ltd. A&P DIVISION Karachi.

19.2(b) Name and Number of the Contract: _____

20.1(a) Deadline for submission of bids:

As notified in Letter of Invitation

23.1 Venue, time, and date of Bid opening:

Venue: *As notified in Letter of Invitation*

Date: *As notified in Letter of Invitation*

Time for opening of bids: *As notified in Letter of Invitation*

32.1 Standard form & amount of Performance Security acceptable to Procuring Agency:

*Performance Security shall be equal to **10%** of Awarded Cost in the form of Pay Order or Bank Demand Draft. In case of 2% bid Security is kept by the Employer, the successful bidder shall then submit remaining 3% of Awarded Cost in shape of pay order / bank demand draft. Remaining 5% shall be retained / deducted from each running payments due to the Contractor @5% until completion of the whole works.*

32.3 Validity of Performance Security:

Performance Security must be valid up to the completion of Defects Liability Period.

33.3 Signing of Contract Agreement:

Within fourteen (14) days from the date of furnishing acceptable Performance Security, the successful bidder shall bring Contract Agreement (as per format given in Tender Documents) on stamp paper of the value as per Stamp Duty Act- latest version, signed and stamped by him for Project Director's signature and stamp.

33.4 Stamp duty

Stamp duty on contract agreement or other papers shall be paid by the successful bidder/contractor as per percentage given in Stamp Duty Act of Government of Sindh-latest version. The updated schedule can be obtained from the office of Chief Inspector of Stamps, Sindh Board of Revenue, opposite MPA Hostel, High Court Road,Karachi.

Annexure- to Bidding Data

Notification issued by Govt. of Sindh regarding Complaint Redressal Committee (CRC)

GOVERNMENT OF SINDH
HOME DEPARTMENT
DEPARTMENT

NOTIFICATION

NO: SO(Admn)HD: In pursuance of Rule-31 of Sindh Public Procurement Rules 2010, (Amended 2019) **"Complaint Redressal Committee"** for procurement of Goods/Works/Non-Consulting Services in respect of scheme **"Establishment of Sindh Forensic Laboratory Karachi, Home Department, Government of Sindh (ADP General Sr. No. 936/2021-22)"** is hereby constituted with following composition: /TORs:

i)	Secretary, Home Department, Government of Sindh	Chairman
ii)	Representative of Office of Accountant General Sindh	Member
iii)	An Independent professional from the relevant field concerning the procurement process in question, to be nominated by the head of procuring agency	Member

Terms of Reference (TORs):-

- As provided under Rule-31 of SPPRA Rules 2010, (Amended 2019) and to perform any other function ancillary and incidental to the above.

-DR. SAEED AHMED MANGNEJO-
SECRETARY, HOME DEPARTMENT

NO: SO(Admn)HD: **Karachi, 22nd March, 2022**

A copy is forwarded for information and necessary action to:-

- The Accountant General Sindh, Karachi
- The Chairman/Members of Committee (all).
- The Deputy Secretary (Staff) to Chief Secretary Sindh.
- P.S to Chief Secretary Sindh.
- P.S to Secretary, Home Department, Government of Sindh.
- P.S to Additional Secretary (Admn), Home Department, Government of Sindh.
- Office/Master File.

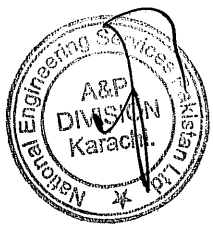
SECTION OFFICER (ADMN)

National Engineering Services Pakistan Ltd. MEP DIVISION Karachi.

Site Location Plan

National Engineering Services Pakistan Ltd.
A&P
DIVISION
Karachi.

FORM OF BID
AND
APPENDICES TO BID



FB-1

FORM OF BID

Bid Reference No. _____

Construction of Reception & Evidence Blocks (Architectural & MEP Works)

To:

The Project Director,
Sindh Forensic Science Laboratory, Karachi
P&D Department
2nd Floor, Tughluq House, Sindh Secretariat, Karachi
Tel: +92 21 99211415

1. Having examined the Bidding Documents including Instructions to Bidders, Bidding Data, Conditions of Contract. Specifications, Drawings and Bill of Quantities and Addenda Nos. _____for the execution of the above-named Works, we, the undersigned, offer to execute and complete such Works and remedy any defects therein in conformity with the Conditions of Contract. Specifications, Drawings, Bill of Quantities and Addenda for the sum of Rs. (Rupees _____ _____ _____) or such other sum as may be ascertained in accordance with the said conditions.

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

3. As security for due performance of the undertakings and obligations of this Bid, we submit herewith a Bid Security in the amount of (Rs. _____), Rupees _____ _____ drawn in your favour or made payable to you and valid for a period of _____days beginning from the date Bids are opened.

4. We/I undertake, if our Bid is accepted, to commence the Works and to complete the whole of the Works comprised in the Contract within time stated in Appendix-A to Bid.

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

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

7. We do hereby declare that the Bid is made without any collusion, comparison of figures or arrangement with any other bidder for the Works.

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

FB-2

9. We undertake, if our/my bid is accepted, to execute the Performance Security referred to in Clause 4.2 of Conditions of Contract for the due performance of the Contract.

10. We confirm, if our bid is accepted, that all partners of the joint venture shall be liable jointly and severally for the execution of the Contract and the composition or the constitution of the joint venture shall not be altered without the prior consent of the procuring agency.

(Please delete this in case of Bid form a single bidder)

in the capacity of _____duly authorized to sign Bids for and on behalf of

Dated this _____day of_____20__

Signature: _____

in the capacity of _____duly authorized to sign Bids for and on behalf of

_____
(Name of Bidder in Block Capitals) (Seal)

Address:_____
_____
_____

Witness:

Signature: _____
Name: _____

Address. _____
_____

Occupation
_____

National Engineering Services Pakistan Ltd. A&P DIVISION Karachi.

SPECIAL STIPULATIONS **BA-1**
Clause in Conditions of Contract **Appendix-A to Bid**

S. No	Description	*Ref	Summary
1.	Engineer's Authority to issue Variation in emergency	3.1	2% of the Contract Price stated in the Letter of Acceptance.
2.	Amount of Performance Security	4.2	*Performance Security shall be equal to 10% of Awarded Cost in the form of Pay Order or Bank Demand Draft. In case of 2% bid Security is kept by the Employer, the successful bidder shall then submit remaining 3% of Awarded Cost in shape of pay order / bank demand draft. Remaining 5% shall be retained / deducted from each running payments due to the Contractor @5% until completion of the whole works.*
3.	Time for Furnishing Program	8.3	Within 14 days from the date of receipt of Letter of Acceptance.
4.	Minimum amount of Third Party Liability Insurance	18.3	Rs.500,000/- for property damage and Rs.500,000/- for personnel injury/death per occurrence with unlimited number of occurrences.
5.	Time for Commencement	8.1	Within 07 days from the date of receipt of Engineer's Notice to Commence, which shall be issued within fourteen (14) days after signing of Contract Agreement.
6.	Time for Completion	8.2	12 Calendar Months from the date of receipt of Engineer's Notice to Commence.
7.	Amount of Liquidated Damages/ Delay Damages/ Penalties (LD)	8.7	The amount of liquidated damages for each day of delay in completion of whole of the works or if applicable for any section thereof shall be sum equal to 8% of the awarded cost stated in the Letter of Acceptance divided by one-fourth of the numbers of days specified as completion time. **Formula: LD per Day = 8% of Awarded Cost / (0.25 x Time for Completion (days))**
8.	Defects Liability Period	11.1	Two (02) years from the effective date of Substantial Completion of building.
9	Percentage of Retention Money	14.3	5% of the amount of Interim/Running Payment Certificate
10	Limit of Retention Money	14.3	5% of Contract Price stated in the Letter of Acceptance
11	Minimum amount of Monthly Interim Payment Certificates	14.6	5% of Contract Price
12	Time of Payment from delivery of Interim Payment Certificate to the Procuring Agency by the Engineer.	14.7	20 working days from Issuance date of Interim Payment Certificate (IPC) by the Engineer. The Engineer shall certify the IPC within 07 working days of receipt of IPC.
13	Mobilization Advance (Interest Free)	*14.2	10% of Contract Price stated in the Letter of Acceptance.

***Note: For complete text please refer related clause in Conditions of Contract**

BB-1
Appendix-B to Bid

FOREIGN CURRENCY REQUIREMENTS

1. The Bidder may indicate here in below his requirements of foreign currency (if any), with reference to various inputs to the Works.

2. Foreign Currency Requirement as percentage of the Bid Price excluding Provisional Sums _____%.

3. Table of Exchange Rates

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

Not Applicable

BC-1
Appendix-C To Bid

PRICE ADJUSTMENT UNDER CLAUSE 13.80 OF CONDITIONS OF CONTRACT

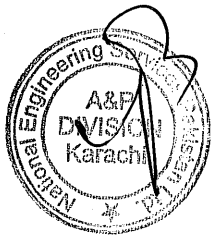
The source of indices and the weightages or coefficients for use in the adjustment formula under Clause 13.80 shall be as follows:

Cost Element	Description	Weightages	Applicable index
(1)	(2)	(3)	(4)
(i)	Fixed Portion	0.35	
(ii)	Cement – in bags	0.30	Government of Pakistan (GP) Federal Bureau of Statistics (FBS) Monthly Statistical Bulletin (Inter-City Consumer Prices).
(iii)	Blocks (all sizes)	0.10	" " "
(iv)	Labour	0.20	" " "
(v)	POL	0.05	" " "
	Total	1.00	

Notes:

1) Indices for "(ii)", "(iii)" & "(iv)" are taken from the Government of Pakistan Federal Bureau of Statistics, Monthly Statistical Bulletin. For steel reinforcement, the prices of ½" dia bar shall be referred as representative to all diameters. For Cement, prices of Ordinary Portland Cement (OPC) shall be referred as representative to all types of cements used in the project for escalation purpose. The base cost indices or prices shall be those applying 28 days prior to the latest day for submission of bids. Current indices or prices shall be those applying 28 days prior to the last day of the monthly billing period.

2) Any fluctuation in the indices or prices of materials other than those given above shall not be subject to adjustment of the Contract Price.



BD-1

Appendix-D to Bid

BILL OF QUANTITIES

Preamble

1. The Bill of Quantities shall be read in conjunction with the Conditions of Contract, Specifications and Drawings.

2. 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 (in case of item not mentioned in Bill of Quantities).

3. The rates and prices entered in the priced Bill of Quantities shall, except insofar as it is otherwise provided under the contract include all costs of contractor's plant, labour, supervision, materials, execution, insurance, profit, taxes and duties, together with all general risks, liabilities and obligations set out or implied in the contract. Furthermore all duties, taxes and other levies payable by the contractor under the contract, or for any other cause, as on the date 14 days prior to deadline for submission of Bids in case of ICB/NCB respectively, shall be included in the rates and prices and the total bid price submitted by the bidder.

4. A rate or price shall be entered against each item in the priced Bill of Quantities, whether quantities are stated or not. The cost of items against which the contractor will have failed to enter a rate or price shall be deemed to be covered by other rates and prices entered in the Bill of Quantities and shall not be paid separately.

5. The whole cost of complying with the provisions of the Contract shall be included in the items provided in the priced Bill of Quantities, and where no items are provided, the cost shall be deemed to be distributed among the rates and prices entered for the related items of the works.

6. General directions and description of work and materials are not necessarily repeated nor summarised in the Bill of Quantities. References to the relevant sections of the bidding documents shall be made before entering prices against each item in the priced Bill of Quantities.

7. Provisional sums included and so designated in the Bill of Quantities shall be expended in whole or in part at the direction and discretion of the Engineer in accordance with sub-clause 13.5 of Part I, General Conditions of Contract.

HOME DEPARTMENT GOVERNMENT OF SINDH
ESTABLISHMENT OF SINDH FORENSIC SCIENCE LABORATORY KARACHI
CONSTRUCTION OF RECEPTION & EVIDENCE COLLECTION BLOCKS
(ARCHITECTURAL FINISHES & MEP WORKS ONLY)
SUMMARY OF BID PRICE

Sr. No.	DESCRIPTION	AMOUNT (Rupees)
A	**RECEPTION BLOCK**	
1.1	Civil Works	
1.2	Plumbing Works	
1.2.1	Water Supply & Sewerage System	
1.2.2	Firefighting	
1.3	Electrical Works	
1.4	Telecommunication Works	
1.4.1	Addressable Fire Alarm & Public Address	
1.4.2	LAN Infrastructure	
1.4.3	IP Based Surveillance System	
	Reception Block (Sub-Total-A) (Rs.)	
B	**EVIDENCE COLLECTION BLOCK**	
1.1	Civil Works	
1.2	Plumbing Works	
1.2.1	Water Supply & Sewerage System	
1.2.2	Fire Fighting	
1.3	Electrical Works	
1.4	Telecommunication Works	
1.4.1	Addressable Fire Alarm & Public Address	
1.4.2	LAN Infrastructure	
1.4.3	IP Based Surveillance System	
1.5	HVAC Works	
1.6	Elevator Works	
	Evidence Collection Block (Sub-Total-B) (Rs.)	
	Total Bid Price (A+B) (Rs.)	

Total Bid Price in Words

(_____)

National Engineering Services Pakistan Ltd. A&P DIVISION Karachi.

RECEPTION BLOCK

HOME DEPARTMENT GOVERNMENT OF SINDH
ESTABLISHMENT OF SINDH FORENSIC SCIENCE LABORATORY KARACHI

BILL OF QUANTITIES

CODE # 02 RECEPTION BLOCK (G+1)

Item No.	Description	Unit	Qty	Rate (Rs.)	Amount (Rs.)
	C. CIVIL WORKS				
	STRUCTURAL STEEL WORKS Ref. Sec.No. 3000, 6700				
02-1C	Providing, fabricating and fixing of M.S.pipes (vertical & horizontal) railing of the following with primer & 2 coats of enamel paint finish including fixing complete in all respects as shown on the drawings, specifications and or as directed by the Engineer.				
	A - Staircase railing floor mounted				
	a) Staircase # 1 & 2	Rft.	117		
	B - Staircase railing wall mounted				
	a) Staircase # 1 & 2	Rft.	120		
	C - Terrace railing	Rft.	123		
02-2C	Providing, fabricating and fixing of M.S.Louckup grill doors with enamel painting & anti-corrosive primer and all other hardwares & fixing accesories etc. complete in all respects as shown on the drawings, specifications and or as directed by the Engineer.				
	a) lockup grill door (male & female)	Kg	1613		
	CARPENTARY & JOINERY Ref.Sec.No. 4600,6700				
02-3C	Providing and fixing doors of the following types consisting of G.I frame (16 SWG) and solid shutter with PVC water proof sheet, golden teak lipping including 1"3 mortar filling in door frame, mortice lock with handle, beading, architrave, fittings, Paint etc., complete in all respects as shown on drawings and schedule & specifications and/or as directed by the Engineer.				
	a) Type D1a	Sft.	84		
	b) Type D3	Sft.	118		
	c) Type D4	Sft.	227		
	d) Type D5	Sft.	315		
	e) Type D6	Sft.	38		
	f) Type D7	Sft.	29		
02-4C	Providing and fixing kitchen/dish washing/store counters of approved design for the following types comprising of 3/4" thick granite top slab with 1-1/2" thick bull nose edge, cutting holes, RCC slab, block masonry with plaster (both sides), 6" thick cement concrete base etc. complete in all respect as shown on the drawing and or as directed by the Engineer.				
i)	**Kitchen Counter, Concrete Base & Service Counter**				
	a) Floor mounted with granite top.	Rft.	57		
	b) 6" thick Cement Concrete 3000 psi 28 days (Cylinder Strength) base/platform including angle iron 1-1/4" x 1-1/4" x 1/4" thick with anchors (Protection of edges).	Rft.	35		
	c) Service Counter with granite top.	Rft.	23		

National Engineering Services Pakistan Ltd. A&P DIVISION Karachi.

BILL OF QUANTITIES

CODE # 02 RECEPTION BLOCK (G+1)

Item No.	Description	Unit	Qty	Rate (Rs.)	Amount (Rs.)
	ALUMINIUM WORKS				
	Ref. Sec.No. 6220, 6250				
02-5C	Providing and fixing fully glazed anodized aluminum doors, windows and ventilators of approved manufacturer using 2mm thick, 100mm wide extruded deluxe sections with distoration free 5mm thick clear glass, fly proof shutter, hardware, PVC/rubber gasket and sealant including fixing and fixing accesories etc. of the following design types; complete in all respect as shown on the drawings and specification.				
	Doors				
	a) Type D1	Sft.	160		
	b) Type D2 & D2a	Sft.	655		
	c) Type D8 (Louvered Type)	Sft.	134		
	Windows				
	a) Type W1	Sft.	1260		
	b) Type W2	Sft.	473		
	c) Type W3	Sft.	521		
	Ventilators				
	a) Type V1	Sft.	44		
	b) Type V2	Sft.	9		
	BLOCK MASONRY				
	Ref. Sec.No. 4100				
02-6C	Solid block masonry wall of the following thickness set in 1:6 cement sand mortar including stiffener columns, anchor bars, D.P.C & curing etc. Complete in all respects as shown on drawings and as per specificatios (anchor bars shall be paid in BOQ Item No. 03-5C).				
	a) 4 inch thick	Cft.	552		
	b) 6 inch thick	Cft.	7250		
	WATER PROOFING AND BUILT-UP ROOFING				
	Ref. Sec.No. 6411				
02-7C	Providing and laying water proofing treatment over roof slab complete in all respects as shown on the drawings, specifications and or as directed by the Engineer.	Sft.	10055		
02-9C	Crystalline Cementitious water proofing coating (Aquafin-IC or approved equivalent) in wet areas as per manufacturer's recommendations.	Sft.	1497		
	CEMENT PLASTER				
	Ref. Sec.No. 6521				
02-10C	1/2 inch thick 1:6 cement sand plaster to specified interior surfaces etc; complete in all respect as shown on the drawings and specifications and or as directed by the Engineer.	Sft.	29857		
02-11C	2 inch thick 1:4 cement sand plaster band in two layers to specified exterior surfaces, plain as specified fixing of galvanized metal lath with nails on surface to entact the plaster layers etc; complete in all respect as shown on the drawings and specifications and or as directed by the Engineer.	Sft.	1079		

National Engineering Services Pakistan Ltd. A&P DIVISION Karachi.

BILL OF QUANTITIES

CODE # 02 RECEPTION BLOCK (G+1)

Item No.	Description	Unit	Qty	Rate (Rs.)	Amount (Rs.)
02-12C	3/4 inch thick 1:4 cement sand rough base plaster prior to plain band surfaces, complete in all respect as shown on the drawings and specifications and or as directed by the Engineer.	Sft.	1079		
02-13C	Providing and applying 3/4" thick comb plaster with 1:4 (cement: Sand) in two layer with fixing aluminium - U in groove 1"X1/2" (H) & aluminium - L 3/4"X1/2" (V). Base plaster 1/2" thick and top layer 1/4" thick with comb trowel finish etc. complete in all respects as shown on the drawings and specifications and or as directed by the Engineer.	Sft.	16040		
02-14C	Providing and applying 3/4" thick plain plaster with 1:4 (cement: Sand) to specified exterior surfaces, plain as specified fixing of galvanized metal lath with nails on surface to entact the plaster layers etc; complete in all respect as shown on the drawings and specifications and or as directed by the Engineer.	Sft.	2801		
	FALSE CEILING				
	Ref. Sec.No. 6560				
02-15C	Providing and fixing 24" X 24" Mineral Fibre false ceiling with approved suspension system including all accessories, G.I bar hangar with 18 SWG G.I. adjuster at any elevation as per approved sample complete in all respects and or as directed by the Engineer.	Sft.	12842		
	FLOOR AND WALL FINISHES				
	Ref. Sec.No. 6531, 6600				
02-17C	**Floor type A:** 24 x 24 x 3/4 inches thick Marble tile (premimum quality) in approved color/shade and texture, gap filled with grout (as per manufacture recommendation) etc, set inleveling base/mortar (1:3) complete in all respect as shown on the drawing & specification.	Sft.	17255		
02-18C	**Skirting type 1:** 6 inch high marble tile (premimum quality) skirting in approved size, color/shade and texture (tile matched with flooring tile) etc, set in specified cement sand mortar including 1/2" thick rough base plaster (1:6) etc; complete in all respect as shown on the drawing & specification.	Sft.	1701		
02-19C	**Floor type B:** 12"x12" full body Porcelain tile (premimum quality) in approved color/shade and texture, gap filled with grout (as per manufacture recommendation) etc, set base/mortar (1:3) complete in all respect as shown on the drawing & specification.	Sft.	924		
02-20C	**Skirting/Dado type 4:** 12"x12" full body pocelain (premimum quality) tile (upto 6ft high) in approved color/ shade and texture, laid along project grid, filled with grout (as per manufacture recommendation), set in specified cement sand mortar including 1/2" thick rough base plaster (1:6) etc; complete in all respect as shown on the drawing & specification.	Sft.	2727		
02-21C	Prepolished Marble (premimum quality) on Tread, riser & skirting of specified size, color and quality including bullnozing (where required), grinding, polishing & buffing, anti slip grooves on treads, washing, cleaning, curing, c.c levelling base (1:3) etc. of the following types; complete in all respect as shown on the drawing and specification.				
	Satircase # 1				
	a) Tread & Landing (3/4" Thick One Piece)	Sft.	122		
	b) Riser & Skirting (1/2" Thick)	Sft.	67		

National Engineering Services Pakistan Ltd. A&R DIVISION Karachi.

BILL OF QUANTITIES

CODE # 02 RECEPTION BLOCK (G+1)

Item No.	Description	Unit	Qty	Rate (Rs.)	Amount (Rs.)
	Satircase # 2				
	a) Tread & Landing (3/4" Thick)	Sft.	286		
	b) Riser & Skirting (1/2" Thick)	Sft.	145		
02-22C	Providing and laying 3" thick Class - "C" (1:2:4) cement concrete in floor laid in panels with broom finish (on ramp) complete in all respects and or as directed by the Engineer.	Sft.	206		
	GRANITE WORKS				
	Ref. Sec.No. 6532				
02-23C	Prepolished granite (premimum quality) on Tread, riser & skirting of specified size, color and quality including bull nozing (where required), grinding, polishing & buffing, making anti slip grooves on treads, washing, cleaning, curing c.c base/mortar (1:3) etc. of the following types; complete in all respect as shown on the drawing and specification. (External Podium & steps)				
	Main Entrance/Podium				
	a) Tread & Landing (3/4" Thick One Piece)	Sft.	275		
	b) Riser & Skirting (1/2" Thick)	Sft.	77		
	C - Rear Entrance				
	a) Tread & Landing (3/4" Thick)	Sft.	69		
	b) Riser & Skirting (1/2" Thick)	Sft.	27		
	Ablution				
	a) Ablution Sets Granite Top (3/4" Thick)	Sft.	13		
	PAINTING				
	Ref. Sec.No. 6700				
02-24C	Providing and applying 3 coats of matt emulsion paint to specified surfaces including surface preparation & primer etc; complete in all respect as shown on the drawing and specification.	Sft.	28272		
02-25C	Providing and applying 3 coats of matt emulsion paint Black/grey colour to specified surfaces (wet areas/kitchen) including surface preparation & primer etc; complete in all respect as shown on the drawing and specification.	Sft.	2969		
02-26C	Proving and applying 3 coats of weather resistant paint to specified surfaces including surface preparation & primer etc; complete in all respect as shown on the drawing and specification.	Sft.	2801		
	MISCELLANIOUS				
02-27C	Providng and fixing precast fairface rain water spouts of approved quality with cement sand mortar (1:2) etc. complete in all respect as shown on the drawing and or as directed by the Engineer.	No.	20		
02-28C	Fairface pre-cast coping 3000 psi 28 days (Cylinder Strength) using modified Portland cement set with 1:2 cement snad mortar etc. as window sills on cavity walls only, complete in all respects as shown on the drawings and specifications and or as directed by the Engineer. (It includes cost of concrete/reinfrocement/foair face form work, mortar for fixing, fabircation, curing & fixing etc.)	Nos.	30		
02-29C	Providng and fixing precast concrete pots complete in all respect as shown on the drawing and or as directed by the Engineer.	No.	6		

BILL OF QUANTITIES

CODE # 02 RECEPTION BLOCK (G+1)

Item No.	Description	Unit	Qty	Rate (Rs.)	Amount (Rs.)
02-30C	Providng and fixing tuff tile flooring placed with 1:4 cement sand complete in all respect as shown on the drawing and or as directed by the Engineer.	Sft.	1157		
02-31C	Providng, fabricating and fixing fibre glass sky light of specified size with M.S. Framing with enamel paint & anti-corrosive primer, all other hardwares and fixing accessories etc. complete in all respect as shown on the drawings and/or as directed by the Engineer.	Sft.	1709		
02-32C	Construction of Service counter complete in all respect as shown on drawings and or as directed by the Engineer.	Job	1		

Total Bid Price of (Civil Works) Rs. _____

Carried Over to Summary _____

National Engineering Services Pakistan Ltd. A&P DIVISION Karachi.

ESTABLISHMENT OF SINDH FORENSIC SCIENCE LABORATORY, KARACHI
RECEPTION BLOCK
BILL OF QUANTITIES

WATER SUPPLY SYSTEM
C.) PLUMBING WORKS

Sr. No.	Description	Quantity	Unit	Rate (PKR)	Amount (PKR)
	INTERNAL PLUMBING FIXTURES				
1.0	Providing & Fixing, SS T-stop cock (½" * ½") of approved make.	33	No.		
1.1	Providing & Fixing, Stainless Steel Wall type Mixer for kitchen sink.	4	No.		
1.2	Providing and fitting, SS Head Shower.	3	No.		
1.3	Providing & Fixing, European type ceramics ware coupled one piece water closet, of approved make and white / light colour of best quality complete in all respect.	3	No.		
1.4	Providing and fitting glazed earthen ware water closet, squatter type, combined with foot rest. i) coloured	12	No.		
1.5	Providing and fitting glazed earthen ware wash hand basin, including all accessories.				
	i) Coloured, with pedestal (560*440*820 mm)	2	No.		
	ii) Coloured, without pedestal (540*450*210 mm)	9	No.		
	iii) Coloured, with half pedestal (560*440*570 mm)	3	No.		
1.6	Providing and fixing Single Bowl Large SS sink, size (540*440*200mm) including all accessories.	4	No.		
1.7	Providing and fixing Toilet Shower Set for European / Indian type WC.	15	No.		
1.8	Providing and fitting glass shelf including all accessories.	5	No.		
1.9	Providing and fitting Stainless Steel Towel Rail.	13	No.		
2.0	Providing and fitting metal soap dish.	13	No.		
2.1	Providing and fixing single long bib cock.	28	No.		
2.2	Providing and fitting stainless steel toilet paper holder with cover.	15	No.		
	INTERNAL WATER SUPPLY SYSTEM				
2.3	Providing, fixing, jointing and testing Polypropylene Random (PPR) pipes or approved equivalent pressure pipe for cold & hot water as per DIN 8077-8078,PN-20 for pipes and DIN 16962,PN-25 for fittings (polyfusion welded joints) inside building including fittings and specials (sockets, tees, elbows, bends, crosses, reducers, adaptor, plugs and union etc.) supported on walls or suspended from roof slab or run in chases including pipe hangers, supports, cutting and making good the chases and holes, complete in all respects.				
	i) 25 mm	132	Rft.		
	ii) 32 mm	77	Rft.		
	iii) 40 mm	110	Rft.		

National Engineering Services Pakistan Ltd. A&P DIVISION Karachi

C.) PLUMBING WORKS

Sr. No.	Description	Quantity	Unit	Rate (PKR)	Amount (PKR)
	iv) 50 mm	66	Rft.		
2.4	Providing and installing Ball valves of approved quality of following nominal dia, including jointing, fitting, painting, testing, complete in all respects to match with PPR/uPVC pipes of following diameters.				
	i) 40 mm	1	No.		
	ii) 50 mm	1	No.		
2.5	Supply and installation of electric gyser of following capacity, including ball valves on inlet and outlet connections. i) 25 L	2	No.		
	INTERNAL SEWERAGE SYSTEM				
2.6	Providing, fixing, cutting, jointing and testing uPVC sewerage, Drainage & vent piping conforming to ISO 3633:1991 including uPVC Drainage fittings with solvent cement jointing include cost of clamping to walls and ceiling, hangers, supports, cutting through walls and providing sleeves through concrete slabs for pipelines and pipe fittings of the following diameter complete in all respect.				
	i) 2" i/d	55	Rft.		
	ii) 3" i/d	285	Rft.		
	iii) 4" i/d	365	Rft.		
2.7	Providing and fixing 3" dia cowel for vent pipe.	6	No.		
2.8	Providing and fixing looking glass 55x40 cm size and 5mm thick, first quality.	98	Sft		
2.9	Providing and fixing cast iron & SS-304 angle drain for 3" or 4" dia rainwater pipe with push fit complete in all respects.	8	No.		
	EXTERNAL WATER SUPPLY SYSTEM				
3.0	Excavation of **trenches** in all kinds of soil except cutting rock for Water Supply pipelines upto 5 ft depth from ground level including trimming, dressing sides, leveling the beds of trenches to correct grade and cutting pits for joints complete in all respect.	580	Cft		
3.1	Supplying & filling **sand** under floor; or plugging in walls.	64	Cft		
3.2	Providing, transportation, laying, cutting, butt fusion jointing, testing, commissioning & disinfecting the High Density Polyethylene Pipe (HDPE) PE-100, (PN-10) SDR 17 including fittings and specials conforming to ISO 4427 or DN8074/8075 or equivalent to the satisfaction of Engineer. The pipe shall be from reputable manufacturer approved by the Engineer.				
	i) 40 mm	35	Rft.		
	ii) 50 mm	140	Rft.		

National Engineering Services Pakistan (Pvt.) Ltd. A&R DIVISION Karachi

C.) PLUMBING WORKS

Sr. No.	Description	Quantity	Unit	Rate (PKR)	Amount (PKR)
3.3	Providing and fixing, submersible pump of capacity 25 gpm and head 30 ft coupled with electric motor, with accessories complete in all repects.	1	No.		
	EXTERNAL SEWERAGE SYSTEM				
3.4	Providing and fitting, stainless steel-304, Grease Trap of 4'x2'x2' size with 40 gallons capacity with accessories complete in all respect.	1	No.		
3.5	Providing and fitting gully trap, including cement concrete, cost of PVC grating 15x15cm and masonry chamber 30x30cm.	6	No.		
3.6	Excavation of trenches for **sewers** line in all types of soil, including dressing to correct section and dimensions according to templates and levels, shoring and removing surface water, including backfilling with excavated material, compaction of earth, and disposal of excavated materials to locations within the site and / or as designated by the Engineer.				
	i) 0 - 7ft	5990	Cft		
3.7	Watering and ramming brick ballast 1½" to 2" guage mixed with 25% sand, for floor foundation, complete in all respects.	479	Cft		
3.8	uPVC drainage pipes of Popular make or approved quality, including (SN-8) uPVC drainage fittings with solvent cement jointing "Type B" or approved equal, rates include cost of clamping to walls and ceiling, hangers, supports, cutting through walls and providing sleeves through concrete slabs for pipe lines and pipe fittings of the following diameter:				
	i) 8" i/d	526	Rft.		
3.9	Providing and fixing uPVC Mutli Floor Trap of approved quality including PVC grating, Cover and P Trap.	39	No.		
4.0	Construction of square block masonry **manhole** (size 2½' x 2½'), including cover and frame.				
	i) upto 5 ft depth	13	No.		
			TOTAL		

National Engineering Services Pakistan (Pvt.) Ltd. A&P DIVISION Karachi

HOME DEPARTMENT GOVERNMENT OF SINDH

ESTABLISHMENT OF SINDH FORENSIC SCIENCE LABORATORY KARACHI

SCHEDULE OF PRICES

FIRE FIGHTING WORKS

CODE # 03 RECEPTION BLOCK (G+1) **Date: 12-04-23**

Item. Each	DESCRIPTION	UNIT	QTY.	UNIT RATE (Rs.)	TOTAL AMOUNT (Rs.)
03-01	Supply, Installation, Testing and Commissioning, Operation and Maintenance of Seamless black steel pipe, conforming to ASTM A-106 schedule 40 and fitting conforming to BS 534, including any sundriess to the system, of following diameter:				
	i) Dia 3 inch(wall thickness 0.216 inches)	RFT	20		
	ii) Dia 2-1/2 inch (wall thickness 0.203 inches)	RFT	20		
	iii) Dia 2 inch (wall thickness 0.154 inches)	RFT	185		
03-02	Supply, Installation, Testing and Commissioning, Operation and Maintenance of Internal Fire Hose cabinet with swinging type drum, 100 ft x 1-1/2" high pressure hose reel with multi-purpose brass nozzle, 1-1/2" hose valve/gate valve, and 25 mm key operated shut off valve within a powder coated, red finish with glass front cabinet, complete in all respects. (FM approved and UL listed). It shall also accommodate 1-1/2" pressure reducing valve as per item # 5	Each	2		
03-03	Supply, Installation, Testing and Commissioning, Operation and Maintenance of Cast iron flanged gate valve PN 16 of following diameters: (FM approved and UL listed):				
	i) Dia 1-1/2 inch	Each	2		
03-04	Supply, Installation, Testing and Commissioning, Operation and Maintenance of Pressure gauge of 16 bars with stop cock including any sundries (UL listed)	Each	2		
03-05	Supply, Installation, Testing and Commissioning, Operation and Maintenance of Pressure reducing valve with all acessories as shown on drawing (FM approved and UL listed):				
	i) Dia 1-1/2 inch	Each	2		
03-06	Supply, Installation, Testing and Commissioning, Operation and Maintenance of Automatic air release valve of required size as specified	Each	1		
03-07	Supply, Installation, Testing and Commissioning, Operation and Maintenance of Drain Cocks with ball valve	Each	1		

National Engineering Services Pakistan Ltd. A&P DIVISION Karachi.

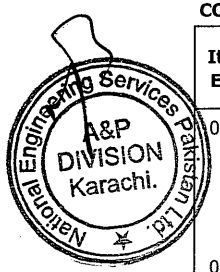
HOME DEPARTMENT GOVERNMENT OF SINDH

ESTABLISHMENT OF SINDH FORENSIC SCIENCE LABORATORY KARACHI

SCHEDULE OF PRICES

FIRE FIGHTING WORKS

CODE # 03 RECEPTION BLOCK (G+1) **Date: 12-04-23**



Item. Each	DESCRIPTION	UNIT	QTY.	UNIT RATE (Rs.)	TOTAL AMOUNT (Rs.)
03-08	Supply, Operation and Maintenance of Portable fire extinguisher of following types:				
	i) Dry chemical powder 6 Kg.	Each	6		
	ii) Carbon dioxide 5 kg.	Each	6		
03-09	Relevant civil works required to complete the system including, cutting, patching, repairing, boxing, opening sealing with fire stopping material, plastering etc. complete an all respect.	Lot	1		
03-10	Spare Parts	Lot	1		
03-11	Overall Testing, Commissioning & Balancing of complete system	Lot	1		
03-11	Provisional Sum	-			

TOTAL (PKR)

HOME DEPARTMENT GOVERNMENT OF SINDH

ESTABLISHMENT OF SINDH FORENSIC SCIENCE LABORATORY KARACHI

RECEPTION BLOCK

BILL OF QUANTITIES

Electrical Works

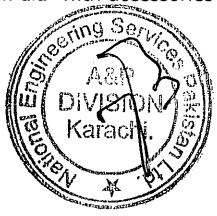
Item No.	Description	Unit	Qty	Rate (Rs.)	Amount (Rs.)
	IMPORTANT NOTES (Applicable to all Electrical Items) All electrical items given below shall be read in conjuction with parts of the Specifications and electrical drawings except otherwise indicated. The Electrical Works include design, supply, transportation, installation, testing and commissioning of the following items of works as mentioned in this BOQ (unless specifically stated otherwise) including all material, labour, tools, accessories, related civil works, etc., as required for proper completion of each item as per specifications unless otherwise mentioned. (Any necessary material not mentioned in specifications, electrical drawings and here in this BOQ required for proper installation, testing and commissioning of equipment and materials shall be included in BOQ rates.				
1.0	**WIRING AND ACCESSORIES**				
1.1	Wiring of light or fan point from switch board/dimmer to the point with 3x1.5 mm2 (P+N+E) PVC insulated single core stranded cables in 25 mm PVC conduit/pipe concealed in walls, columns and slabs including accessories, PVC box, 10 Amp. gang switch 1 or 2 way as required, one for each light or fan and installed as in specifications complete in all respects.	Each	450		
1.2	Circuit wiring from DB MCBs to gang switches board and from switch board to another switch board with 3x2.5 mm2 (P+N+E) PVC insulated single core stranded cables in 25mm PVC pipe/conduit concealed in walls, columns and slabs as required complete in all respects.	Each	12		
1.3	The same as item No. 1.1 but from one light point to another light point.	Each	210		
1.4	10/13 Amp 3 pin universal flush mounting switch socket outlet wired from DB MCBs to first outlet with 3x4 mm2 (P+N+E) single core cable stranded (away from switch board) in 25mm PVC pipe/conduit concealed in walls, columns and slabs as required complete in all respects.	Each	24		
1.5	The same as item No.1.4 but wiring from one socket outlet to another socket outlet with 3x2.5 mm2 (P+N+E) single core stranded cable in 25mm PVC pipe/conduit concealed in walls, columns and slabs as required complete in all respects.	Each	48		
1.6	20 Amp 3 pin universal flush mounting switch socket outlet wired from DB MCBs to independent socket outlet with 3x6 mm2 (P+N+E) single core stranded cable (away from switchboard) in 25mm PVC pipe/conduit concealed in walls, columns and slabs as required complete in all respects.	Each	38		
2.0	**LIGHTING FIXTURES & FANS** Following LED Luminaries of suitable wattage make Philips, GE, Pierlite or approved equivalent suitable for the project requirements. Contractor to submit lighting design calculation to determine the adequacy of the wattage and should adjust the number of LEDs/wattage as per project lighting requirements.The fitting shall be approved by the Engineer.				

National Engineering Services Pakistan Ltd. A&R DIVISION Karachi.

BILL OF QUANTITIES

Electrical Works

Item No.	Description	Unit	Qty	Rate (Rs.)	Amount (Rs.)
2.1(a)	Light Fixture Type LED Batten surface mounted, 10W above mirror in toilets complete in all respect with allied accessories make Philips, GE, Pierlite or approved equivalent. The fitting shall be approved by the Engineer.	Each	22		
2.1(b)	Light Fixture Type LED Batten surface mounted , 18W complete in all respect with allied accessories make Philips, GE, Pierlite or approved equivalent. The fitting shall be approved by the Engineer.	Each	10		
2.1(c)	Light Fixture Type LED Water tight, 30W, complete in all respect with allied accessories make Philips, GE, Pierlite or approved equivalent. The fitting shall be approved by the Engineer.	Each	20		
2.1(d)	Light Fixture Type LED panel 2'x2', 40W recessed mounted complete in all respect with allied accessories make Philips, GE, Pierlite or approved equivalent. The fitting shall be approved by the Engineer.	Each	206		
2.1(e)	Light Fixture Type LED Recessed Type down lighter, 18W, complete in all respect with allied accessories make Philips, GE, Pierlite or approved equivalent. The fitting shall be approved by the Engineer.	Each	170		
2.1(f)	Light Fixture Type LED Recessed Type down lighter, 14W, complete in all respect with allied accessories make Philips, GE, Pierlite or approved equivalent. The fitting shall be approved by the Engineer.	Each	40		
2.1(g)	Light Fixture Type LED Planter Light IP-65, 15W, complete in all respect with allied accessories make Philips, GE, Pierlite or approved equivalent. The fitting shall be approved by the Engineer.	Each	6		
2.1(h)	Wall bracket fan 24" sweep make (Royal, Pak, GFC or approved equivalent) capacitor type, copper winding complete with all required accessories etc. The fitting shall be approved by the Engineer.	Each	10		
2.1(i)	Exhuast fan 12" sweep make (Royal, Pak, GFC or approved equivalent) capacitor type, copper winding complete with all required accessories etc. The fitting shall be approved by the Engineer.	Each	20		
2.1(j)	False ceiling '2x2' 18" Fan capacitor type, (Royal, Pak, GFC or approved equivalent) copper winding complete with all required accessories etc. The fitting shall be approved by the Engineer.	Each	125		
3.0	**PVC CONDUIT**				
3.1	PVC pipe/conduit Class-B 100 mm dia with accessories suitable for laying multi-core cables	Rft	100		
3.2	PVC pipe/conduit 50 mm dia with accessories suitable for laying multi-core cables	Rft	100		
3.3	PVC pipe/conduit Class-D 100 mm dia with accessories suitable for laying multi-core cables	Rft	50		



BILL OF QUANTITIES

Electrical Works

Item No.	Description	Unit	Qty	Rate (Rs.)	Amount (Rs.)
4.0	**CABLE TRAY**				
4.1	Supply and Installation of 16 SWG thick galvanized steel perforated cable tray/ladder with all supporting hangers, cover, brackets, elbows, tee & mounting accessories complete in all respects as required.				
(a)	100 mm x 50 mm	Rft	100		
(b)	150 mm x 50 mm	Rft	100		
5.0	**LOW VOLTAGE ELECTRICAL POWER CABLES**				
5.1	Supply, installation, testing, commissioning and termination of following sizes of PVC insulated 600/1000 Voltage grade unarmoured Copper cables laid direct in ground, pulled in PVC pipe already laid, on surface of wall or cable trays etc including all accessories as required complete in all respects (Imported copper shall be used. Verified documentary evidence for source of copper & PVC shall be furnished prior to manufacturing)				
(a)	4 core 150 mm^2 (For MPB-Reception Block)	Rft	300		
(b)	4 core 16 mm^2 (FOR DB-GF-Zone-01&02)	Rft	200		
(c)	4 core 10 mm^2 (FOR DB-FF-Zone-01& 02)	Rft	200		
5.2	Supply, installation, testing, commissioning and termination of following sizes of PVC insulated single core 450/750 Voltage grade unarmoured Copper cables as circuit protective conductor/ earth continuity conductor (CPC/ECC) laid direct in ground, pulled in PVC pipe already laid, on surface of wall or cable trays etc. including all accessories as required complete in all respects (Imported copper shall be used. Verified documentary evidence for source of copper & PVC shall be furnished prior to manufacturing)				
(a)	1 core 70 mm^2	Rft	300		
(b)	1 core 25 mm^2	Rft	100		
(c)	1 core 16 mm^2	Rft	200		
(d)	1 core 10 mm^2	Rft	200		
6.0	**EARTHING SYSTEM** Supply, installation, testing and commissioning of following items for Earthing system for grounding of the electrical installation with all allied accessories as required complete in all respects.				
6.1	Providing and fixing of copper deposited steel rod earth point including all accessories and civil works complete in all respects as required and shown in drawing.	Each	4		

BILL OF QUANTITIES

Electrical Works

Item No.	Description	Unit	Qty	Rate (Rs.)	Amount (Rs.)
7.0	**LV DISTRIBUTION BOARDS**				
7.1	Supply, Installation, testing and commissioning of following Distribution Boards with 14/16 SWG sheet steel housing (14 SWG for Floor Standing & 16 SWG for Wall Mounted) with approved colour and having specified circuit breakers, CTs, VTs, selector switches, push buttons, LED indication lights, as shown on drawings and mentioned below cubicle with electrolytic copper bus bar with electrical grade PVC mountings 3 for each, nuts, bolts and washers, control MCB etc. with all allied accessories complete in all respects as required				
(a)	DB-GF- Zone-01&2 - 01 No. Incoming 63 Amp (Adj.) MCCB, TP, RC= 25kA - 08 Nos. Outgoing 10 Amp MCB, SP, RC, 10 kA 11 Nos. Outgoing 20 Amp MCB, SP, RC, 10 kA - 02 Nos. Outgoing 10/20 Amp (spare) MCB, SP, RC, 10 kA 03 Nos. Outgoing 10/20 Amp (space) MCB, SP, RC, 10 kA - Indication lights, ammeter with selector switch, voltmeter with selector switch, Panel box SWG 16 powder coated RAL colour 7032, IP class 44 and with all accessories.	Each	2		
(b)	DB-FF-Zone-01&02 - 01 No. Incoming 40 Amp (Adj.) MCCB, TP, RC= 25kA - 06 Nos. Outgoing 10 Amp MCB, SP, RC, 10 kA - 06 Nos. Outgoing 20 Amp MCB, SP, RC, 10 kA - 03 Nos. Outgoing 10/20 Amp (spare) MCB, SP, RC, 10 kA 03 Nos. Outgoing 10/20 Amp (space) MCB, SP, RC, 10 kA - Indication lights, ammeter with selector switch, voltmeter with selector switch, Panel box SWG 16 powder coated RAL colour 7032, IP class 44 and with all accessories.	Each	2		
8.0	**MAIN PANEL BOARD**				
8.1	Main panel board designated with all installation and operational accessories as per site requirements, as per tender specifications and as directed by the Engineer. The MPB shall comprise the following:				
(a)	MPB-Reception Block INCOMING - 01 No. 320 Amps (Adj.) TP MCCB RC=36kA - 06 Nos. 2/25 Amps Protection Fuses - 01 No. VSS (RY-YB-BR-OFF-RN) 7-position - 01 No. 0-600 Volts AC DIGITAL Voltmeter - 03 Nos. 300/5 Amps Current Transformers - 01 No. ASS (R-Y-B-OFF) 4-position - 01 No. 0-300 Amps AC DIGITAL Ammeter - 06 Nos. RYB and ON OFF TRIP LED indication lights OUTGOING - 02 No.63 Amp (Adj.) MCCB, TP, RC= 25kA (For DB-GF-Zone-01 & 02) - 02 Nos.40 Amp (Adj.) MCCB, TP, RC= 25kA (For DB-FF-Zone-01& 02) - 01 No. 63 Amps (spare)(adj.) TP MCCB RC= 25kA - 01 No. 40 Amps (spare)(adj.) TP MCCB RC= 25kA - 01 No. 100 Amps (space)(adj.) TP MCCB RC= 25kA - 14 SWG powder painted 01-cubicle with electrolytic copper bus bar with electrical grade PVC mountings 3 for each, nuts, bolts and washers etc.	Job	1		

BILL OF QUANTITIES

Electrical Works

Item No.	Description	Unit	Qty	Rate (Rs.)	Amount (Rs.)
9.0	**EMERGENCY AND EXIT LIGHTING WITH CENTRAL BATTERY SYSTEM** Supply, testing and commissioning of addressable emergency and exit lighting with central battery system comporising of following equipments including all allied accessories complete in all respect as required. The system shall be approved by the Engineer.				
9.1	PVC insulated 2-core, fire rated 1.5mm^2 cable in 25 mm dia. PVC conduit (From CBS panel to devices) complete with all allied accessories. (Prysmian, Cavicel (Italy), Belden, Firecell or approved equivalent)	Rft.	500		
9.2	Supply, Testing and Commissioning of Addressable Sub-Main central battery system input 220VAC and output 216VDC CEAG or equally approved ABB, Emerson. The Sub-Panel must be equipped with spare reserve for final assembly up to final circuits with 1 hour battery backup, Complete with all necessary fixing accessories. The system shall have an option of saving configuration through SD card	Each	1		
9.3	Addressable high performance SAFELITE having 400 lm wall/ceiling mounted emergency LED luminaire.	Each	40		
9.4	Addressable High performance LED emergency exit sign luminaire with 24LED strip and 20m viewing distance, plug in removable legend configurable for surface and recessed mounting.	Each	10		
9.5	Testing & Commissioning of Entire Centralized Battery System as per project specified requirements complete in all respect.	Job	1		
	Note :Contractor is advised to submit complete technical data of the system to the Engineer for approval before commencement of work at site.				

Total Cost of (Electrical Works) Rs. _____

Carried Over to Summary _____

HOME DEPARTMENT GOVERNMENT OF SINDH
ESTABLISHMENT OF SINDH FORENSIC SCIENCE LABORATORY KARACHI

ENGINEER'S COST ESTIMATE

CODE # 03 RECEPTION BLOCK (G+1)

Item No.	Description	Unit	Qty	Rate (Rs.)	Amount (Rs.)
	C. COMMUNICATION WORKS				
	ADDRESSABLE FIRE ALARM SYSTEM				
	Ref. Sec.No. 8331				
03-1C	1" dia PVC conduit installed concealed including all installation and mounting accessories.	Rft.	1,566		
03-2C	1.5 sq.mm fire resistant 2 core (120 min) LSZH enhanced cable complying BS5839, BS6387, and EN50200 in already installed conduit.	Rft.	2,666		
03-3C	Intelligent addressable multi optical and heat detector complete with built-in isolator, base including all mounting and installation accessories.	No.	48		
03-4C	Intelligent addressable heat detector complete with built in isolator, base including all mounting and installation accessories.	No.	7		
03-5C	Addressable manual call point including built-in isolator module including all mounting and installation accessories.	No.	7		
03-6C	Addressable loop powered audio visual sounder with built-in isolator including all mounting and installation accessories.	No.	7		
03-7C	Addressable loop powered monitor / input module with manufaturer's recommended interfacing cable including all mounting and installation accessories.	No.	2		
03-8C	Adressable Fire alarm repeater/Annunciation panel including all mounting and installation accessories.	No.	1		
	PUBLIC ADDRESS SYSTEM				
	Ref. Sec.No. 8341				
03-1C	1" dia PVC conduit installed concealed including all installation and mounting accessories.	Rft.	1,254		
03-2C	6 Watts Recessed Wide Dispersion Ceiling speaker with matching transformer including all installation and mounting accessories	No.	48		

National Engineering Services Pakistan Ltd. A&P DIVISION Karachi.

ENGINEER'S COST ESTIMATE

CODE # 03 RECEPTION BLOCK (G+1)

Item No.	Description	Unit	Qty	Rate (Rs.)	Amount (Rs.)
03-3C	Wiring of speakers from PA Rack with 2.5 sq.mm fire resistant 2 core (120 min) LSZH enhanced cable / manufacturer's recommended cable in already installed conduit.	Rft.	1,807		
03-4C	One Port CAT-6A STP RJ45 telecommunication wall outlet with sheet steel back box and face plate including all installation accessories.	No.	1		
03-5C	Remote Microphone Outlet and Wiring from Remote Microphone Outlet upto PA Rack as shown on drawing at Ground Floor with CAT-6A STP LSZH cable / manufacturer's recommended cable in already installed conduit / cable tray.	Rft.	675		
03-6C	Detail engineering designing of Public Address System for Prayer area (Male), having mixer amplifier, headgear and unidirectional dynamic microphone with floor stand, microphone socket outlet, required number of speakers, including any other essential interconnecting equipment, cabling, conduiting, rack as required. Complete in all respect.	Job.	1		

National Engineering Services Pakistan (Pvt.) Ltd. A&P DIVISION Karachi.

Total Cost of (Communication Works) Rs. _____

Carried Over to Summary _____

HOME DEPARTMENT GOVERNMENT OF SINDH

ESTABLISHMENT OF SINDH FORENSIC SCIENCE LABORATORY KARACHI

RECEPTION BLOCK

BILL OF QUANTITIES

LAN Infrastructure

Item No.	Description	Unit	Qty	Rate (Rs.)	Amount (Rs.)
1	24 Port Layer-2 Manageable Network Switch	Fixed configuration manageable layer-2 switch, 24 x 10/100/1000Base T Ports, 4 x 10 GE SFP ports for SFP based uplink connectivity over fibre optics, Forwarding speed: 96 Mpps, Switching capacity 128 Gbps, support 802.1X authentication, MAC address authentication, support multiple VLANs, ACL, with complete installation, testing and minimum one year comprehensive warranty	1		
2	10G SFP+ Modules	10 Gigabit SFP Module Single Mode LX/LH with standard manufacturer warranty and complete in all aspects	4		
3	12 Core Single Mode Fiber Optics cable	12 Core Fiber Optic Cable Single Mode with Steel Tape armoured cable with complete installation, testing and minimum 20 years comprehensive warranty and complete in all aspects	1,000 ft. APA		
4	12 Ports Rack Mountable Fiber Optic Patch Panel	12 Ports Rack Mountable Fiber Optic Patch Panel OFDF Loaded capacity of 06 Nos. of LC Duplex Coupler with complete installation, testing and minimum one year comprehensive warranty and complete in all aspects	1		
5	Fiber Patch Cord	Fiber Patch Cord Duplex LC- LC Patch Cord, LSZH, 1 Meters with	4		
6	Pigtails	Pigtail 1 meter, Single mode with complete installation and	8		
7	Splicing	Fiber Optic Cable Fusion Splicing Single Mode with complete	8		
8	UTP Patch Panel	Patch Panel 24 Port Cat-6 A loaded with Unshielded IO with	1		
9	12 U Floor	12U Wall Mount Rack glass door with 02 Fans and PDU 4 port, Lock	1		
10	Cat-6 A 4 Pair U/UTP Cable	Cat-6 A 4 Pair U/UTP Cable, 305M Box with complete installation, testing and minimum 20 years comprehensive warranty and complete in all aspects	40000 ft. APA		
11	Front Cable	Rack mountable Front Cable Manager of size 1U with complete	1		
12	UTP Patch Cord Cat-6 A of size 1 Meter	UTP Patch Cord Cat-6 A U/UTP of size 1 Meter with complete installation, testing and minimum 20 years comprehensive warranty and complete in all aspects	24		
13	UTP Patch Cord Cat-6 AU/UTP of size 3 Meter	UTP Patch Cord Cat-6 A U/UTP of size 3 Meter with complete installation, testing and minimum 20 years comprehensive warranty and complete in all aspects	24		
14	Face Plate Shuttered Simplex with Cat-6 ATool Less Keystone Jack Unshielded & Back box	Face Plate Shuttered Simplex with Cat-6 A Tool Less Keystone Jack Unshielded & Back box with complete installation, testing and minimum one year comprehensive warranty and complete in all aspects	24		
15	PVC Pipe 1.5 inch	PVC pipe 1.5 inch (10 ft. per length) with complete installation, testing and minimum one year comprehensive warranty and complete in all aspects	500 ft. APA		
16	PVC Pipe 1"	PVC pipe 1 inch (10 ft. per length) with complete installation, testing and minimum one year comprehensive warranty and complete in all aspects	5,000 ft. APA		

LAN Infrastructure

Item No.	Description	Unit	Qty	Rate (Rs.)	Amount (Rs.)
17	UPVC Pipe 2"	UPVC pipe 2 inch (10 ft. per length) with complete installation, testing and minimum one year comprehensive warranty and complete in all aspects	200 ft. APA		
18	Flexible Pipe	Flexible pipe with complete installation, testing and minimum one year comprehensive warranty and complete in all aspects	75 ft. APA		
19	Cable Tray 1feet	Cable tray 1 feet wide of 16 AWG, MS Powder Coated perforated with covers and complete in all aspects	1,000 ft. APA		
20	Cable Ladder 1 feet	1 feet Cable Ladder 16AWG, MS Powder Coated perforated with covers and complete in all aspects	200 ft. APA		
21	UPS 1 KVA with 20 minutes battery backup	UPS 1 KVA with 20 minutes battery backup at full load of 1000 VA with minimum one year comprehensive warranty and complete in all aspects	1		
22	RJ 45 Connectors	RJ 45 connectors for UTP Cable with complete installation, testing and minimum one year comprehensive warranty and complete in all aspects	48		
23	Cable tags and labelling	Polyethylene Cable tags with labelling with complete installation, testing and minimum one year comprehensive warranty and complete in all aspects	1 job		
24	Earthing	Earthing in complete aspects with complete installation, testing and minimum one year comprehensive warranty and complete in all aspects	1 Job		
25	UTP Cable testing	Fluke testing of UTP cabling infrastructure and complete in all aspects	1 Job		
26	Fiber Testing	OTDR Fiber cabling infrastructure testing and complete in all aspects	1 Job		
				Total	

National Engineering Services Pakistan Ltd.
A&P DIVISION Karachi.

HOME DEPARTMENT GOVERNMENT OF SINDH
ESTABLISHMENT OF SINDH FORENSIC SCIENCE LABORATORY KARACHI
BILL OF QUANTITIES

Reception Block

Item No.	Description	Unit	Qty	Unit Rate	Total Amount
	IP based Surveillance System				
1	**Indoor Fixed Dome Camera Type-I** Full HD IP based PoE Indoor Dome camera with 2 Mega Pixel resolution (1920 × 1080), minimum built-in IR distance up to 20 meter or more, 25/30 fps@ full HD, 2.8 mm fixed lens, H.264/H.265 compression, WDR, Back light Compensation (BLC), 10/100/1000 M Ethernet RJ45 Port, Motion Detection, Built in web server, ONVIF support, IP 66 rating, Operating Temperature -10°C to +55°C with junction box size 4x4 and complete installation, configuration & testing and with one year comprehensive warranty or warranty provided by Principal Manufacturer whichever is on higher side.	No.	25		
2	**Indoor Fixed Lens Bullet Camera Type-II** Full HD IP based PoE Indoor Bullet camera with 2 Mega Pixel resolution (1920 × 1080), minimum built-in IR distance up to 20 meter or more, 25/30 fps@ full HD, 2.8 mm fixed lens, H.264/H.265 compression, WDR, Back light Compensation (BLC), 10/100/1000 M Ethernet RJ45 Port, Motion Detection, Built in web server, ONVIF support, IP 66 rating, Operating Temperature -10°C to +55°C with junction box size 4x4 and complete installation, configuration & testing and with one year comprehensive warranty or warranty provided by Principal Manufacturer whichever is on higher side.	No.	5		
3	**48 Port PoE Switch** Fixed configuration PoE enabled manageable layer-2 switch with Rack Mount Kit, 48-Ports 10/100/1000 Mbps RJ-45 interface for camera connectivity over UTP, 2 dual 1G Ports for uplink connectivity (SFP Interface), 802.3af compliant built-in power supply, support PoE cameras on all 48 ports up to 15 watts power simultaneously, power cable, installation, configuration & testing with standard manufacturer warranty	No.	1		
3	**Single mode Fiber Optics cable** 8 Core Fiber Optic Cable Single Mode with Steel Tape armored cable with complete installation, testing and minimum 20 years comprehensive warranty	FT.	3,000 ft APA		
4	**8 Ports Rack Mountable Fiber Optic Patch Panel** 8 Ports Rack Mountable Fiber Optic Patch Panel OFDF Loaded capacity of 04 Nos. of LC Duplex Coupler with complete installation, testing and minimum one year comprehensive warranty	No.	1		
5	**Fiber Patch Cord** Fiber Patch Cord Duplex LC- LC Patch Cord, LSZH, 1 Meters with complete installation, testing and minimum one year comprehensivewarranty	No.	4		

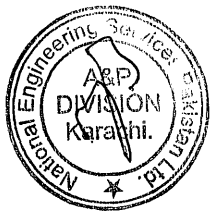
National Engineering Services Pakistan Ltd. A&P DIVISION Karachi.

Reception Block

Item No.	Description	Unit	Qty	Unit Rate	Total Amount
6	**pigtails** Pigtail 1 meter, Single mode with installation in complete aspects and standard manufacturer warranty	No.	8		
7	**Splicing** Fiber Optic cable fusion splicing single mode with complete installation	No.	8		
8	**Dual SFP module** 1 Gigabit dual SFP Module single mode LX/LH with standard warrenty	No.	2		
9	**Cat-6 4 Pair U/UTP Cable** Cat-6 4 Pair U/UTP Cable with complete installationwith minimum 20years comprehensive warranty	No.	10,000 ft. APA		
10	**UTP Patch Panel 48 Port** UTP 48-Port Patch Panel with 48 I/O, complete with rear cable management and all accessories, installation and testing, standard manufacturer warranty	No.	1		
11	**Front Cable Manager 1U** Rack mountable Front Cable Manager of size 1U with complete installation, testing and minimum one year comprehensive warranty	No.	1		
12	**12 U Wall Mount Rack** 12 U Wall Mount Rack glass door with 02 Fans and PDU 4 port, Lock and keys with complete installation, testing and minimum one year comprehensive warranty	No.	1		
13	**UPS 1KVA** UPS 1 KVA with 20 minutes battery backup at full load of 1000 VA with minimum one year comprehensive warranty and complete in all aspects	No.	1		
14	**UTP Patch Cord 1m** UTP Patch Cord Cat-6 U/UTP of size 1 Meter with complete installation, testing and minimum 20 years comprehensive warranty	No.	30		
15	**PVC Pipe 1"** PVC Pipe 1" along with pipe bracket, solvent and installation charges in complete aspects with standard manufacturer warranty	Ft.	2000		
16	**Flexible Pipe** Flexible pipe for cable termination in complete aspects with standard manufacturer warranty	Ft.	300		
17	**UTP Cable testing** Fluke testing of UTP cabling infrastructure complete in all aspects	Job	1		

Reception Block

Item No.	Description	Unit	Qty	Unit Rate	Total Amount
18	**Fiber Testing** OTDR Fiber cabling infrastructure testing in complete aspects.	Job	1		
19	**RJ 45 Connectors** RJ 45 connectors for manufacturer warranty UTP Cable in complete aspects with	No.	60		
30	**Cable tags and labelling** Polyethylene Cable tags with labelling in complete aspects with manufacturer warranty	Job	1		
				Total	



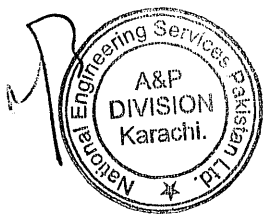
EVIDENCE COLLECTION BLOCK

HOME DEPARTMENT GOVERNMENT OF SINDH
ESTABLISHMENT OF SINDH FORENSIC SCIENCE LABORATORY KARACHI

BILL OF QUANTITIES

CODE # 02 EVIDENCE BLOCK (B+G+1)

Item No.	Description	Unit	Qty	Rate (Rs.)	Amount (Rs.)
	C. CIVIL WORKS				
	STRUCTURAL STEEL WORKS				
	Ref. Sec.No. 3000, 6700				
02-1C	Providing, fabricating and fixing of M.S.pipes (vertical & horizontal) railing of the following with primer & 2 coats of enamel paint finish including fixing complete in all respects as shown on the drawings, specifications and or as directed by the Engineer.				
	A - Staircase railing floor mounted				
	a) Staircase # 1 & 2	Rft.	97		
	CARPENTARY & JOINERY				
	Ref.Sec.No. 4600,6700				
02-3C	Providing and fixing doors of the following types consisting of G.I frame (16 SWG) filled 1:3 mortar comprising solid shutter made of Mahagony wood with vision panel, all around lipping including, access control system as per specified, approved Handle lock, beading/architrave, hinges, fittings, Polish etc., complete in all respects as shown on drawings and schedule & specifications and/or as directed by the Engineer.				
	a) Type D2	Sft.	64		
	b) Type D3	Sft.	140		
	c) Type D4	Sft.	504		
	Providing and fixing doors of the following types consisting of G.I frame (16 SWG) and solid shutter with PVC water proof sheet, golden teak lipping including 1:3 mortar filling in door frame, heavy duty cubical door lock with indicator, beading, architrave, fittings,etc., complete in all respects as shown on drawings and schedule & specifications and/or as directed by the Engineer.				
	d) Type D5	Sft.	140		
02-3C	Providing and fixing kitchen counter of approved design for the following types comprising of 3/4" thick granite top slab with 1-1/2" thick bull nose edge, cutting holes, RCC slab, block masonry with plaster (both sides), 6" thick cement concrete base etc. complete in all respect as shown on the drawing and or as directed by the Engineer.				
	a) Floor mounted with granite top.	Rft.	17		
	ALUMINIUM WORKS				
	Ref. Sec.No. 6220, 6250				
02-5C	Providing and fixing fully glazed anodized aluminum doors, windows and ventilators of approved manufacturer using 2mm thick, 100mm wide extruded deluxe sections with distoration free 5mm thick clear glass, fly proof shutter, hardware, PVC/rubber gasket and sealant including fixing and fixing accesories etc. of the following design types; complete in all respect as shown on the drawings and specification.				
	Doors				
	a) Type D1	Sft.	182		
	b) Type D1a	Sft.	48		



BILL OF QUANTITIES

CODE # 02 EVIDENCE BLOCK (B+G+1)

Item No.	Description	Unit	Qty	Rate (Rs.)	Amount (Rs.)
	Windows				
	a) Type CW	Sft.	199		
	b) Type W	Sft.	120		
	b) Type W1	Sft.	180		
	b) Type W2	Sft.	320		
	c) Type W3	Sft.	15		
	Ventilators				
	a) Type V	Sft.	9		
	b) Type V1	Sft.	6		
	c) Type V2	Sft.	6		
	d) Type V3	Sft.	63		
	BLOCK MASONRY				
	Ref. Sec.No. 4100				
02-6C	Solid block masonry wall of the following thickness set in 1:6 cement sand mortar including stiffener columns, anchor bars, D.P.C & curing etc. Complete in all respects as shown on drawings and as per specificatios (anchor bars shall be paid in BOQ Item No. 03-5C).				
	a) 4 inch thick	Cft.	358		
	b) 6 inch thick	Cft.	5186		
	WATER PROOFING AND BUILT-UP ROOFING				
	Ref. Sec.No. 6411				
02-7C	Providing and laying water proofing treatment over roof slab complete in all respects as shown on the drawings, specifications and or as directed by the Engineer.	Sft.	5827		
02-9C	Crystalline Cementitious water proofing coating (Aquafin-IC or approved equivalent) in wet areas as per manufacturer's recommendations.	Sft.	3456		
	CEMENT PLASTER				
	Ref. Sec.No. 6521				
02-10C	1/2 inch thick 1:6 cement sand plaster to specified interior surfaces etc; complete in all respect as shown on the drawings and specifications and or as directed by the Engineer.	Sft.	27602		
02-11C	2 inch thick 1:4 cement sand plaster band in two layers to specified exterior surfaces, plain as specified fixing of galvanized metal lath with nails on surface to entact the plaster layers etc; complete in all respect as shown on the drawings and specifications and or as directed by the Engineer.	Sft.	682		
02-12C	3/4 inch thick 1:4 cement sand rough base plaster prior to plain band surfaces, complete in all respect as shown on the drawings and specifications and or as directed by the Engineer.	Sft.	682		
02-13C	Providing and applying 3/4" thick comb plaster with 1:4 (cement: Sand) in two layer with fixing aluminium - U in groove 1"X1/2" (H) & aluminium - L 3/4"X1/2" (V). Base plaster 1/2" thick and top layer 1/4" thick with comb trowel finish etc. complete in all respects as shown on the drawings and specifications and or as directed by the Engineer.	Sft.	8019		

BILL OF QUANTITIES

CODE # 02 EVIDENCE BLOCK (B+G+1)

Item No.	Description	Unit	Qty	Rate (Rs.)	Amount (Rs.)
02-14C	Providing and applying 3/4" thick plain plaster with 1:4 (cement: Sand) to specified exterior surfaces, plain as specified fixing of galvanized metal lath with nails on surface to entact the plaster layers etc; complete in all respect as shown on the drawings and specifications and or as directed by the Engineer.	Sft.	3036		
	FALSE CEILING Ref. Sec.No. 6560				
02-15C	Providing and fixing 24" X 24" Mineral Fibre false ceiling with approved suspension system including all accessories, G.I bar hangar with 18 SWG G.I. adjuster at any elevation as per approved sample complete in all respects and or as directed by the Engineer.	Sft.	3971		
	FLOOR AND WALL FINISHES Ref. Sec.No. 6531, 6600				
02-16C	**Floor type A:** 24 x 24 x 3/4 inches thick Marble tile (premimum quality) in approved color/shade and texture, gap filled with grout (as per manufacture recommendation) etc, set inleveling base/mortar (1:3) complete in all respect as shown on the drawing & specification.	Sft.	6436		
02-18C	**Skirting type 1:** 6 inch high marble tile (premimum quality) skirting in approved size, color/shade and texture (tile matched with flooring tile) etc, set in specified cement sand mortar including 1/2" thick rough base plaster (1:6) etc; complete in all respect as shown on the drawing & specification.	Sft.	689		
02-19C	**Floor type B:** 12"x12" full body Porcelain tile (premimum quality) in approved color/shade and texture, gap filled with grout (as per manufacture recommendation) etc, set base/mortar (1:3) complete in all respect as shown on the drawing & specification.	Sft.	814		
02-20C	**Skirting/Dado type 4:** 12"x12" full body pocelain (premimum quality) tile (upto 6ft high) in approved color/ shade and texture, laid along project grid, filled with grout (as per manufacture recommendation), set in specified cement sand mortar including 1/2" thick rough base plaster (1:6) etc; complete in all respect as shown on the drawing & specification.	Sft.	2237		
02-21C	Prepolished Marble (premimum quality) on Tread, riser & skirting of specified size, color and quality including bullnozing (where required), grinding, polishing & buffing, anti slip grooves on treads, washing, cleaning, curing, c.c levelling base (1:3) etc. of the following types; complete in all respect as shown on the drawing and specification.				
	Satircase # 1				
	a) Tread & Landing (3/4" Thick One Piece)	Sft.	147		
	b) Riser & Skirting (1/2" Thick)	Sft.	82		
	Satircase # 2				
	a) Tread & Landing (3/4" Thick)	Sft.	260		
	b) Riser & Skirting (1/2" Thick)	Sft.	150		
02-22C	Providing and laying 3" thick Class - "C" (1:2:4) cement concrete in floor laid in panels with broom finish (on ramp) complete in all respects and or as directed by the Engineer.	Sft.	341		

National Engineering Services Pakistan Ltd. A&P DIVISION Karachi.

BILL OF QUANTITIES

CODE # 02 EVIDENCE BLOCK (B+G+1)

Item No.	Description	Unit	Qty	Rate (Rs.)	Amount (Rs.)
	GRANITE WORKS				
	Ref. Sec.No. 6532				
02-23C	Prepolished granite (premimum quality) on Tread, riser & skirting of specified size, color and quality including bull nozing (where required), grinding, polishing & buffing, making anti slip grooves on treads, washing, cleaning, curing c.c base/mortar (1:3) etc. of the following types; complete in all respect as shown on the drawing and specification. (External Podium & steps)				
	Main Entrance/Podium				
	a) Tread & Landing (3/4" Thick One Piece)	Sft.	403		
	b) Riser & Skirting (1/2" Thick)	Sft.	106		
	C - Rear Entrance				
	a) Tread & Landing (3/4" Thick)	Sft.	56		
	b) Riser & Skirting (1/2" Thick)	Sft.	28		
	PAINTING				
	Ref. Sec.No. 6700				
02-24C	Providing and applying 3 coats of matt emulsion paint to specified wall surfaces including surface preparation & primer etc; complete in all respect as shown on the drawing and specification.	Sft.	17167		
02-25C	Providing and applying 3 coats of matt emulsion paint Black/grey colour to specified ceiling surfaces including surface preparation & primer etc; complete in all respect as shown on the drawing and specification.	Sft.	10772		
02-26C	Proving and applying 3 coats of weather resistant paint to specified surfaces including surface preparation & primer etc; complete in all respect as shown on the drawing and specification.	Sft.	3036		
	MISCELLANIOUS				
02-27C	Providng and fixing precast fairface rain water spouts of approved quality with cement sand mortar (1:2) etc. complete in all respect as shown on the drawing and or as directed by the Engineer.	No.	20		
02-28C	Construction of Evidence Collection Service counter complete in all respect as shown on drawings and or as directed by the Engineer.	Job	1		
02-29C	Fairface pre-cast coping 3000 psi 28 days (Cylinder Strength) using modified Portland cement set with 1:2 cement snad mortar etc. as window sills on cavity walls only, complete in all respects as shown on the drawings and specifications and or as directed by the Engineer. (It includes cost of concrete/reinfrocement/foair face form work, mortar for fixing, fabircation, curing & fixing etc.).	No	30		

National Engineering Services Pakistan Ltd. A&P DIVISION Karachi.

Total Cost of (Civil Works) Rs. _____

Carried Over to Summary _____

ESTABLISHMENT OF SINDH FORENSIC SCIENCE LABORATORY, KARACHI
EVIDENCE COLLECTION BLOCK
BILL OF QUANTITIES

WATER SUPPLY SYSTEM
C.) PLUMBING WORKS

Sr. No.	Description	Quantity	Unit	Rate (PKR)	Amount (PKR)
	INTERNAL PLUMBING FIXTURES				
1.0	Providing & Fixing, SS T-stop cock (½" * ½") of approved make.	32	No.		
1.1	Providing & Fixing, Stainless Steel Wall type Mixer for kitchen sink.	1	No.		
1.2	Providing & Fixing, European type ceramics ware coupled one piece water closet, of approved make and white / light colour of best quality complete in all respect.	9	No.		
1.3	Providing & Fixing, Ceramics ware coupled Urinal, of approved make and white / light colour of best quality complete in all respect.	2	No.		
1.4	Providing and fitting glazed earthen ware wash hand basin, including all accessories.				
	i) Coloured, without pedestal (540*450*210 mm)	10	No.		
	ii) Coloured, with half pedestal (560*440*570 mm)	1	No.		
1.5	Providing and fixing Single Bowl Large SS sink, size (540*440*200mm) including all accessories.	1	No.		
1.6	Providing and fixing Toilet Shower Set for European / Indian type WC.	9	No.		
1.7	Providing and fitting glass shelf including all accessories.	1	No.		
1.8	Providing and fitting Stainless Steel Towel Rail.	6	No.		
1.9	Providing and fitting metal soap dish.	6	No.		
2.0	Providing and fixing single long bib cock.	9	No.		
2.1	Providing and fitting stainless steel toilet paper holder with cover.	9	No.		
	INTERNAL WATER SUPPLY SYSTEM				
2.2	Providing, fixing, jointing and testing Polypropylene Random (PPR) pipes or approved equivalent pressure pipe for cold & hot water as per DIN 8077-8078,PN-20 for pipes and DIN 16962,PN-25 for fittings (polyfusion welded joints) inside building including fittings and specials (sockets, tees, elbows, bends, crosses, reducers, adaptor, plugs and union etc.) supported on walls or suspended from roof slab or run in chases including pipe hangers, supports, cutting and making good the chases and holes, complete in all respects.				
	i) 25 mm	55	Rft.		
	ii) 32 mm	84	Rft.		
	iii) 40 mm	22	Rft.		

National Engineering Services Pakistan Ltd. A&P DIVISION Karachi.

C.) PLUMBING WORKS

Sr. No.	Description	Quantity	Unit	Rate (PKR)	Amount (PKR)
2.3	Providing and installing Ball valves of approved quality of following nominal dia, including jointing, fitting, painting, testing, complete in all respects to match with PPR/uPVC pipes of following diameters.				
	i) 40 mm	1	No.		
	ii) 50 mm	1	No.		
2.4	Supply and installation of electric gyser of following capacity, including ball valves on inlet and outlet connections.				
	i) 25 L	1	No.		
	INTERNAL SEWERAGE SYSTEM				
2.5	Providing, fixing, cutting, jointing and testing uPVC sewerage, Drainage & vent piping conforming to ISO 3633:1991 including uPVC Drainage fittings with solvent cement jointing include cost of clamping to walls and ceiling, hangers, supports, cutting through walls and providing sleeves through concrete slabs for pipelines and pipe fittings of the following diameter complete in all respect.				
	i) 2" i/d	22	Rft.		
	ii) 3" i/d	146	Rft.		
	iii) 4" i/d	213	Rft.		
2.6	Providing and fixing 3" dia cowel for vent pipe.	5	No.		
2.7	Providing and fixing looking glass 55x40 cm size and 5mm thick, first quality.	75	Sq. ft		
2.8	Providing and fixing cast iron & SS-304 angle drain for 3" or 4" dia rainwater pipe with push fit complete in all respects.	5	No.		
	EXTERNAL WATER SUPPLY SYSTEM				
2.9	Excavation of **trenches** in all kinds of soil except cutting rock for Water Supply pipelines upto 5 ft depth from ground level including trimming, dressing sides, leveling the beds of trenches to correct grade and cutting pits for joints complete in all respect.	580	Cft		
3.0	Supplying & filling **sand** under floor; or plugging in walls.	64	Cft		
3.1	Providing, transportation, laying, cutting, butt fusion jointing, testing, commissioning & disinfecting the High Density Polyethylene Pipe (HDPE) PE-100, (PN-10) SDR 17 including fittings and specials conforming to ISO 4427 or DN8074/8075 or equivalent to the satisfaction of Engineer. The pipe shall be from reputable manufacturer approved by				
	i) 32 mm	14	Rft.		
	ii) 40 mm	204	Rft.		
	iii) 50 mm	11	Rft.		

National Engineering Services Pakistan Ltd. A&P DIVISION Karachi.

C.) PLUMBING WORKS

Sr. No.	Description	Quantity	Unit	Rate (PKR)	Amount (PKR)
	EXTERNAL SEWERAGE SYSTEM				
3.2	Providing and fitting, stainless steel-304, Grease Trap of 4'x2'x2' size with 40 gallons capacity with accessories complete in all respect.	1	No.		
3.3	Providing and fitting gully trap, including cement concrete, cost of PVC grating 15x15cm and masonry chamber 30x30cm.	5	No.		
3.4	Excavation of trenches for **sewers** line in all types of soil, including dressing to correct section and dimensions according to templates and levels, shoring and removing surface water, including backfilling with excavated material, compaction of earth, and disposal of excavated materials to locations within the site and / or as designated by the Engineer.				
	i) 0 - 7ft	1370	Cft		
3.5	Watering and ramming brick ballast 1½" to 2" guage mixed with 25% sand, for floor foundation, complete in all respects.	110	Cft		
3.6	uPVC drainage pipes of Popular make or approved quality, including (SN-8) uPVC drainage fittings with solvent cement jointing "Type B" or approved equal, rates include cost of clamping to walls and ceiling, hangers, supports, cutting through walls and providing sleeves through concrete slabs for pipe lines and pipe fittings of the following diameter:				
	i) 8" i/d	121	Rft.		
3.7	Providing and fixing uPVC Mutli Floor Trap of approved quality including PVC grating, Cover and P Trap.	28	No.		
3.8	Construction of square block masonry **manhole** (size 2½' x 2½'), including cover and frame.				
	i) upto 5 ft depth	5	No.		
			TOTAL		

National Engineering Services Pakistan Ltd. A&P DIVISION Karachi.

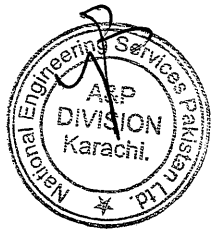
HOME DEPARTMENT GOVERNMENT OF SINDH

ESTABLISHMENT OF SINDH FORENSIC SCIENCE LABORATORY KARACHI

ENGINEERS COST ESTIMATE

FIRE FIGHTING WORKS

CODE # 02 EVIDENCE BLOCK (B+G+1) **Date: 12-04-23**



Item. Each	DESCRIPTION	UNIT	QTY.	UNIT RATE (Rs.)	TOTAL AMOUNT (Rs.)
02-01	Supply, Installation, Testing and Commissioning, Operation and Maintenance of Seamless black steel pipe, conforming to ASTM A-106 schedule 40 and fitting conforming to BS 534, including any sundriess to the system, of following diameter:				
	i) Dia 4 inch (wall thickness 0.237 inches)	RFT	80		
	ii) Dia 3 inch(wall thickness 0.216 inches)	RFT	85		
	iii) Dia 2-1/2 inch (wall thickness 0.203 inches)	RFT	40		
	iv) Dia 2 inch (wall thickness 0.154 inches)	RFT	530		
	v) Dia 1-1/2 inch (wall thickness 0.145 inches)	RFT	410		
	vi) Dia 1 inch (wall thickness 0.133 inches)	RFT	500		
02-02	Supply, Installation, Testing and Commissioning, Operation and Maintenance of Pendant Sprinklers with electroless nickle PTFE plating (K-factor = 5.6) as specified (FM approved and UL listed):				
	i) 68°C temperature	Each	126		
	ii) 79°C temperature	Each	1		
02-03	Supply, Installation, Testing and Commissioning, Operation and Maintenance of Internal Fire Hose cabinet with swinging type drum, 100 ft x 1-1/2" high pressure hose reel with multi-purpose brass nozzle, 1-1/2" hose valve/gate valve, and 25 mm key operated shut off valve within a powder coated, red finish with glass front cabinet, complete in all respects. (FM approved and UL listed). It shall also accommodate 1-1/2" pressure reducing valve as per item # 6	Each	4		
02-04	Supply, Installation, Testing and Commissioning, Operation and Maintenance of Cast iron flanged gate valve PN 16 of following diameters: (FM approved and UL listed):				
	i) Dia 1-1/2 inch	Each	4		

HOME DEPARTMENT GOVERNMENT OF SINDH

ESTABLISHMENT OF SINDH FORENSIC SCIENCE LABORATORY KARACHI

ENGINEERS COST ESTIMATE

FIRE FIGHTING WORKS

CODE # 02 EVIDENCE BLOCK (B+G+1) **Date: 12-04-23**

Item. Each	DESCRIPTION	UNIT	QTY.	UNIT RATE (Rs.)	TOTAL AMOUNT (Rs.)
02-05	Supply, Installation, Testing and Commissioning, Operation and Maintenance of Pressure gauge of 16 bars with stop cock including any sundries (UL listed)	Each	4		
02-06	Supply, Installation, Testing and Commissioning, Operation and Maintenance of Pressure reducing valve with all acessories as shown on drawing (FM approved and UL listed):				
	i) Dia 1-1/2 inch	Each	4		
02-07	Supply, Installation, Testing and Commissioning, Operation and Maintenance of Zone control valve assembly as specified with all accessories (UL listed)				
	i) Dia 4 inch	Each	3		
02-08	Supply, Installation, Testing and Commissioning, Operation and Maintenance of Automatic air release valve of required size as specified	Each	2		
02-09	Supply, Installation, Testing and Commissioning, Operation and Maintenance of Drain Cocks with ball valve	Each	2		
02-10	Supply, Operation and Maintenance of Portable fire extinguisher of following types:				
	i) Dry chemical powder 6 Kg.	Each	7		
	ii) Carbon dioxide 5 kg.	Each	7		
	iii) Wet Chemical 6 Ltr.	Each	1		
02-11	Supply, Operation and Maintenance of Fire Blanket of Medium Size	Each	1		
02-12	Electrical works including connection from LT panel, connection with Building Control System, cabling, cable trays, conduiting and related works is in Contractor scope of works.	Lot	1		
02-13	Relevant civil works required to complete the system including, cutting, patching, repairing, boxing, opening sealing with fire stopping material, plastering etc. complete an all respect.	Lot	1		
02-14	Spare Parts	Lot	1		
02-15	Overall Testing, Commissioning & Balancing of complete system	Lot	1		
02-16	Provisional Sum	-			

TOTAL (PKR)

HOME DEPARTMENT GOVERNMENT OF SINDH

ESTABLISHMENT OF SINDH FORENSIC SCIENCE LABORATORY KARACHI

EVIDENCE BLOCK

BILL OF QUANTITIES

Electrical Works

Item No.	Description	Unit	Qty	Rate (Rs.)	Amount (Rs.)

IMPORTANT NOTES (Applicable to all Electrical Items)

All electrical items given below shall be read in conjuction with parts of the Specifications and electrical drawings except otherwise indicated.

The Electrical Works include design, supply, transportation, installation, testing and commissioning of the following items of works as mentioned in this BOQ (unless specifically stated otherwise) including all material, labour, tools, accessories, related civil works, etc., as required for proper completion of each item as per specifications unless otherwise mentioned. (Any necessary material not mentioned in specifications, electrical drawings and here in this BOQ required for proper installation, testing and commissioning of equipment and materials shall be included in BOQ rates.

1.0 WIRING AND ACCESSORIES

1.1	Wiring of light or fan point from switch board/dimmer to the point with 3x1.5 mm2 (P+N+E) PVC insulated single core stranded cables in 25 mm PVC conduit/pipe concealed in walls, columns and slabs including accessories, PVC box, 10 Amp. gang switch 1 or 2 way as required, one for each light or fan and installed as in specifications complete in all respects.	Each	180
1.2	Circuit wiring from DB MCBs to gang switches board and from switch board to another switch board with 3x2.5 mm2 (P+N+E) PVC insulated single core stranded cables in 25mm PVC pipe/conduit concealed in walls, columns and slabs as required complete in all respects.	Each	15
1.3	The same as item No. 1.1 but from one light point to another light point.	Each	110
1.4	10/13 Amp 3 pin universal flush mounting switch socket outlet wired from DB MCBs to first outlet with 3x4 mm2 (P+N+E) single core cable stranded (away from switch board) in 25mm PVC pipe/conduit concealed in walls, columns and slabs as required complete in all respects.	Each	30
1.5	The same as item No.1.4 but wiring from one socket outlet to another socket outlet with 3x2.5 mm2 (P+N+E) single core stranded cable in 25mm PVC pipe/conduit concealed in walls, columns and slabs as required complete in all respects.	Each	50
1.6	20 Amp 3 pin universal flush mounting switch socket outlet wired from DB MCBs to independent socket outlet with 3x6 mm2 (P+N+E) single core stranded cable (away from switchboard) in 25mm PVC pipe/conduit concealed in walls, columns and slabs as required complete in all respects.	Each	41

2.0 LIGHTING FIXTURES & FANS

Following LED Luminaries of suitable wattage make Philips, GE, Pierlite or approved equivalent suitable for the project requirements. Contractor to submit lighting design calculation to determine the adequacy of the wattage and should adjust the number of LEDs/wattage as per project lighting requirements. The fitting shall be approved by the Engineer.

National Engineering Services Pakistan Ltd. A&P DIVISION Karachi.

BILL OF QUANTITIES

Electrical Works

Item No.	Description	Unit	Qty	Rate (Rs.)	Amount (Rs.)
2.1(a)	Light Fixture Type LED Batten surface mounted, 10W above mirror in toilets complete in all respect with allied accessories make Philips, GE, Pierlite or approved equivalent. The fitting shall be approved by the Engineer.	Each	10		
2.1(b)	Light Fixture Type LED Batten surface mounted , 18W complete in all respect with allied accessories make Philips, GE, Pierlite or approved equivalent. The fitting shall be approved by the Engineer.	Each	88		
2.1(c)	Light Fixture Type LED Water tight, 30W, complete in all respect with allied accessories make Philips, GE, Pierlite or approved equivalent. The fitting shall be approved by the Engineer.	Each	15		
2.1(d)	Light Fixture Type LED panel 2'x2', 40W recessed mounted complete in all respect with allied accessories make Philips, GE, Pierlite or approved equivalent. The fitting shall be approved by the Engineer.	Each	100		
2.1(e)	Light Fixture Type LED Recessed Type down lighter, 18W, complete in all respect with allied accessories make Philips, GE, Pierlite or approved equivalent. The fitting shall be approved by the Engineer.	Each	142		
2.1(f)	Light Fixture Type LED Recessed Type down lighter, 14W, complete in all respect with allied accessories make Philips, GE, Pierlite or approved equivalent. The fitting shall be approved by the Engineer.	Each	25		
2.1(g)	Light Fixture Type LED Planter Light IP-65, 15W, complete in all respect with allied accessories make Philips, GE, Pierlite or approved equivalent. The fitting shall be approved by the Engineer.	Each	4		
2.1(h)	Wall bracket fan 24" sweep make (Royal, Pak, GFC or approved equivalent) capacitor type, copper winding complete with all required accessories etc. The fitting shall be approved by the Engineer.	Each	6		
2.1(i)	Exhaust fan 12" sweep make (Royal, Pak, GFC or approved equivalent) capacitor type, copper winding complete with all required accessories etc. The fitting shall be approved by the Engineer.	Each	15		
3.0	**PVC CONDUIT**				
3.1	PVC pipe/conduit Class-B 100 mm dia with accessories suitable for laying multi-core cables	Rft	100		
3.2	PVC pipe/conduit 50 mm dia with accessories suitable for laying multi-core cables	Rft	100		
3.3	PVC pipe/conduit Class-D 100 mm dia with accessories suitable for laying multi-core cables	Rft	50		
4.0	**CABLE TRAY**				
4.1	Supply and Installation of 16 SWG thick galvanized steel perforated cable tray/ladder with all supporting hangers, cover, brackets, elbows, tee & mounting accessories complete in all respects as required.				
(a)	100 mm x 50 mm	Rft	100		
(b)	150 mm x 50 mm	Rft	100		

National Engineering Services Pakistan Ltd. A&P DIVISION Karachi.

BILL OF QUANTITIES

Electrical Works

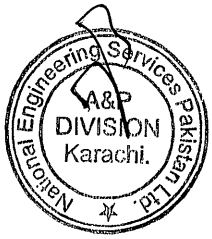
Item No.	Description	Unit	Qty	Rate (Rs.)	Amount (Rs.)
5.0	**LOW VOLTAGE ELECTRICAL POWER CABLES**				
5.1	Supply, installation, testing, commissioning and termination of following sizes of PVC insulated 600/1000 Voltage grade unarmoured Copper cables laid direct in ground, pulled in PVC pipe already laid, on surface of wall or cable trays etc including all accessories as required complete in all respects (Imported copper shall be used. Verified documentary evidence for source of copper & PVC shall be furnished prior to manufacturing)				
(a)	4 core 120 mm^2 (For MPB-Evidence Block)	Rft	300		
(b)	4 core 16 mm^2 (FOR DB-GF-Zone-01)	Rft	100		
(c)	4 core 10 mm^2 (FOR DB-GF- Zone-02, DB-FF-Zone-01& 02 & DB-Basement)	Rft	400		
5.2	Supply, installation, testing, commissioning and termination of following sizes of PVC insulated single core 450/750 Voltage grade unarmoured Copper cables as circuit protective conductor/ earth continuity conductor (CPC/ECC) laid direct in ground, pulled in PVC pipe already laid, on surface of wall or cable trays etc. including all accessories as required complete in all respects (Imported copper shall be used. Verified documentary evidence for source of copper & PVC shall be furnished prior to manufacturing)				
(a)	1 core 70 mm^2	Rft	300		
(b)	1 core 25 mm^2	Rft	100		
(c)	1 core 16 mm^2	Rft	100		
(d)	1 core 10 mm^2	Rft	400		
6.0	**EARTHING SYSTEM** Supply, installation, testing and commissioning of following items for Earthing system for grounding of the electrical installation with all allied accessories as required complete in all respects.				
6.1	Providing and fixing of copper deposited steel rod earth point including all accessories and civil works complete in all respects as required and shown in drawing.	Each	4		
7.0	**LV DISTRIBUTION BOARDS**				
7.1	Supply, Installation, testing and commissioning of following Distribution Boards with 14/16 SWG sheet steel housing (14 SWG for Floor Standing & 16 SWG for Wall Mounted) with approved colour and having specified circuit breakers, CTs, VTs, selector switches, push buttons, LED indication lights, as shown on drawings and mentioned below cubicle with electrolytic copper bus bar with electrical grade PVC mountings 3 for each, nuts, bolts and washers, control MCB etc. with all allied accessories complete in all respects as required				
(a)	**DB-GF- Zone-01** - 01 No. Incoming 80 Amp (Adj.) MCCB, TP, RC= 25kA - 10 Nos. Outgoing 10 Amp MCB, SP, RC, 10 kA 13 Nos. Outgoing 20 Amp MCB, SP, RC, 10 kA - 04 Nos. Outgoing 10/20 Amp (spare) MCB, SP, RC, 10 kA 03 Nos. Outgoing 10/20 Amp (space) MCB, SP, RC, 10 kA	Each	1		

National Engineering Services Pakistan Ltd. Karachi DIVISION A&P

BILL OF QUANTITIES

Electrical Works

Item No.	Description	Unit	Qty	Rate (Rs.)	Amount (Rs.)
	- Indication lights, ammeter with selector switch, voltmeter with selector switch, Panel box SWG 16 powder coated RAL colour 7032, IP class 44 and with all accessories.				
	(b) **DB-GF-Zone-02, DB-FF-Zone-01&02 & DB-Basement** - 01 No. Incoming 50 Amp (Adj.) MCCB, TP, RC= 25kA - 07 Nos. Outgoing 10 Amp MCB, SP, RC, 10 kA - 07 Nos. Outgoing 20 Amp MCB, SP, RC, 10 kA - 04 Nos. Outgoing 10/20 Amp (spare) MCB, SP, RC, 10 kA 03 Nos. Outgoing 10/20 Amp (space) MCB, SP, RC, 10 kA - Indication lights, ammeter with selector switch, voltmeter with selector switch, Panel box SWG 16 powder coated RAL colour 7032, IP class 44 and with all accessories.	Each	4		
8.0	**MAIN PANEL BOARD**				
8.1	Main panel board designated with all installation and operational accessories as per site requirements, as per tender specifications and as directed by the Engineer. The MPB shall comprise the following:				
	(a) **MPB-Evidence Block** INCOMING - 01 No. 250 Amps (Adj.) TP MCCB RC=36kA - 06 Nos. 2/25 Amps Protection Fuses - 01 No. VSS (RY-YB-BR-OFF-RN) 7-position - 01 No. 0-600 Volts AC DIGITAL Voltmeter - 03 Nos. 300/5 Amps Current Transformers - 01 No. ASS (R-Y-B-OFF) 4-position - 01 No. 0-300 Amps AC DIGITAL Ammeter - 06 Nos. RYB and ON OFF TRIP LED indication lights OUTGOING - 01 No.80 Amp (Adj.) MCCB, TP, RC= 25kA (For DB-GF-Zone-01) - 04 Nos.50 Amp (Adj.) MCCB, TP, RC= 25kA (For DB-GF-Zone-02, DB-FF-Zone-01& 02 & DB-Basement) - 01 No. 50 Amps (spare)(adj.) TP MCCB RC= 25kA - 01 No. 80 Amps (spare)(adj.) TP MCCB RC= 25kA - 01 No. 100 Amps (space)(adj.) TP MCCB RC= 25kA - 14 SWG powder painted 01-cubicle with electrolytic copper bus bar with electrical grade PVC mountings 3 for each, nuts, bolts and washers etc.	Job	1		
9.0	**EMERGENCY AND EXIT LIGHTING WITH CENTRAL BATTERY SYSTEM** Supply, testing and commissioning of addressable emergency and exit lighting with central battery system comprising of following equipment including all allied accessories complete in all respect as required. The system shall be approved by the Engineer.				
9.1	PVC insulated 2-core, fire rated 1.5mm^2 cable in 25 mm dia. PVC conduit (From CBS panel to devices) complete with all allied accessories. (Prysmian, Cavicel (Italy), Belden, Firecell or approved equivalent)	Rft.	500		
9.2	Supply, Testing and Commissioning of Addressable Sub-Main central battery system input 220VAC and output 216VDC CEAG or equally approved ABB, Emerson. The Sub-Panel must be equipped with spare reserve for final assembly up to final circuits with 1 hour battery backup, Complete with all necessary fixing accessories. The system shall have an option of saving configuration through SD card	Each	1		



BILL OF QUANTITIES

Electrical Works

Item No.	Description	Unit	Qty	Rate (Rs.)	Amount (Rs.)
9.3	Addressable high performance SAFELITE having 400 lm wall/ceiling mounted emergency LED luminaire.	Each	25		
9.4	Addressable High performance LED emergency exit sign luminaire with 24LED strip and 20m viewing distance, plug in removable legend configurable for surface and recessed mounting.	Each	10		
9.5	Testing & Commissioning of Entire Centralized Battery System as per project specified requirements complete in all respect.	Job	1		
	Note :Contractor is advised to submit complete technical data of the system to the Engineer for approval before commencement of work at site.				

Total Cost of (Electrical Works) Rs. _____

Carried Over to Summary _____

National Engineering Services Pakistan Ltd. A&E DIVISION Karachi.

HOME DEPARTMENT GOVERNMENT OF SINDH
ESTABLISHMENT OF SINDH FORENSIC SCIENCE LABORATORY KARACHI

BILL OF QUANTITIES

CODE # 02 EVIDENCE BLOCK (B+G+1+R)

Item No.	Description	Unit	Qty	Rate (Rs.)	Amount (Rs.)
	C. COMMUNICATION WORKS				
	ADDRESSABLE FIRE ALARM SYSTEM				
	Ref. Sec.No. 8331				
02-1C	1" dia PVC conduit installed concealed including all installation and mounting accessories.	Rft.	1,161		
02-2C	1.5 sq.mm fire resistant 2 core (120 min) LSZH enhanced cable complying BS5839, BS6387, and EN50200 in already installed conduit.	Rft.	1,161		
02-3C	Intelligent addressable multi optical and heat detector complete with built-in isolator, base including all mounting and installation accessories.	No.	24		
02-4C	Intelligent addressable heat detector complete with built-in isolator, base including all mounting and installation accessories.	No.	10		
02-5C	Addressable manual call point including built-in isolator module including all mounting and installation accessories.	No.	6		
02-6C	Addressable loop powered audio visual sounder with built-in isolator including all mounting and installation accessories.	No.	7		
02-7C	Addressable loop powered monitor / output module with manufaturer's recommended interfacing cable including all mounting and installation accessories.	No.	2		
02-8C	Addressable loop powered monitor / input module with manufaturer's recommended interfacing cable including all mounting and installation accessories.	No.	2		
02-9C	Adressable Fire alarm repeater/Annunciation panel including all mounting and installation accessories.	No.	1		

National Engineering Services Pakistan Ltd. A&P DIVISION Karachi.

BILL OF QUANTITIES

CODE # 02 EVIDENCE BLOCK (B+G+1+R)

Item No.	Description	Unit	Qty	Rate (Rs.)	Amount (Rs.)
	PUBLIC ADDRESS SYSTEM Ref. Sec.No. 8341				
02-1C	1" dia PVC conduit installed concealed including all installation and mounting accessories.	Rft.	1,254		
02-2C	6 Watts Recessed Wide Dispersion Ceiling speaker with matching transformer including all installation and mounting accessories	No.	48		
02-3C	Wiring of speakers from PA Rack with 2.5 sq.mm fire resistant 2 core (120 min) LSZH enhanced cable / manufacturer's recommended cable in already installed conduit.	Rft.	1,807		
02-4C	One Port CAT-6A STP RJ45 telecommunication wall outlet with sheet steel back box and face plate including all installation accessories.	No.	1		
02-5C	Remote Microphone Outlet and Wiring from Remote Microphone Outlet upto PA Rack as shown on drawing at Ground Floor with CAT-6A STP LSZH cable / manufacturer's recommended cable in already installed conduit / cable tray.	Rft.	1		

Total Cost of (Communication Works) Rs. _____

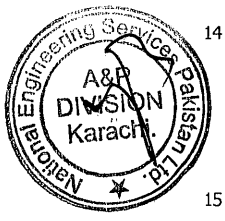
Carried Over to Summary _____

National Engineering Services Pakistan (Pvt.) Ltd. A&P DIVISION Karachi.

HOME DEPARTMENT GOVERNMENT OF SINDH
ESTABLISHMENT OF SINDH FORENSIC SCIENCE LABORATORY KARACHI
EVIDENCE BLOCK
BILL OF QUANTITIES

LAN Infrastructure

Item No.	Description	Unit	Qty	Rate (Rs.)	Amount (Rs.)
1	24 Port Layer-2 Manageable Network Switch	Fixed configuration manageable layer-2 switch, 24 x 10/100/1000Base T Ports, 4 x 10 GE SFP ports for SFP based uplink connectivity over fibre optics, Forwarding speed: 96 Mpps, Switching capacity 128 Gbps, support 802.1X authentication, MAC address authentication, support multiple VLANs, ACL, with complete installation, testing and minimum one year comprehensive warranty	1		
2	10G SFP+ Modules	10 Gigabit SFP Module Single Mode LX/LH with standard manufacturer warranty and complete in all aspects	4		
3	12 Core Single Mode Fiber Optics cable	12 Core Fiber Optic Cable Single Mode with Steel Tape armoured cable with complete installation, testing and minimum 20 years comprehensive warranty and complete in all aspects	1,000 ft. APA		
4	12 Ports Rack Mountable Fiber Optic Patch Panel	12 Ports Rack Mountable Fiber Optic Patch Panel OFDF Loaded capacity of 06 Nos. of LC Duplex Coupler with complete installation, testing and minimum one year comprehensive warranty and complete in all aspects	1		
5	Fiber Patch Cord	Fiber Patch Cord Duplex LC- LC Patch Cord, LSZH, 1 Meters with	4		
6	Pigtails	Pigtail 1 meter, Single mode with complete installation and	8		
7	Splicing	Fiber Optic Cable Fusion Splicing Single Mode with complete	8		
8	UTP Patch Panel 48 Port	Patch Panel 48 Port Cat-6 A loaded with Unshielded IO with complete installation, testing and minimum one year comprehensive warranty and complete in all aspects	1		
9	27 U Floor Standing Rack	27U Wall Mount Rack glass door with 02 Fans and PDU 4 port, Lock and keys with complete installation, testing and minimum one year comprehensive warranty and complete in all aspects	1		
10	Cat-6 A 4 Pair U/UTP Cable	Cat-6 A 4 Pair U/UTP Cable, 305M Box with complete installation, testing and minimum 20 years comprehensive warranty and complete in all aspects	40000 ft. APA		
11	Front Cable Manager 1U	Rack mountable Front Cable Manager of size 1U with complete installation, testing and minimum one year comprehensive warranty and complete in all aspects	1		
12	UTP Patch Cord Cat-6 A of size 1 Meter	UTP Patch Cord Cat-6 A U/UTP of size 1 Meter with complete installation, testing and minimum 20 years comprehensive warranty and complete in all aspects	48		
13	UTP Patch Cord Cat-6 AU/UTP of size 3 Meter	UTP Patch Cord Cat-6 A U/UTP of size 3 Meter with complete installation, testing and minimum 20 years comprehensive warranty and complete in all aspects	48		
14	Face Plate Shuttered Simplex with Cat-6 ATool Less Keystone Jack Unshielded & Back box	Face Plate Shuttered Simplex with Cat-6 A Tool Less Keystone Jack Unshielded & Back box with complete installation, testing and minimum one year comprehensive warranty and complete in all aspects	5		
15	Face Plate Shuttered Simplex with Cat-6 A Tool Less Keystone Jack Unshielded & Back box	Face Plate Shuttered Simplex with Cat-6 A Tool Less Keystone Jack Unshielded & Back box with complete installation, testing and minimum one year comprehensive warranty and complete in all aspects	38		
16	PVC Pipe 1.5 inch	PVC pipe 1.5 inch (10 ft. per length) with complete installation, testing and minimum one year comprehensive warranty and complete in all aspects	500 ft. APA		



LAN Infrastructure

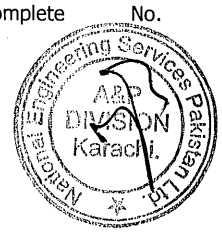
Item No.	Description	Unit	Qty	Rate (Rs.)	Amount (Rs.)
17	PVC Pipe 1"	PVC pipe 1 inch (10 ft. per length) with complete installation, testing and minimum one year comprehensive warranty and complete in all aspects	5,000 ft. APA		
18	UPVC Pipe 2"	UPVC pipe 2 inch (10 ft. per length) with complete installation, testing and minimum one year comprehensive warranty and complete in all aspects	200 ft. APA		
19	Flexible Pipe	Flexible pipe with complete installation, testing and minimum one year comprehensive warranty and complete in all aspects	75 ft. APA		
20	Cable Tray 1feet	Cable tray 1 feet wide of 16 AWG, MS Powder Coated perforated with covers and complete in all aspects	1,000 ft. APA		
21	Cable Ladder 1 feet	1 feet Cable Ladder 16AWG, MS Powder Coated perforated with covers and complete in all aspects	200 ft. APA		
22	UPS 3 KVA with standard battery backup	UPS 3 KVA with Standard battery backup with minimum one year comprehensive warranty and complete in all aspects	1		
23	RJ 45 Connectors	RJ 45 connectors for UTP Cable with complete installation, testing and minimum one year comprehensive warranty and complete in all aspects	96		
24	Cable tags and labelling	Polyethylene Cable tags with labelling with complete installation, testing and minimum one year comprehensive warranty and complete in all aspects	1 job		
25	Earthing	Earthing in complete aspects with complete installation, testing and minimum one year comprehensive warranty and complete in all aspects	1 Job		
26	UTP Cable testing	Fluke testing of UTP cabling infrastructure and complete in all aspects	1 Job		
27	Fiber Testing	OTDR Fiber cabling infrastructure testing and complete in all aspects	1 Job		
				Total	

National Engineering Services Pakistan Ltd. A&T DIVISION Karachi

HOME DEPARTMENT GOVERNMENT OF SINDH
ESTABLISHMENT OF SINDH FORENSIC SCIENCE LABORATORY KARACHI
BILL OF QUANTITIES

Evidence Block

Item No.	Description	Unit	Qty	Unit Rate	Total Amount
	IP based Surveillance System				
1	**Indoor Fixed Dome Camera Type-I** Full HD IP based PoE Indoor Dome camera with 2 Mega Pixel resolution (1920 × 1080), minimum built-in IR distance up to 20 meter or more, 25/30 fps@ full HD, 2.8 mm fixed lens, H.264/H.265 compression, WDR, Back light Compensation (BLC), 10/100/1000 M Ethernet RJ45 Port, Motion Detection, Built in web server, ONVIF support, IP 66 rating, Operating Temperature -10°C to +55°C with junction box size 4x4 and complete installation, configuration & testing and with one year comprehensive warranty or warranty provided by Principal Manufacturer whichever is on higher side.	No.	12		
2	**Indoor Fixed Lens Bullet Camera Type-II** Full HD IP based PoE Indoor Bullet camera with 2 Mega Pixel resolution (1920 × 1080), minimum built-in IR distance up to 20 meter or more, 25/30 fps@ full HD, 2.8 mm fixed lens, H.264/H.265 compression, WDR, Back light Compensation (BLC), 10/100/1000 M Ethernet RJ45 Port, Motion Detection, Built in web server, ONVIF support, IP 66 rating, Operating Temperature -10°C to +55°C with junction box size 4x4 and complete installation, configuration & testing and with one year comprehensive warranty or warranty provided by Principal Manufacturer whichever is on higher side.	No.	12		
3	**48 Port PoE Switch** Fixed configuration PoE enabled manageable layer-2 switch with Rack Mount Kit, 48-Ports 10/100/1000 Mbps RJ-45 interface for camera connectivity over UTP, 2 dual 1G Ports for uplink connectivity (SFP Interface), 802.3af compliant built-in power supply, support PoE cameras on all 48 ports up to 15 watts power simultaneously, power cable, installation, configuration & testing with standard manufacturer warranty	No.	1		
4	**Single mode Fiber Optics cable** 8 Core Fiber Optic Cable Single Mode with Steel Tape armored cable with complete installation, testing and minimum 20 years comprehensive warranty	FT.	5,000 ft APA		
5	**8 Ports Rack Mountable Fiber Optic Patch Panel** 8 Ports Rack Mountable Fiber Optic Patch Panel OFDF Loaded capacity of 04 Nos. of LC Duplex Coupler with complete installation, testing and minimum one year comprehensive warranty	No.	1		
6	**Fiber Patch Cord** Fiber Patch Cord Duplex LC- LC Patch Cord, LSZH, 1 Meters with complete installation, testing and minimum one year comprehensivewarranty	No.	4		
7	**pigtails** Pigtail 1 meter, Single mode with installation in complete aspects and standard manufacturer warranty	No.	8		
8	**Splicing** Fiber Optic cable fusion splicing single mode with complete installation	No.	8		



Evidence Block

Item No.	Description	Unit	Qty	Unit Rate	Total Amount
9	**Dual SFP module** 1 Gigabit dual SFP Module single mode LX/LH with standard warrenty	No.	2		
10	**Cat-6 4 Pair U/UTP Cable** Cat-6 4 Pair U/UTP Cable with complete installationwith minimum 20years comprehensive warranty	No.	15,000 ft. APA		
11	**UTP Patch Panel 48 Port** UTP 48-Port Patch Panel with 48 I/O, complete with rear cable management and all accessories, installation and testing, standard manufacturer warrantv	No.	1		
12	**Front Cable Manager 1U** Rack mountable Front Cable Manager of size 1U with complete installation, testing and minimum one year comprehensive warrantv	No.	1		
13	**12 U Wall Mount Rack** 12 U Wall Mount Rack glass door with 02 Fans and PDU 4 port, Lock and keys with complete installation, testing and minimum one vear comprehensive warrantv	No.	1		
14	**UPS 1KVA** UPS 1 KVA with 20 minutes battery backup at full load of 1000 VA with minimum one year comprehensive warranty and complete in all aspects	No.	1		
15	**UTP Patch Cord 1m** UTP Patch Cord Cat-6 U/UTP of size 1 Meter with complete installation, testing and minimum 20 years comprehensive warrantv	No.	24		
16	**PVC Pipe 1"** PVC Pipe 1" along with pipe bracket, solvent and installation charges in complete aspects with standard manufacturer warrantv	Ft.	2200 ft. APA		
17	**Flexible Pipe** Flexible pipe for cable termination in complete aspects with standard manufacturer warranty	Ft.	300 ft. APA		
18	**UTP Cable testing** Fluke testing of UTP cabling infrastructure complete in all aspects	Job	1		
19	**Fiber Testing** OTDR Fiber cabling infrastructure testing in complete aspects.	Job	1		
20	**RJ 45 Connectors** RJ 45 connectors for manufacturer warranty UTP Cable in complete aspects with	No.	48		
21	**Cable tags and labelling** Polyethylene Cable tags with labelling in complete aspects with manufacturer warranty	Job	1		
				Total	

National Engineering Services Pakistan A&P DIVISION Karachi

FORENSIC SCIENCE LABORATORY, KARACHI
HOME, DEPARTMENT, GOVERNMENT OF SINDH
SCHEDULE OF PRICES (SOP)

EVIDENCE BLOCK (G+1)

Item No.	Description	Unit	Quantity	Rate (Rs.)	Amount (Rs.)
	HVAC WORKS				
1	Supply and installation of Decorative Cooling/Heating Ceiling Cassette Type and Ceiling Concealed Ducted Type DX-Variable Refrigerant Flow (VRF) Air Conditioners with DC inverter including Distributers, Thermostats, LED, Expansion Valve with all Indoor Units, , refrigerant piping, insulation, etc. as per specification/drawings, transportation, unloading, storage, lifting, and fixing at locations including all taxes and duties complete in all respect.				
a)	CIU-1 (Capacity Nominal 18000 BTU/HR) Decorative Ceiling cassette Type Indoor Unit	No.	7		
b)	TFU-1 (Capacity Nominal 48000 BTU/HR, Air Flow 600 CFM, ESP 1") Ceiling Concealed Ducted Type Fresh Air Indoor Unit	No.	1		
c)	VRF-OD-1(Capacity Nominal 174000 BTU/HR)	No.	1		
d)	Refrigerant Piping including insulation	Lot	1		
2	Supply and installation of Decorative Wall Mounted indoor units, outdoor condensing units and hanging arrangements, including refrigerant pipe, and insulation, complete in all respect.				
a)	SAC-1/ OU-1 (Nominal Capacity = 18,000 BTU/HR) - Decorative Wall Mounted Type Unit	No.	2		
3	Supply and installation of hangers and supports for ducting works and VRF units, including all taxes and duties.	Lot	1		
4	Supply, Installation, Testing & Commissioning of Ventilation Fans of Type & Charcteristics as Specified and Scheduled, Complete in all Respect with Un-Loading, Transportation, Insurance, Lifting, Storage and Fixing at Locations Including all Taxes and Duties.				
a)	EF-1	No.	6		
b)	EF-2	No.	4		
c)	EF-3	No.	1		
d)	EF-4	No.	2		
5	Supply, fabrication and installation of G.I. Sheet Metal Ductworks complete splitter dampers, bracings etc. including all taxes and duties.				
a-1)	US Gauge 26	Sft	400		
a-2)	US Gauge 24	Sft	100		
6	Supply, fabrication and installation of Volume Dampers including all taxes and duties.	Sft	15		
7	Supply & installation of G.I, Air Inlets/Outlets, transportation, unloading, storage, lifting, and fixing at locations including all taxes and duties.				
a)	Code A: Supply Air Diffuser Square Face Rectangular Neck	Sft	7		
b)	Code B: Exhaust Air Diffuser Square Face Rectangular Neck	Sft	8		
c)	Code C: Outdoor Air Sand Trap Anti Bird & Anti Vermin Screen Louvers	Sft	10		
d)	Code D: Exhaust Air Sand Trap Anti Bird & Anti Vermin Screen Louvers	Sft	10		
8	Supply, installation, testing and commissioning of complete electrical equipment/material and controls as per specifications and drawings including all taxes and duties.				
a)	ACP-01	No.	1		
b)	ACP-02	No.	1		
b)	All electrical works as specified except MCC and ACP mentioned under item (a) above including all HVAC equipment, Wiring works complete in all respect	Lot	1		
9	Relevant civil works required to complete the system including, equipment foundations, cutting, patching, repairing, boxing, opening, sealing, plastering, painting etc. complete an all respect.	Lot	1		
				Total Cost (Rs.) (Carried Forward - Summary)	

National Engineering Services Pakistan Ltd. A&R DIVISION Karachi.

HOME DEPARTMENT GOVERNMENT OF SINDH

ESTABLISHMENT OF SINDH FORENSIC SCIENCE LABORATORY KARACHI

BILL OF QUANTITIES

CODE # 02 EVIDENCE BLOCK (B+G+1)

Item No.	Description	Unit	Qty	Rate (Rs.)	Amount (Rs.)
	ELEVATOR WORKS Ref. Specifications				
02-01	Supply, Installation, testing and Commissioning of imported brand new Simplex Elevator, Machine Room Less (MRL Type), heavy duty fully complied and certified by EN 81-20, EN 81-50 and EN 81-70 Standards of minimum features including but not limited to VVVF high efficiency motor, complete inside stainless steel or as approved by the engineer finish,indoor type for ambient condition of 0~40 °C, capacity of 1000 kg, Cabin Size 1100 mm x 2100 mm x 2300 mm (W×D×H), speed 1.0 m/s, 03 stops/03 openings, approx. total travel height 7.3 meter, entrance 900 mm. Lift shall minimum includes car, hoisting machinery, counter-weight, supports, brackets, automatic controls,embedded parts, access ladder, separator screen & trap door, electric overload, shaft lightening, intercom system, gong, emergency operation for cabin/door, emergency rescue device (ups/battery) safety devices & Manual emergency operation lever, all essential spare parts for use for one (01) year of defect liability period complete in all respects as per specification & Drawings and according to EN 81 standard compliance.All taxes/duties shall be included.	No.	1		
02-02	Civil and Allied Works relevant to necessary adjustments which will be required during installation of new equipment.	Lot	1		
02-03	Electrical & Ancillary Works for elevator, fan & AC including outside DB to elevator, breakers cabling and other accessories etc. (Complete in all respect).				
a)	Electrical DB	No.	1		
b)	Relevant electrical works including cables, conduits, hangers, supports etc. complete in all respect except DB mentioned in Item here above.	Lot	1		
02-04	Supply and installation of exhaust fan propeller type of size 800 CFM	No.	1		
02-05	Supply and installation of Split Air Conditioner Inverter type of Capacity 2TR	No.	1		
02-06	Pre shipment/Third party Inspection as specified in bidding documents	Lot	1		
02-07	Third party validation for Testing & commissioning of elevator in Pakistan	Lot	1		
02-08	Regular daily Operation (10 hours/day, 6 days/week and 300 days/year) during One (01) year of Defects Liability Period.	Months	12		

National Engineering Services Pakistan Ltd. A&P DIVISION Karachi.

Total Cost of (Elevator Works) Rs. _____

Carried Over to Summary _____

LIST OF APPROVED MANUFACTURERS

NATIONAL ENGINEERING SERVICES PAKISTAN (PVT.) LTD.
ARCHITECTURE & PLANNING DIVISION

LIST OF APPROVED MANUFACTURERS/BRANDS OFMATERIALS/EQUIPMENT

1. Brand Name approved this list of manufactures/suppliers of different materials/equipment with brand names has been provided in order to establish a standard level of performance and do not necessarily indicate a preference for a particular manufacture or material.

2. List of Manufacturer recommended and as approved the names of manufacturer recommended given below are indicate the level of quality and performance of such material/equipment is the sole opinion of the Architect/Engineer are at least equal to better than the material offered by the recommended manufacture listed under:

Civil & Architectural Items

Sr. No.	Materials	Manufactures
1.	Crushed Stone Aggregate	Source as approval by the Engineer
2.	Reinforcement Steel	i) Amrelli, ii) Razzaq, iii) Prime, iv) Naveena, v) Agha, vi) Faizan Steel or approved equivalent
3.	Sand	Source as approved by the Engineer
4.	Cement	(i) Pakland (ii) Falcon, (iii) Power, (iv) Lucky, (v) D.G. Cement or approved equivalent
5.	Porcelain Tiles	Premium Quality locally made (Master, Shabbir or approved equivalent)
6.	Paints & Varnish	(i) ICI, (ii) Berger, (iii) Jotun, (iv) Kansai, (v) Brighto, (vi) Nippon or approved equivalent
7	Aluminum	(i) Pakistan Cable (ii) Alcop (iii) Chawla Aluminum (iv) Prime Aluminum or approved equivalent
8.	Hardware Stays, Hinges, Handles & Door Locks	JB Saeed or approved equivalent
9.	Concrete Floor Tiles/Pavers/Curbstone	Tuff Pavers (ii) Izhar (iii) Envicrete (iv) National Tiles (v) Bincrete (vi) Magna Crete (vii) Hub Crete viii) Bin Crete or approved equivalent
10.	Concrete Blocks	As approved by the Engineer
11.	MDF	(i) Pakistan Chipboard (ii) Al-Noor or approved equivalent
12.	Lamination Board, Veneer Board	i) Formite, ii) Al-Noor or approved equivalent
13.	Wooden Doors	(i) Home-Pro (ii) Sterling (iii) Interwood (iv) Al-Rehmat Corporation or approved equivalent
14.	Formica	(i) Formite (Tuff), (ii) Al-Noor(iii) Built mart
15.	Glass, Tinted glass / Double Glasses Tempered/ Reflective/ Wired Glasses Mirror Glass	(i) Gunj Glass, (ii) Ghani Glass (iii) Pakistan Safety Glass or approved equivalent
16.	False Ceiling & Suspension System	Elephant or approved quivalent.
17.	Gypsum Board False Ceiling including Suspension System	(i) Boral, (ii) DFB, (iii) Elephant make or approved equivalent

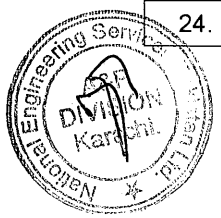
National Engineering Services Pakistan Ltd. A&P DIVISION Karachi.

Sign & Stamp of The Contractor

NATIONAL ENGINEERING SERVICES PAKISTAN (PVT.) LTD.
ARCHITECTURE & PLANNING DIVISION

LIST OF APPROVED MANUFACTURERS/BRANDS OFMATERIALS/EQUIPMENT

18.	Marble / Granite	Saleem Industries (ii) Stone World (iii) Asif Marbl, iv) Progressive e
19.	**Termite Proofing** For Soil For Wood	(i) Fiprokill (ii) Biflex (ii) Merage or approved equivalent (i) Bio Wood, (ii) Power Max (iii) Solignum (iv) Bifliesor approved equivalent
20.	Construction Chemicals	(i) CORMIX International Ltd, (ii) FOSPAK, (iii) SIKA (iv) Fosroc (v) Vandex, or approved equivalent
21.	Fabricated Steel Structure	(i) Shabbir Iron (ii) Safiy Iron (iii) Hathmi (iv) Shafi Iron or approved equivalent
22.	Roof Insulation & Water Proofing	(i) Aquafin (ii) Matrix(iii) Sika (iv) Fosroc
23.	Cement Concrete Jali	(i) Muhammadi (ii) Pak Vaneer (iii) Ceratiles
24.	Fire Rated Door	(i) MEK, (ii) Smart Solutions (iii) Zara Engineering



Sign & Stamp of The Contractor

LIST OF APPROVED MANUFACTURER & SUPPLIERS

2.1 MATERIALS AND MANUFACTURERS

2.1.1 WATER SUPPLY SYSTEM

i. COLD AND HOT WATER PIPES & FITTINGS

Material

- Polyethylene (P.E) pipes for supply to underground and overhead tanks.
- Polypropylene Random Copolymer (PPRC) for water supply to toilets/kitchens.

Manufacturers

- Dadex
- Tetra Plast
- Beta Pipes
- MAF Pipes

ii. VALVES

Valves up to 50mm diameter shall have bronze bodies and trim with screwed connections. Valves greater than 50mm diameter and above shall have cast iron or cast steel bodies, bronze trim with flanged connections.

Manufacturer:

- Kitz Valves
- SCON Valves
- Niko Valves
- KSB Pumps Company Limited

iii. PUMPS AND VALVES

- Bronze bodies and trim, screwed connection up to 50mm dia.

- Cast iron or cast steel bodies, bronze trim, flanged connections for greater than 50mm dia.
- Non-slam type check valves at discharge side of water supply pumps.
- Centrifugal pump sets for water supply from underground to overhead tank.

iv. Manufacturer of Pumps:

- KSB Pumps Company Limited
- Grundfos (HMA) Pumps

2.1.2 SEWERAGE SYSTEM

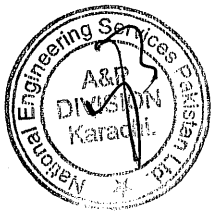
i. SOIL AND WASTE PIPES & FITTINGS

Material

- UnplasticizedPolyvinyle chloride (uPVC) soil and waste pipes.

Manufacturers

- Dadex
- Tetra Plast
- Beta Pipes
- MAF Pipes



ii. FLOOR TRAPS, CLEANOUTS, ROOF DRAINS GULLY TRAPS AND ELECTRIC WATER HEATER/GEYSERS

a. Floor Traps

Material

Floor trap shall be of uPVC or of other anti-corrosive material, compatible with the material of pipe.

b. Cleanouts

Material

Cleanout shall be of the same nominal size as that of the pipe on which it is installed. uPVC cleanout shall consist of either two 45° bends or one long radius bend both with a removable end cap and other necessary fittings/material

c. Roof Drains

Material

Roof drains shall be of bitumen coated cast iron/ brass or uPVC or of other anti-corrosive material, compatible with the material of pipe.

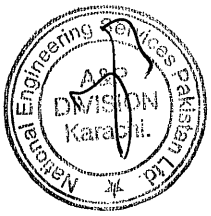
d. Gully Trap

Material

Gully trap shall be of upvc with specified size outlet. The inlet shall be provided with stainless steel grating.

Manufacturers

- Dadex
- Tetra Plast
- Beta Pipes
- MAF Pipes



e. Electric Water Heater/Geysers:

Material

Inner tank shall be extra heavy gauge anti-rust G.I. sheet metal to hold maximum inside water pressure. As insulation, imported genuine glass wool shall be used to maintain the desired temperature that controls the liting up of the burner. The outer body shall be made of requisite gauge M.S. sheet shaped into reinforced circumference. Flow and delivery pipes shall be of high quality G.I. pipes fabricated with heavy gauge anti-rust baffle plate. Special anti-rust-baked primer-heavy coated stoved enamel paint with high gloss automotive shine shall be used on sheet metal.

Manufacturers

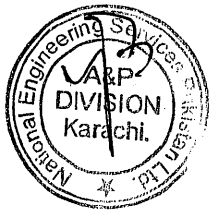
- Asia Geysers
- Canon Geysers
- Embassador

APPENDIX-I

LIST OF APPROVED MANUFACTURERS FOR ITEMS/ MATERIALS/EQUIPMENT OF FIRE FIGHTING WORKS

The Bidder should note that only Equipment/materials from the following approved manufacturers shall be allowed to be used on this Project provided their products meet the specified requirements.

SR. NO.	EQUIPMENT/ MATERIAL	APPROVED MANUFACTURER/ SUPPLIER	COUNTRY (origin, manufacturing, assembly, testing & supply)
1.	Fire Fighting Pumps (FM Approved /UL Listed)	ITT PATTERSON READY BAFFALO PEARLESS GRUNDFOS NAFFCO SFEECO AURORA KSB EBITT OR APPROVED EQUAL	USA/UAE/EUROPE
2.	Pump Motors (UL Listed /NEMA)	ABB SIEMENS WEG OR APPROVED EQUAL	UK/USA/EUROPE
3.	Diesel Engine (UL Listed /NEMA)	CLARKE BLACK STALLION OR APPROVED EQUAL	USA/EUROPE/UAE
4.	Gas Suppression System	KIDDIE FIKE VIKING SFFECO LIFECO OR APPROVED EQUAL	USA/EUROPE/UAE
5.	Hose Reel & Cabinets	NAFFCO SFEECO LIFECO OR APPROVED EQUAL	UAE/UK
6.	External Hydrants	NAFFCO SFEECO LIFECO OR APPROVED EQUAL	UAE/UK



7.	Sprinklers	TYCO VIKING SHIELD LIFECO OR APPROVED EQUAL	JAPAN/USA/UK/ EUROPE
8.	Valves, Alarm Check Valve Assembly, Zone Control Valve Assembly, Pressure Reducing Valve, Pressure Relief valve, Drain Cocks, Air vents etc.	TYCO VIKING SHIELD LIFECO REDAY FLOW OR APPROVED EQUAL	JAPAN/USA/UK/ EUROPE
9.	MS Seamless Pipe	HUFFAZ ECONOSTO OR APPROVED EQUAL	PAKISTAN/China
10.	HDPE pipe	DADEX OR APPROVED EQUAL	PAKISTAN
11.	Hangers / Supports	FISCHER HILTI OR APPROVED EQUAL	UK/EUROPE
12.	Portable Fire Extinguishers	NAFFCO SFFECO OR APPROVED EQUAL	UAE

NOTE 1: ALL EQUIPMENT/MATERIAL MUST BE SUPPLIED FROM AUTHORIZED/SOLE DISTRIBUTORS. MANUFACTURERS AUTHORIZATION CERTIFICATE IN ORIGINAL MUST BE PROVIDED.

NOTE 2: MINIMUM QUALIFICATION CRITERIA REQUIREMENT OF FIREFIGHTING EQUIPMENT MANUFACTURER

For all proposed equipment manufacturer shall meet the minimum following criteria:

- Minimum ten (10) years of international experience for same offered equipment.
- Minimum three (03) years national experience with local authorization representative and after sale service available in Pakistan.
- Compliance with international standards/codes as per Clause S-08 of specifications of firefighting works applicable to relevant equipment.
- High ambient compatibility equipment.
- Most energy efficient equipment/model available in market and offered for the project.

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- Testing facilities as per project requirement.
- Verifiable list of minimum five (05) projects in last five (05) years in Pakistan.
- All major parts used inside equipment like pumps, hydrants, valves etc. shall be supplied from the manufacturers' best source available in international market.
- International certificate of performance of proposed equipment/model available as per international standards.

NOTE: ALL EQUIPMENT/MATERIALS OTHER THAN STATED ABOVE SHALL BE SUBJECT TO PRIOR APPROVAL OF THE ENGINEER IN RESPECT OF MAKE & COUNTRY OF ORIGIN.

Initials of Signatory to Bid: _____

LIST OF MANUFACTURERS/BRANDS OF EQUIPMENT / MATERIALS FOR ELECTRICAL WORKS

The list of manufacturers/suppliers of different equipment/materials given as below in order to establish conformance of the product in accordance with the relevant International Standards as applicable. The contractor shall provide and fix the equipment/materials of brand new & superior quality as indicated below or approved equivalent as per approval of the Engineer/Employer.

SR. NO.	EQUIPMENT/ MATERIALS	MANUFACTURERS/BRANDS
1.	PVC Conduit & Accessories	Beta, Popular and Dadex
2	MV/LV Cables	As per Client approved list (Newage, Fast, Pioneer, Pakistan cable)
3	Steel/G.I Conduit & Accessories	Hilall Industries, IIL & Jamal Pipe
4	Cable Trays & Accessories	Ashraf Industries, Green T&D, South Asia & Bilal Switchgear
5.	MCCBs, MCB Magnetic Contactors	Schneider (France), ABB (Italy), Legrand (France), Terasaki (Japan), Panasonic Green power (Japan) & Telemecanique
6.	ACBs, ELCBs	ABB (Italy), Siemens (Germany), Schneider (France) Terasaki (Japan) & Legrand (France)
7.	UPS	Borri, APC, GE and Siemens
8.	Transformers (11/0.415 kV)	a) (Oil Immersed) PEL, Elmetec & Transfopower b) (Dry Type) ABB, Legrand & Schneider
9.	11 kV Panels	Elmetec, Siemens, PEMPAK, Schneider, ABB and PEL
10.	MV Termination/Straight	Jointing kit, Raychem (Germany), 3M (USA) and Elastimold (Egypt)
11.	Programmable Logic Controllers	Siemens and ABB
12.	Photoelectric EE Switches	National Photoelectric EE Switches
13.	Relays and Timers	Finder (Italy) and Inter (Turkey)
14.	LV Changeover Switch	Socomec (France), ABB (France/Germany), LG, Elcontrol (Itlay) and Entus
15.	Capacitors	Amber, Nokian and Ducati

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16.	PFI Relays	Nokian (Finland) and Entes (turkey)
17.	Voltmeter/Ammeters	Circulor (Italy), Revalco (Italy), Inter (Turkey), and Entes (Turkey)
18.	Current Transformer/Voltage Transformer	Metalx, Revalco (Italy) and Fico
19.	Back Boxes, Pull boxes etc.	Bosch, Hero, Legrand, Clipsal and ABB.
20.	Data Network Accessories and Communication Cable Trays	3 M, Amps, Crosheind, Baynet, APC & Panduit.
21.	Fire Alarm and Detection System	Bosch, GST, Honeywell, Novec, Fike, Foton, Cooper, Cooper Menvier
22.	Fans	Climax, Pak, Millat, Royal and SK
23.	Selector Switches/ Push Button/Switches/Switch socket	Kraus & Naimer, ABB, Legrand, Clipsal Revalco (Italy) Bosch & Crosehind
24.	Indication Lamps	Legrand (France), Breter (Italy) ABB and Telemecanique
25.	Low Voltage Panel, MCC & ACP	Saoth Asian, Elmetec, MESI, PEL, Green T&D Bilal Switchgear and PEMPAK.
26*.	DG Sets	Cater Pillar, FG Wilson, Siemens,SDMO, Mitsubishi and Cummins power
26(a).	Diesel Engine	Volvo (Sweden), Perkins (UK), Cummins (UK), FG Wilson (UK) Mitsubishi (Japan), John Deere (France) & Cater Pillar (UK)
26(b).	Alternator	Siemens (German), Newage/Stamford/Cummins (UK), Lorrey Sommer (France) and Cater Pillar(UK)
27.	MV/LV Bus Tie Duct	Legrand, ABB, Schneider, GE & Siemens
28.	Terminal Blocks	Legrand (France), ABB, Phoenix & Cabour
29.	Road Light Poles	Jamal Pipe Industries, Bashir Pipe Industries and Lion Steel Industries
30.	Lighting	GE, Signify (Philips), Thorn, Pierelite, Osram, NVC,
31.	Earthing and Grounding	Furse, Erico, and Aplicaciones Technologicas. Accessories.

32.	Lightning Protection System	Aplicaciones Technologicas, Furse & Erico
33.	Earthing System	Aplicaciones Technologicas, Furse & Erico
34.	Energy Monitoring System	Schneider, ABB, GE, Janitza & Siemens
36.	2-Core Fire Resistance Cable	Prysmian, Cavicel (Italy), Belden, Firecell & 2M KABLO (FireKab) Turkey

*The DG Set offered shall have the engine and alternator of the brand as mentioned under item 26(a) & 26(b).

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APPENDIX – IIA TO BILL OF QUANTITIES

LIST OF COMMUNICATION EQUIPMENT MANUFACTURERS ON WHICH THE BID IS BASED
(To be filled in and signed by the Bidder)*

The Material's and Equipment's required in the Bid shall be selected from the following recommended / approved manufacturer's / supplier's. The Bidder shall procure the required materials and equipment's for this project from the following recommended / approved manufacturers / suppliers or their authorized dealer's / agent's. The Bidder shall also provide the letter of authenticity. Other makes may be accepted provided the quality and performance of such equipments in the sole opinion of the Engineer are atleast equal to or better than the equipment offered by the recommended manufacture list here under:-

The Engineer has the right to reject any of the alternate manufacturer proposed by the bidder/contractor other than listed manufacturer, without assigning any reason thereof.

SR. NO.	EQUIPMENT. / MATERIAL.	NAME OF MANUFACTURER.
1.	Addressable Fire Alarm System	GENT BY HONEYWELL NOTIFIER OR APPROVED EQUIVALENT
2.	Addressable Fire Alarm Cable	PRYSMIAN CAVICEL FIRECEL OR APPROVED EQUIVALENT
3.	Public Address System	TOA BOSCH WHARFEDALE PRO OR APPROVED EQUIVALENT
4.	Public Address Speaker Cable	PROEL PRYSMIAN CAVICEL FIRECEL OR APPROVED EQUIVALENT
5.	Perimeter Intrusion Detection System	NEMTEK OR APPROVED EQUIVALENT
6.	Local Area Network System	CISCO JUNIPER HUAWEI H3C OR APPROVED EQUIVALENT
7.	Wireless Local Area Network	CISCO JUNIPER HUAWEI H3C OR APPROVED EQUIVALENT
8.	UTP CAT 6-A Cable for LAN	3M CORNING

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SR. NO.	EQUIPMENT. / MATERIAL.	NAME OF MANUFACTURER.
		CONTECH VIVANCO OR APPROVED EQUIVALENT
9.	UTP CAT 6 Cable for CCTV	3M CORNING CONTECH VIVANCO OR APPROVED EQUIVALENT
10.	Fiber Optics Cable	3M CORNING CONTECH VIVANCO OR APPROVED EQUIVALENT
11.	Fiber Optics Patch Panel	3M CORNING CONTECH VIVANCO OR APPROVED EQUIVALENT
12.	Fiber Optics Patch Cord	3M CORNING CONTECH VIVANCO OR APPROVED EQUIVALENT
13.	Pigtail	3M CORNING CONTECH VIVANCO OR APPROVED EQUIVALENT
14.	SFP Module	CISCO JUNIPER HUAWEI H3C OR APPROVED EQUIVALENT
15.	UTP Patch Panel	3M CORNING CONTECH VIVANCO OR APPROVED EQUIVALENT
16.	UTP Patch Cord	3M CORNING CONTECH VIVANCO OR APPROVED EQUIVALENT
17.	Cable Tags	LOCAL

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Bidder's Seal and Signature

SR. NO.	EQUIPMENT. / MATERIAL.	NAME OF MANUFACTURER.
18.	CCTV based Surveillance System	BOSCH HONEYWELL DAHUA HIKVISION HUAWEI OR APPROVED EQUIVALENT
19.	Video Wall	SAMSUNG PANASONIC HIKVISION DAHUA OR APPROVED EQUIVALENT
20.	Video Wall Controller	HIKVISION DAHUA DIGIBIRD OR APPROVED EQUIVALENT
21.	Keyboard Controller	BOSCH HONEYWELL DAHUA HIKVISION HUAWEI OR APPROVED EQUIVALENT
22.	Embedded Storage	BOSCH HONEYWELL DAHUA HIKVISION HUAWEI OR APPROVED EQUIVALENT
23.	Network Management & Monitoring System	SOLARWIND FORTINET SANGFOR OR APPROVED EQUIVALENT
24.	Servers & Storage	DELL IBM HP HUAWEI OR APPROVED EQUIVALENT
25.	Virtual Desktop Interface	DELL IBM HP HUAWEI OR APPROVED EQUIVALENT
26.	Employee Attendance System	HIKVISION ZKTECO OR APPROVED EQUIVALENT

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Bidder's Seal and Signature

SR. NO.	EQUIPMENT. / MATERIAL.	NAME OF MANUFACTURER.
27.	Access Control System	HIKVISION ZKTECO OR APPROVED EQUIVALENT
28.	EM Lock	ZK TECO OR APPROVED EQUIVALENT
29.	Exit Button	ZK TECO OR APPROVED EQUIVALENT
30.	Walk through gates	GARRATE CEA OR APPROVED EQUIVALENT
31.	Baggage Scanning Machine	RAPISCAN ASTROPHYSICS OR APPROVED EQUIVALENT
32.	Under Vehicle Surveillance System	DAHUA HIKVISION OR APPROVED EQUIVALENT
33.	Microphone Conferencing System	TAIDEN BOSCH TELEVIC OR APPROVED EQUIVALENT
34.	Hydraulic Road Blocker	DAHUA HIKVISION OR APPROVED EQUIVALENT
35.	Hydraulic Tyre Killer	DAHUA HIKVISION OR APPROVED EQUIVALENT
36.	Signal Light (Red & Green)	LOCAL
37.	Video Conferencing System	CISCO PANASONIC POLY HUAWEI OR APPROVED EQUIVALENT
38.	Queue Management System	QMATIC OR APPROVED EQUIVALENT
39.	Computer	DELL HP LENOVO OR APPROVED EQUIVALENT
40.	Laptop	DELL HP LENOVO OR APPROVED EQUIVALENT
41.	Data Rack	TOTEN VERTIV

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SR. NO.	EQUIPMENT. / MATERIAL.	NAME OF MANUFACTURER.
		VIVANCO CONTECH OR APPROVED EQUIVALENT
42.	Outdoor Data Racks	LOCAL
43.	UPS	APC GE DOUCHE POWER ABB OR APPROVED EQUIVALENT
44.	HDMI cable	LOCAL
45.	PVC Conduits & Accessories / uPVC Pipes & accessories, Flexible pipe, HDPE Pipe	DADEX GALCO CIVIC POPULAR TURKPLAST OR APPROVED EQUIVALENT
46.	Power Cable	FAST CABLE NEWAGE CABLE PAKISTAN CABLE OR APPROVED EQUIVALENT
47.	Pole	LOCAL

The Bidder shall fill name of only one manufacturer for each equipment/material on which the Bid is based. He shall be bound to supply the equipment from the same manufacturer. In case, the Bidder gives names of more than one manufacturer against any equipment, the Engineer is authorized to ask the Bidder to supply the equipment from any one of them.

The names of the Manufacturer for each equipment/material filled in this Appendix by each Bidder shall be reviewed at the evaluation stage and if it is noted that any of the equipment/material offered by the Bidder does not meet the specification requirements or it is of unacceptable quality, the Engineer reserves the right to ask the Bidder before signing of the Contract to replace the manufacturer meeting the quality and specification requirements.

The Bidder must fill the list of Equipment/Material for all Systems as per format given below:

SR. NO.	EQUIPMENT. / MATERIAL.	NAME OF MANUFACTURER.	COUNTRY OF ORIGIN.

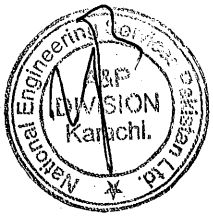
Bidder's Seal and Signature

APPENDIX - IIC

DEVIATIONS FROM SPECIFICATION OF COMMUNICATION WORKS
(To be filled in by the Bidder)

The bid submitted contains the following deviations from the Specification of Communication works. State specifically if the Tender does not contain any deviation.

SR. NO	REF. OF BOQ ITEM NO.(s)	DESCRIPTION OF DEVIATION(s)	REASON(s)



Bidder's Seal and Signature

*** Additional sheets to be attached if necessary. Each sheet to be signed and sealed.

APPENDIX – IID TO BILL OF QUANTITIES

SPECIAL TOOLS FOR COMMUNICATION WORKS
(To be filled in by the Bidder)*

The following tools required in accordance with the Bid will be supplied. No separate payment will be made for this item of work.

SR. NO	NAME OF SPECIAL TOOLS	QUANTITY	MANUFACTURER
1.	OTDR	1 No.	
2.	Tool Box	1 No.	
3.	Spanner Set (6 – 22 mm)	1 No.	
4.	Screw Driver Set (3 x Flat & 3 x Phillips)	1 No.	
5.	Allen Key Set (star type)	1 No.	
6.	Phillips Screw Driver (0 size)	1 No.	
7.	Wrenches Set	1 No.	
8.	Multimeter	1 No.	
9.	Soldering Iron	1 No.	
10.	Soldering Sucker	1 No.	
11.	Soldering Wire	1 No.	
12.	Cutter	1 No.	
13.	Plier	1 No.	
14.	Nose Plier	1 No.	
15.	Flash Light	1 No.	
16.	Working Gloves	1 No.	
17.	Any other tools recommended by the manufacturers of various Equipment to be installed. ***		

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Bidder's Seal and Signature

*** Additional sheets to be attached if necessary. Each sheet to be signed and sealed.

ESTABLISHMENT OF FORENSIC SCIENCE LABORATORY, KARACHI
HOME DEPARTMENT, GOVERNMENT OF SINDH
(EVIDENCE BLOCK)

LIST OF RECOMMENDED/ APPROVED MANUFACTURERS-HVAC WORKS

The Bidder should note that only Equipment/materials from the following approved manufacturers or approved equivalent shall be allowed to be used on this Project provided their products meet the specified requirements. All equipment shall be supplied from Manufacturer's own Plant/Facility.

S. No.	Equipment/ Material	Recommended Manufacturer/ Supplier or approved Equivalent	Country (origin, manufacturing, assembly, testing & supply)
1	VRF Units	TOSHIBA DAIKIN HITACHI TRANE SAMSUNG GENERAL HISENSE LG GREE CARRIER MEDIA YORK HAIER	USA/JAPAN/WEST EUROPE/THAILAND/MALAYSIA/KOREA/CHINA
2	DX-Type Split Air Conditioning Units	TOSHIBA DAIKIN HITACHI SAMSUNG LG GREE MIDEA YORK PEARL MITSUBISH OGENERAL	MALAYSIA/KOREA/CHINA/TURKEY/THAILAND/JAPAN
3	Fans i)Tube Axial and Centrifugal	AIR MECH AEROTECH, SASA, GREEN HECK, LOREN COOK, PENBERRY SISTEVEN SODECA ROSENBERG CASALS	PAKISTAN, USA, SPAIN, UK, GERMANY, EUROPE
	ii)Propeller	PAK FANS, CLIMAX, MILLAT AIR MECH AEROTECH, SASA GREEN HECK, LOREN COOK, PENBERRY, SISTEVEN, SODECA ROSENBERG CASALS	PAKISTAN, USA, SPAIN, UK, GERMANY, EUROPE
4	Cooper Pipe	MULLER WEDNESBURY CRANE GOLDEN DRAGON	USA/EUROPE/KOREA/CHINA
5	Duct/pipe insulation, Sound Liner	KIMMCO AFICO IZTOPRAK, IZOCAM, ODE OWENS CORNING, KNAUF, ARMAFLEX, DURKFLEX, AEROFOAM	KUWAIT / SAUDI ARABIA/ TURKEY / EUROPE / USA
6	G.I. Sheets	PAK STEEL MILLS KARACHI, ILL, imported make available locally, approved by Engineer.	PAKISTAN / Imported
7	Air Inlets/Outlets	MEHRAN, THERMEC, AIR CONTROL STEELCRAFT, SA INDUSTRIES, AEROTECH, PAK PRIEMER, EAP	PAKISTAN

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S. No.	Equipment/ Material	Recommended Manufacturer/ Supplier or approved Equivalent	Country (origin, manufacturing, assembly, testing & supply)
8	Testing & Maintenance Instruments	DWYER FLUKE OR APPROVED EQUAL	USA
9	Paint	ICI, MASTER PAINTS, BERGER	PAKISTAN
10	Fasteners, Hanging Rods, Rawal Plugs, Supports etc.	FISHER, HILTI, SPIT, SIKLA MUNGO, NORM, INDEX, INKA, DIAMOND WALRAVEN	AS PER MANUFACTURER'S FACILITY
11	White Glue	FOSTER	USA/EUROPE
12	Duct Sealant	DOW CORNING ZAHBIA	USA/TURKEY
13	Low Voltage Panel,SA Electric Concern, Siemens, Elmetec, PEL,	SA ELECTRIC CONCERN, SIEMENS, ELMETEC, PEL, BILAL SWITCHGEAR MESI, CEECO, JEI, ELECTRECH QUALITY SWITCHGEAR, MTECH	PAKISTAN
14	LV and Control Cables and Wires (600/1000V)	PAKISTAN CABLES PIONEER CABLES NEWAGE CABLES FAST CABLES	PAKISTAN
15	PVC Conduit and Accessories	BETA POPULAR GALCO	PAKISTAN
16	Steel Conduit, Cable Trays and Accessories	HILALL INDUSTRIES, IIL, JAMAL, PIONEER, NIB ASHRAF INDUSTRIES	PAKISTAN
17	MCCBs, MCB and Magnetic Contactors	SCHNEIDER, SIEMENS ABB, LEGRAND, TERASAKI PANASONIC GREEN POWER TELEMECANIQUE	FRANCE/GERMANY/ ITALY/JAPAN

S. No.	Equipment/ Material	Recommended Manufacturer/ Supplier or approved Equivalent	Country (origin, manufacturing, assembly, testing & supply)
18	ACBs, ELCBs	ABB, SIEMENS, SCHNEIDER, TERASAKI, LEGRAND	FRANCE/ITALY/JAPAN
19	Relays and Timers	FINDER INTER	ITALY/TURKEY
20	PFI Relays	NOKIAN ENTES	FINLAND/TURKEY
21	Voltmeters/Ammeters	CIRCULOR REVALCO INTER ENTES	ITALY/TURKEY
22	Current Transformer/ Voltage Transformer	CIRCULOR REVALCO FICO	ITALY/PAKISTAN
23	Selector Switches/ Push Button	LEGRAND KRAUS & NAIMER ABB, BOSCH, CLIPSAL REVALCO	SWEDEN/FRANCE/ ITALY
24	Indication Lamps	LEGRAND BRETER ABB TELEMECANIQUE	FRANCE/ITALY
25	Terminal Blocks	LEGRAND ABB PHOENIX CABOUR	FRANCE/ITALY/JAPAN
26	Programmable Logic Controller	SEIMENS, ABB	GERMANY/ITALY
27	Photoelectric EE Switch	NATIONAL PHOTOELECTRIC EE SWITCHES	JAPAN
28	LV Change over Switch Capacitors	SOCOMEC, ABB, AMBER, NOKIAN, DUCATI	FRANCE/GERMANY/ JAPAN/PAKISTAN
29	Isolators Switches	BRETTER SIEMENS	ITALY GERMANY

Notes:

1. All equipment/ material must be supplied from authorized/sole distributors
2. Manufacturers Authorization Certificate in original must be provided.
3. Compliance to the mentioned country (origin, manufacturing, assembly, testing & supply) for offered/supplied equipment is mandatory.
4. Any approved equivalent brand other than the above mentioned recommended manufacturer shall submit the following additional information in addition to qualification information with the technical bid.

   A. Compliance of equipment parts and their origin as mentioned in specifications.
   B. Compliance statement of specifications from the equipment manufacturer.
   C. Comparison of each part/system of proposed brand with one of the brands provided in suggested manufacturer's list along with the test reports.
   D. Approved equivalent brand shall clearly be mentioned in the technical bid along with above said information

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LIST OF APPROVED MANUFACTURER & SUPPLIERS

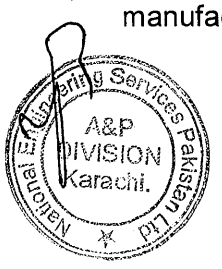
(LIFT WORKS)

Complete equipment, to be supplied under the Contract, shall be of imported origin and can be provided by any one of the following manufacturers or approved equivalent subject to meeting the specification requirement (models fully complied and certified with latest EN 81 Standards only):

- DOPPLER (WEST EUROPE)
- HYUNDAI (KOREA, CHINA)
- KOHLER (WEST EUROPE)
- KONE (WEST EUROPE, CHINA)
- MITSUBISHI (JAPAN)
- SHANGHAI MITSUBISHI (CHINA)
- ORONA (WEST EUROPE)
- OTIS (WEST EUROPE, CHINA)
- SCHINDLER (WEST EUROPE, CHINA)
- SIGMA BY OTIS (KOREA, CHINA)
- THYSSEN KRUPP (WEST EUROPE, CHINA)

OR APPROVED EQUIVALENT

All major elevator components shall be manufactured/ assembled in the manufacturers authorized factories/plants and shall be quoted only from authorized agents of manufacturer in Pakistan.



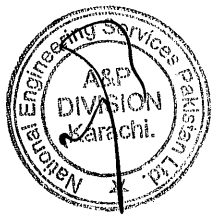
BE-1
Appendix-E to Bid

PROPOSED CONSTRUCTION SCHEDULE

Pursuant to Sub-Clause 8.2 of the General Conditions of Contract, the Works shall be completed on or before the date stated in Appendix-A to Bid. The Bidder shall provide as Appendix-E to Bid, the Construction Schedule in the bar chart (CPM, PERT or any other to be specified herein) at least in form of latest MS Project or approved, showing the sequence of work items and the period of time during which he proposes to complete each work item in such a manner that his proposed program for completion of the whole of the Works and parts of the Works may meet Procuring Agency's overall completion targets in days noted below and counted from the date of receipt of Engineer's Notice to Commence. The bidders shall propose completion time for major milestones of the project to ensure effective monitoring:

The contractor shall submit work plan for each school and a comprehensive plan for complete project containing all school units.

Description	Time for Completion
Reception & Evidence Blocks (Architecture & MEP Works Only)	12 Calendar Months



BF-1

Appendix-F to Bid

METHOD OF PERFORMING THE WORK

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

1. Organization Chart indicating head office and field office personnel involved in management and supervision, engineering, equipment maintenance and purchasing.

2. Mobilization, the type of facilities including personnel accommodation, office accommodation, provision for maintenance and for storage, communications, security and other services to be used.

3. The method of executing the Works, the procedures for installation of equipment and machinery and transportation of equipment and materials to the site of each school and complete project containing all school units.

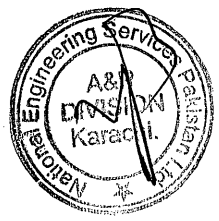
4. Arrangements for temporary school academic facilities.

BG-1

Appendix-G to Bid

LIST OF MAJOR EQUIPMENT – RELATED ITEMS

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

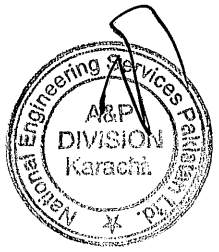


BG-2

Appendix-G to Bid

LIST OF MAJOR EQUIPMENT

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



BH-1

Appendix-H to Bid

CONSTRUCTION CAMP AND HOUSING FACILITIES

The Contractor in accordance with the Conditions of Contract shall provide description of his construction camp's facilities and staff housing requirements for each school site and for complete project containing all school units.

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

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

1. Site Preparation (clearing, land preparation, etc.).

2. Provision of Services.

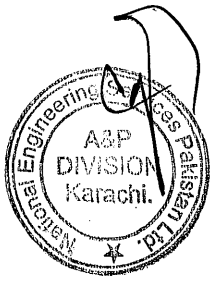
   a) Power (expected power load, etc.).
   b) Water (required amount and system proposed).
   c) Sanitation (sewage disposal system, etc.).

3. Construction of Facilities

   a) Contractor's Office. Workshop and Work Areas (areas required and proposed layout, type of construction of buildings, etc.).
   b) Warehouses and Storage Areas (area required, type of construction and layout).
   c) Housing and Staff Facilities (Plans for housing for proposed staff, layout, type of construction, etc.).

4. Construction Equipment Assembly and Preparation (detailed plans for carrying out this activity).

5. Other Items Proposed (Security services, etc.).



BI-1

Appendix-I to Bid

LIST OF SUBCONTRACTORS

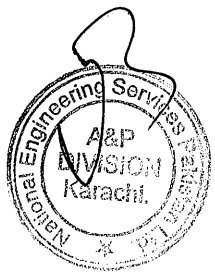
I/We intend to subcontract the following parts of the Work to subcontractors. In my/our opinion, the subcontractors named hereunder are reliable and competent to perform that part of the work for which each is listed.

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

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

Note:

- *Sublet/Sub-Contractor awarding should not be more than 10% of the awarded cost.*



BJ-1

Appendix-J to Bid

ESTIMATED PROGRESS PAYMENTS

Bidder's estimate of the value of work which would be executed by him during each of the periods stated below, based on his Programme of the Works and the Rates in the Bill of Quantities, expressed in thousands of Pakistani Rupees:

Quarter/ Year/ Period	Max. upto %age	Amounts (1,000 Rs.)
1st Quarter		
2nd Quarter		
3rd Quarter		
4th Quarter		
Bid Price	**100%**	

The Contractor shall submit to 'Project Manager / The Engineer's Cash Flow in 'S-Curve' and update regularly according to the progress payments.

BK-1

Appendix-K to Bid

ORGANIZATION CHART FOR THE SUPERVISORY STAFF AND LABOUR

(To be filled in by the bidder)

The Contractor should have team of reasonably skilled persons in the field of building construction led by a Project Manager (BE Civil) registered in PEC as Professional Engineer, having at least 20 years' experience in the relevant field. The Project Manager should be authorized to take instruction from the Engineer and direct contractor's crew to complete the works in accordance with the specifications.

The Contractor shall depute BE civil site engineers in appropriate number as per law and at least two experienced supervisor (DAE) at site to be directly responsible for the execution of works at site. The contractor must employee experienced lab technician in his laboratory to conduct required QA/QC testing at site / lab and to keep record of all tests.

BL-1
Appendix-L to Bid

(INTEGRITY PACT)

DECLARATION OF FEES, COMMISSION AND BROKERAGE ETC.
PAYABLE BY THE SUPPLIERS OF GOODS, SERVICES & WORKS CONTRACT

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

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

Without limiting the generality of the foregoing, [name of Contractor] represents and warrants that it has fully declared the brokerage, commission, fees etc. paid or payable to anyone and not given or agreed to give and shall not give or agree to give to anyone within or outside Pakistan either directly or indirectly through any natural or juridical person, including its affiliate, agent, associate, broker, consultant, director, promoter, shareholder, sponsor or subsidiary, any commission, gratification, bribe, finder s fee or kickback, whether described as consultation fee or otherwise, with the object of obtaining or inducing the procurement of a contract, right, interest, privilege or other obligation or benefit in whatsoever form from, from Procuring Agency (PA) except that which has been expressly declared pursuant hereto.

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

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

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

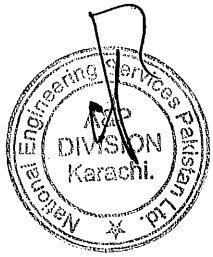
Name of Buyer: .....

..... Signature: .....

.....
[Seal]
[Seal]

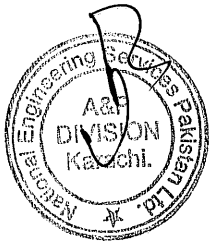
Name of Seller/Supplier:

Signature:



SAMPLE FORMS

BID SECURITY (BANK GUARANTEE)
PERFORMANCE SECURITY
CONTRACT AGREEMENT
MOBILIZATION ADVANCE GUARANTEE/BOND
INDENTURE BOND FOR SECURED ADVANCE



BS-1

BID SECURITY
(Bank Guarantee)

Not Applicable

Security Executed on
(Date) Name of Surety (Bank) with Address: _____
(Scheduled Bank in Pakistan)

Name of Principal (Bidder) with Address _____

Penal Sum of Security _____ (Rs _____)
Rupees. Bid Reference No. _____ KNOW ALL MEN BY THESE PRESENTS, that in pursuance of the terms of the bid and at the request of the said
Principal (Bidder) we, the Surety above named, are held and firmly bound unto

_____

(hereinafter called the 'Procuring Agency') in the sum stated above for the payment of which sum well and truly to be made, we bind ourselves, our heirs, executors, administrators and successors, jointly and severally, firmly by these presents.

THE CONDITION OF THIS OBLIGATION IS SUCH, that whereas the Bidder has submitted the accompanying bid dated _____ for Bid No. _____ for_____(Particulars of Bid) to the said Procuring Agency, and

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

(1) that the bid security shall remain in force up to and including the date 28 days after the deadline for validity of bids as stated in the Instructions to bidders or as it may be extended by the procuring agency, notice of which extension(s) to the Surety is hereby waived;

(2) that the bid security of unsuccessful bidders will be returned by the procuring agency after expiry of its validity or upon signing of the Contract Agreement; and

(3) that in the event of failure of the successful bidder to execute the proposed Contract Agreement for such work and furnish the required Performance Security, the entire said sum be paid immediately to the said procuring agency pursuant to Clause 15.6 of the Instruction to bidders for the successful bidder's failure to perform.

NOW THEREFORE, if the successful bidder shall, within the period specified therefore, on the prescribed form presented to him for signature enter into a formal Contract with the said procuring agency in accordance with his bid as accepted and furnish within twenty eight (28) days of his being requested to do so, a Performance Security with good and sufficient surety, as may be required, upon the form prescribed by the said procuring agency for the faithful performance and proper fulfillment of the said Contract or in the event of non-withdrawal of the said bid within the time specified for its validity then this obligation shall be void and of no effect, but otherwise to remain in full force and effect.

National Engineering Services Pakistan Ltd. NESPAK DIVISION Karachi

PROVIDED THAT the Surety shall forthwith pay the procuring agency, thesaid sum upon first written demand of the procuring agency (without cavil or argument) and without requiring the procuring agency to prove or to show grounds or reasons for such demand, notice of which shall be sent by the procuring agency by registered post duly addressed to the Surety at its address given above.

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

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

SURETY (Bank)

WITNESS:

Signature

Name

Title

Corporate Secretary (Seal)

Corporate Guarantor (Seal)

2.

Name, Title & Address

Not Applicable

National Engineering Services Pakistan Ltd. MEP DIVISION Karachi

PS-1

FORM OF PERFORMANCE SECURITY
(Bank Guarantee)

Guarantee No._____
Executed on _____
Expiry date _____

[Letter by the Guarantor to the Procuring Agency]

Name of Guarantor (Bank) with address:_____
(Scheduled Bank in Pakistan)
Name of Principal (Contractor) with address:_____
_____
Penal Sum of Security (express in words and figures)_____
Letter of Acceptance _____ Dated _____
No.

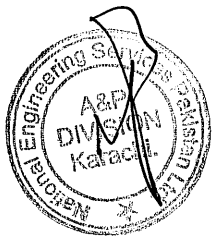
KNOW ALL MEN BY THESE PRESENT that in pursuance of the terms of the Bidding Documents and above said Letter of Acceptance (hereinafter called the Documents) and at the request of the said Principal, we, the Guarantor above named, are held and firmly bound unto the _____ (hereinafter called the Procuring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

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

NOW THEREFORE, if the Principal (Contractor) shall well and truly perform and fulfill all the undertakings, covenants, terms and conditions of the said Documents during the original terms of the said Documents and any extensions thereof that may be granted by the Procuring Agency, with or without notice to the Guarantor, which notice is, hereby, waived and shall also well and truly perform and fulfill all the undertakings, covenants terms and conditions of the Contract and of any and all modifications of said Documents that may hereafter be made, notice of which modifications to the Guarantor being hereby waived, then, this obligation to be void; otherwise to remain in full force and virtue till all requirements of Clause 11, Defects Liability, of Conditions of Contract are fulfilled.

Our total liability under this Guarantee is limited to the sum stated above and it is a condition of any liability attaching to us under this Guarantee that the claim for payment in writing shall be received by us within the validity period of this Guarantee, failing which we shall be discharged of our liability, if any, under this Guarantee.

Not Applicable



PS-2

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

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

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

Guarantor (Bank)

Witness:

1. _____

Signature _____

_____

Corporate Seal
(Seal)

Name _____

Title _____

2. _____

_____

Name, Title & Address

_____

Corporate Guarantor (Seal)

Not Applicable

CA-1

FORM OF CONTRACT AGREEMENT

THIS CONTRACT AGREEMENT (hereinafter called the "Agreement") made on the _____ day of_____(month) 2022 between _____ (hereafter called the "Procuring Agency") of the one part and _____ (hereafter called the "Contractor") of the other part.

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

NOW this Agreement witnessed as follows:

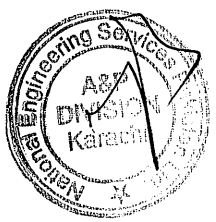
1. In this Agreement words and expressions shall have the same meanings as are respectively assigned to them in the Conditions of Contract hereinafter referred to.

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

   (a) The Contract Agreement;
   (b) The Letter of Acceptance;
   (c) The completed Form of Bid;
   (d) Special Stipulations (Appendix-A to Bid);
   (e) The Particular Conditions of Contract – Part II;
   (f) The General Conditions – Part I;
   (g) The priced Bill of Quantities (Appendix-D to Bid);
   (h) The completed Appendices to Bid (B, C, E to L);
   (i) The Drawings;
   (j) The Specifications.
   (k) _____ (any other)

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

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



CA-2

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

Signature of the Contactor	Signature of Procuring Agency
(Seal)	(Seal)

Signed, Sealed and Delivered in the presence of:

Witness:	Witness:
(Name, Title and Address)	(Name, Title and Address)

MG-1

MOBILIZATION ADVANCE GUARANTEE

Guarantee No._____ Date _____

WHEREAS _____(hereinafter called the 'Procuring Agency') has entered into a Contract for _____
(Particulars of Contract)
with _____ (hereinafter called the "Contractor').

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

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

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

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

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

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

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

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

National Engineering Services Pakistan Ltd. A&P DIVISION Karachi.

MG-2

GUARANTOR

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

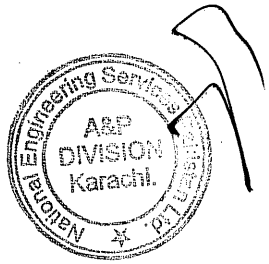
WITNESS

1. _____

   Corporate Secretary (Seal)

2. _____ _____

   (Name Title & Address) Corporate Guarantor



IB-1

INDENTURE FOR SECURED ADVANCES

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

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

WHEREAS by an agreement, dated (hereinafter called the said agreement, the contractor has agreed to perform the under-mentioned works (hereinafter referred to as the said work):- (Here enter (the description of the works). 1

AND WHEREAS the contractor has applied to the ....for an advance to him of Rupees ..... (Rs. .....) on the security of materials absolutely belonging to him and brought by him to the site of the said works the subject of the said agreement for use in the construction of such of the said works as he has under taken to execute at rates fixed for the finished work (inclusive of the cost of materials and labour and other charge) AND

WHEREAS the Government has agreed to advance to the Contractor the sum of Rupees, (Rs. .....) on the security of materials the quantities and other particulars of which are detailed in Part II of Running Account Bill (B). the said works signed by the contractor Fin R.Form.I7.A On ..... and on such covenants and conditions as are hereinafter contained and the Government has reserved to itself the option of marking any further advance or advances on the security of other materials brought by the Contractor to the site of the said works.

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

IB-2

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

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

(3) That the said materials detailed in the said Running Account Bill (B) and all other materials on the security of which any further advance or advances may hereafter be made as aforesaid (hereinafter called the said materials) shall be used by the Contractor solely in *the* execution of the said works in accordance with the directions of the Divisional Officer (hereinafter called the Divisional Officer) and in the terms of the said agreement.

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

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

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

National Engineering Services Pakistan (Pvt.) Ltd. A&E DIVISION Karachi

(7) at if the Contractor shall at any time make any default in the performance or observation in any respect of any of the terms and provisions of the said agreement or of these presents the total amount of the advance or advances that may still be owing to the Government shall immediately on the happening of such default be repayable by the Contractor to the Government together with interest thereon at twelve percent per annum from the date or respective dates of such advance or advances to the date or repayment and with all costs, charges, damages and expenses incurred by the Government in or for the recover y thereof or the enforcement of this security or otherwise by reason of (the default of the Contractor and any moneys so becoming due and payable shall constitute a debt due from the Contractor to the Government and the Contractor hereby covenants and agrees with the Government to repay and the same respectively to it accordingly.

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

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

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

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

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

(10) That in the event of any conflict between the provisions of these presents and the said agreement the provisions of these presents shall prevail and in the event of any dispute or difference arising over the construction or effect of these presents the settlement of which has not been hereinbefore expressly provided for the same shall be referred to the Superintending Engineer/Executive District Officer/Officer one grade higher to officer signed the agreement Circle whose decision shall be final and the provisions of the Arbitration Act 1940 for the time being in force so far as they are applicable shall apply to any such reference.

IB-4

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

WITNESS

1. _____ _____
(Name Title & Address) Corporate Secretary (Seal)

2. _____ _____
(Name Title & Address) Corporate Guarantor (Seal)

(GENERAL CONDITIONS OF CONTRACT PART-I)

Conditions of Contract
CONSTRUCTION for

FOR BUILDING AND ENGINEERING
WORKS DESIGNED BY THE PROCURING AGENCY

Multilateral Development Bank Harmonized Edition
March 2006
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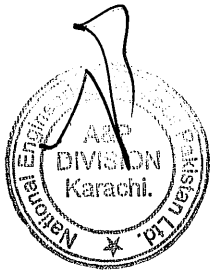
FEDERATION INTERNATIONALE DES INGENIEURS-CONSEILS INTERNATIONAL FEDERATION OF CONSULTING ENGINEERS INTERNATIONALE VEREINIGUNG BERATENDER INGENIEURE FEDERACION INTERNACIONAL DE INGENIEROS CONSULTORES



(It is presumed that all the bidders possess original copy of FIDIC for their reference while preparation of Bid and copy of the same is also required to submit at the time of signing of Contract Agreement)

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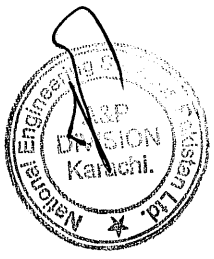

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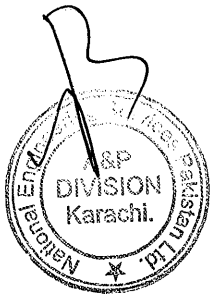

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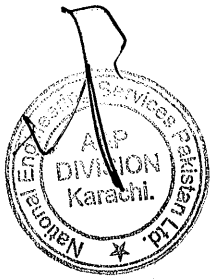

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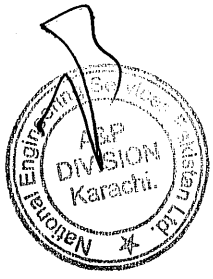

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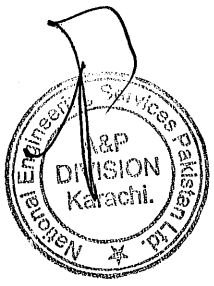

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PART II - SPECIAL /PARTICULAR CONDITIONS OF CONTRACT

1.1 Definitions

1.1.1.4 "Form of Bid" is synonymous with "Letter of Tender".

1.1.1.8 "Bid" is synonymous with "Tender".

1.1.1.10 "Bidding" is synonymous with "contract".

The following paragraph is added:

1.1.1.11 "Programme" means the program to be submitted by the contractor in accordance with Sub- Clause 8.3 and any approved revisions thereto.

1.1.2.4 The Engineer is National Engineering Services Pakistan (Pvt.) Limited (NESPAK), 4th Floor NICL Building, Abbasi Shaheed Road, Karachi, or any other competent person appointed by the Procuring Agency, and notified to the Contractor, to act in replacement of the Engineer. Provided always that except in cases of professional misconduct, the outgoing Engineers is to formulate his certifications/recommendations in relation to all outstanding matters, disputes and claims relating to the execution of the Works during his tenure.

1.12.2 "Procuring Agency" is synonymous with "Procuring Agency"

1.1.2.9 "DAB" is synonymous with "Committee".

1.1.3.7 "Defects notification Period" is synonymous with "Defects liability Period".

1.4 Law and Language(s)

(a) The Contract Documents shall be drawn up in the English language.
(b) The Contract shall be subject to the Laws of Islamic Republic of Pakistan.

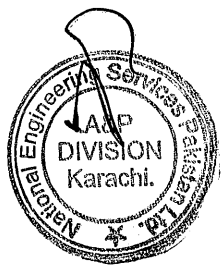
1.5 Priority of Contract Documents

Add following paragraph at the end of Sub-clause:

In case of discrepancies between drawings, those of larger scale shall govern unless they are superseded by a drawing of later date regardless of scale. All Drawings and Specifications shall be interpreted in conformity with the Contract and these Conditions. Addendum, if any, shall be deemed to have been incorporated at the appropriate places in the documents forming the Contract.

1.15 Inspections and Audit by the Procuring Agency

The Contractor shall give access to Procuring Agency or its representative to its record and audit to verify the funds of the project has been used for the purposes intended in the Tender documents.



3.1 Engineer's Duties and Authority.

The following paragraph is added after duties:

Procuring agency shall ensure that the Engineer's Representative/Staff is a professional Engineer as defined in the Pakistan Engineering Council Act 1975 (V of 1976)

The Engineer shall obtain the specific approval of the Procuring Agency before carrying out his duties in accordance with the following Clauses:

(i) Consenting to the sub-letting of any part of the Works under Sub Clause 4.4 "Subcontracting".

(ii) Certifying additional cost determined under Sub-Clause 4.12 "Not Foreseeable Physical Obstructions or Conditions".

(iii) Any action under Sub-Clause 4.2 "Performance Security" and Clause 18 "Insurance" of sorts.

(iv) Any action under Clause 16 "Suspension".

(v) Any action under Clause 8.4 "Extension of Time for Completion".

(vi) Any action under Clause 8.7 "Delay Damages" or Payment of Bonus for Early Completion of Works.

(vii) Issuance of "Taking-Over Certificate" under Clause 10.

(viii) Issuing a Variation Order under Clause 13,except:

a) in an emergency* situation, as stated here below, and

b) if such variation would increase the Contract Price by less than the amount stated in the Appendix-A to Bid.

(ix) Fixing rates or prices under Clause 13.3.

(x) Extra payment as a result of Contractor's claims under Clause 20.

(xi) Release of Retention Money to the Contractor under Sub-Clause 14.9 "Payment of Retention Money".

(xii) Issuance of "Final Payment Certificate" under Sub-Clause 14.11 & 14.13.

(xiii) Issuance of "Defect Liability Certificate" under Sub-Clause 11.

* (The Contractor shall notify the Engineer at the earliest opportunity of specific likely future events or circumstances that may adversely affect the work, and if in the opinion of the Engineer an emergency occurs (whether notified by the Contractor or not) affecting the safety of life or of the Works or of adjoining property, the Engineer may, without relieving the Contractor of any of his duties and responsibilities under the Contract, instruct the Contractor to execute all such work or to do all such things as may, in the opinion of the Engineer, be necessary to abate or reduce the risk. The Contractor shall forthwith comply with any such instruction of the Engineer. The Engineer shall determine an addition to the Contract Price, in respect of such instruction, in accordance with Clause 13 and shall notify the Contractor accordingly, with a copy to the Procuring Agency.)

The following sub-clause 3.6 is added in (GCC):

3.6 Engineer Not Liable

Approval, reviews and inspection by the Engineer of any part of the Works does not relieve the Contractor from his sole responsibility and liability for the supply of materials, plant and equipment for construction of the Works and their parts in accordance with the Contract and neither the Engineer's authority to act nor any decision made by him in good faith as provided for under the Contract whether to exercise or not to exercise such authority shall give rise to any duty or responsibility of the Engineer to the Contractor, any Subcontractor, any of their representatives or employees or any other person performing any portion of the Works.

4.2 Performance Security

Delete and replace '28' days with '14' days wherever found in the sub-clause.
Add the following text at the end;

The Performance Security shall be binding irrespective of changes in the quantities or variations in the Works or Extensions in Time for Completion of the Works which are granted or agreed upon under the provisions of the Contract.

4.3 Contractor's Representative

The following text is to be added after first paragraph:

The contractor's authorized representative or Project Manager must be a graduate civil engineer i.e. BE or B.Sc. (Civil) registered with the Pakistan Engineering Council as Professional Engineer having at least 20 years' experience in the relevant field and should not be more than 50 years old. The Project Manager should be authorized to take instruction from the Engineer and direct contractor's team to complete the works in accordance with the specifications.

In case the Contractor fails to appoint his representative / PM and other staff, as stated above & as indicated in Appendix-K to bid, the Engineer may order to stop complete or appropriate portion of work at site until Contractor fulfills the requirement of staff employment.

Following are added after sub clause 4.24;

4.25 Vesting of Contractor's Plant, Equipment Temporary Works and Materials:

(a) **Definitions**

For the purpose of Sub-Clause 4.17.

(i) The expression "Construction Plant" shall be deemed to exclude vehicles engaged in transporting any labour equipment or materials to or from the site.

(ii) The expression "Essential Hired Plant" shall mean all Constructional Plant, Equipment Temporary Works and materials of Temporary Work the withdrawal of which in the event of termination under Sub-Clause 15.2 hereof might (having regard to the methods of construction employed prior to the termination) endanger the safety or stability of or result in serious disturbance to the execution of any part of the Works and which are held by the Contractor under any agreement for hire thereof.

(iii) The expression "Hired Plant" shall mean any Constructional Plant, Equipment, Temporary Works (other than essential hired plant) held by the Contractor under any agreement for hire thereof.

(iv) The expression "Agreement for Hire" shall be deemed not to include an agreement for hire purchase with an option to purchase or for conditional sale either of which is herein referred to as an "agreement for the purchase".

(v) The expression "Hire Purchase Plant" shall mean any Constructional Plant, Equipment, Temporary Works held by the Contractor under an agreement for hire purchase thereof.

(vi) The expression "owner" means the owner of the plant and equipment of any Hire Purchase Plant.

(b) Vesting of Certain Plant

All Constructional Plant, Equipment, Temporary Works and material owned by the Contractor or by any company in which the Contractor has a controlling interest shall when brought on to the site (or in the case of hire purchase plant upon becoming the property of the Contractor) and shall be deemed to become the property of the Procuring Agency.

(c) Conditions of Hire of Certain Plant

With a view to securing in the event of termination Sub-Clause 15.2 hereof the continued availability for the purpose of executing the Works of any essential hired plant and equipment the Contractor shall not bring on to the Site any essential hired plant unless the agreement for hire thereof contains a provision that the owner will on request in writing made by the Procuring Agency within 7 days after the date on which any such termination has become effective and on the Procuring Agency undertaking to pay all hire charges in respect thereof on the same terms in all respects as the same was hired to the contractor save that the Procuring Agency shall be entitled to permit the use thereof by any other contractor employed by it for the purposes of completing the works under the terms of Sub-Clause 15.2 hereof.

(d) Costs for purpose of Approval of Materials not implied

In the event of the Procuring Agency entering into any agreement for hire of essential hired plant pursuant to the contract provisions, all sums properly paid by the Procuring Agency under the provisions of any such agreement and all expenses incurred by it (including stamp duties) in entering into such agreement shall be deemed for the purpose of Sub-Clause 15.2 hereof to be part of the cost of completing the Works.

(e) Contractor's Certificate as to Hiring Provisions

The Contractor shall upon request made by the Engineer at any time in relation to any item of essential hired plant forthwith notify to the Engineer in writing the name and address of the owner and shall certify that the agreement for the hire thereof contains a provision in accordance with the requirements of Approval of Materials not Implied. The Contractor shall also upon request as aforesaid give a like notification (but without certificate) in regard to any hire purchase plant.

(f) Hire Purchase Payment by the Procuring Agency

The Procuring Agency shall in order to avoid seizure by the owner of any hire purchase plant be entitled to pay to such owner the amount of any overdue installment or other sum payable optionally or otherwise under any Agreement of hire purchase and in the event of his doing so any amount so paid by him shall be debt due from the Contractor to the Procuring Agency and may be deducted by the Procuring Agency from any moneys due or that may become due to the Contractor under the Contract or may be recovered by the Procuring Agency from the Contractor at law.

(g) Irrevocability of Certain Plant etc.

No Constructional Plant, Equipment Temporary Works or materials or any part thereof shall be removed from the site without the written consent of the Engineer which consent shall not be unreasonably withheld where the same is no longer immediately required for the purposes of completion of the Works but the Procuring Agency will permit the Contractor the exclusive use of all such Constructional Plant, Equipment, Temporary Works and materials in and for the completion of the Works until the occurrence of any event which gives the Procuring Agency the right to expel the Contractor from the site and proceed with the completion of the Works.

(h) Re-vesting and Removal of Plant

Upon the removal with the consent of the Engineer of any such Constructional Plant Equipment, Temporary Works or materials as have been deemed to have become the property of the Procuring Agency, the property therein shall be deemed to re-vest in the Contractor and, upon completion of the Works the property in the remainder of such Constructional Plant, Equipment, Temporary Works and materials as aforesaid shall subject to the provisions of Sub-Clause 15.2 be deemed to re-vest in the Contractor who shall remove the same together with any essential hired plant or hire purchase plant. If the Contractor shall fail to remove any Constructional Plant, Equipment, Temporary Works or materials as aforesaid or any essential hire plant or hire purchase plant within such reasonable time after completion of the Works as may be allowed by the Engineer then the Procuring Agency may:

i) sell any such Constructional Plant, Equipment, Temporary Works and materials as aforesaid, and

ii) return at the Contractor's expenses to the person firm or company from whom any Essential Hired Plant or any Hire Purchase Plant was held by the Contractor such essential hired plant or hire purchase plant, and after deducting from any proceeds of sale, the costs, charges and expenses of and in connection with such sale and return as aforesaid shall pay the balance (if any) to the Contractor but to the extent that the proceeds of any sale are insufficient to meet all such cost, charges and expenses the excess shall be a debt due from the Contractor to the Procuring Agency and shall be deductible or recoverable by the Procuring Agency accordingly as aforesaid.

(j) Liability for loss or injury to plant

The Procuring Agency shall not at any time be liable for the loss of or injury to any of the Constructional plant, Temporary Works or materials which have been deemed to become the property of the Procuring Agency, hereof save as mentioned in Sub-Clause 20 hereof.

(k) Incorporation of Sub-Clause in Sub-Contracts

The Contractor shall when entering into any sub-contract for the execution of any part of the Works incorporate in such sub-contract (by reference or otherwise) the provisions of this Sub-Clause in relation to Constructional Plant, Temporary Works and materials. Essential Hired Plant and Hire Purchase Plant to be brought on the Site by the sub- contractor.

(l) Approval of Materials etc., not implied

The contractor's operation shall not be deemed to imply any approval by the Engineer of the materials or other matters referred to therein nor shall it prevent the rejection of any materials at any time by the Engineer.

6.9 Engineer at Liberty to Object

The following is added at the end of sub clause in General Conditions of Contract:

If the Procuring Agency asks the Engineer to direct Contractor to remove a person who is a member of his staff or workforce stating the reasons the Contractor shall ensure that the person leaves the site immediately and has no further connection with the work in the Contract.

6.10 Records of Contractor's Personnel and Equipment

The following paragraph is added:

The Contractor shall, upon request by the Engineer at any time in relation to any item of hired Contractor's Equipment, forthwith notify the Engineer in writing the name and address of the Owner of the equipment and shall certify that the agreement for the hire thereof contains a provision in accordance with the requirements set forth above.

Add the following sub-clause at the end of 6.22 in (GCC)

6.23 Compliance by Subcontractors

The Contractor shall be responsible for compliance by his Subcontractors of the provisions of this Clause.

The following sub-clause 7.9 is added in (GCC)

7.9 Use of Pakistani Materials and Services

The contractor shall, so far as may be consistent with the contract, make the maximum use of materials, supplies, plant and equipment indigenous to or produced or fabricated in Pakistan and services, available in Pakistan provided such materials, supplies, plant, equipment and services shall be of required standard.

8.1 Commencement of Works

The last Para is deleted and substituted with the following:

The contractor shall commence the works on site within the period named in Appendix-A to Bid from the date of receipt by him from the Engineer of a written Notice to Commence. Thereafter, the contractor shall proceed with the works with due expedition and without delay.

8.3 Program

The following paragraphs are added:

The program/schedule shall be submitted in the form of Critical Path Method (CPM) identifying the critical path/activities, in hard form as well as in soft form in latest version of MS Project or as agreed with the Engineer.

a) The Contractor shall submit to the Engineer detailed programme for the following:

(1) Execution of Works;
(2) Key Deliverables and submittals
(3) Labour Resources;
(4) Local Material Procurement;
(5) Material Imports, if any; and
(6) Other details as required by the Engineer.

b) If Contractor fails to submit updated work schedule within the time instructed by the Engineer/Project Manager, the Engineer/Project Manager may withhold an amount at his discretion from next due amount and continue to withhold this amount until the next payment after the date on which the overdue program has been submitted.

c) During the period of the Contract, the Contractor shall submit to the Engineer no later than the 8th day of the following month, 04 copies each of Monthly Progress Reports covering:

(1) Progress update of the project program/schedule indicating the monthly progress in percentages with actual start and finish dates;
(2) Description of all work carried out since the last report;
(3) Description of the work planned for the next 56 days sufficiently detailed to enable the Engineer to determine his programme of inspection and testing;
(4) Monthly summary of daily job record; and
(5) Information about problems and difficulties encountered, if any, and proposals to overcome the same.

d) During the period of the Contract, the Contractor shall keep a daily record of the work progress, which shall be made available to the Engineer as and when requested. The daily record shall include particulars of weather conditions, number of men working, deliveries of materials, quantity, location and assignment of Contractor's equipment.

e) The detailed Cash Flow Estimate shall be submitted within 21 days from the date of receipt of Letter of Acceptance

8.11 Prolonged Suspension

Replace 84 days by 120 days.

13.1 Right to vary

In the last line of last Para, after the word "Variation", the word "in writing" is added.

13.3 Variation procedure

In the 2nd line, after the words "as soon as practicable" following is added: "and within a period not exceeding one-eighth of the completion time"

13.8 Adjustment for changes in cost

The following provision is added for Bidding Contracts:

The amounts payable to the Contractor, pursuant to Sub-Clause 14.6, shall be adjusted in respect of the rise or fall in the cost of materials only, and will be paid to the contractor on those items mentioned in the **Appendix –C to Bid**.

Similarly reduction in the cost of these materials will also be recovered as De-Escalation from the contractor accordingly.

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.

Add the following sub clauses at the end of 13.80;

(a) 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 last day of the period 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.

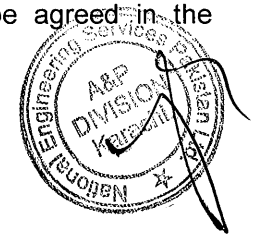
If any adjustable item(s) as stated in Appendix-C is not used in a particular billing period then the ratio of current date price and base date price for that particular adjustable item(s) shall be considered as one.

(b) Adjustment during extension period after stipulated Completion date

If the Contractor fails to complete the Works within the Time for Completion prescribed under Clause 8.2, 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 Procuring Agency, provided that if an extension of time is granted pursuant to Clause 8.4, 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 Appendix-C 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 13. Such adjustment(s) shall have to be agreed in the variation order.



14.1 The Contract Price

Sub-para (d) & (e) are deleted.

14.2 Advance Payment

The Text is deleted and replaced with following:

Advance Payment/ Mobilization Advance shall be made available to the Contractor by the procuring agency on following conditions:

Mobilization Advance/Advance Payment

(i) Interest free Mobilization Advance up to 10 % of the Contract Price may be paid by the procuring agency to the Contractor on the works costing Rs 2.5 million or above on following conditions:

a. on submission of a mobilization advance guarantee by the Contractor for the full amount of the advance in the form of Bank Guarantee, from a Scheduled Bank in Pakistan, acceptable to the procuring agency;

b. First half (50%) within 14 days after signing of the Contract Agreement or date of receipt of Engineer's Notice to Commence, whichever is earlier; and

c. Second half (50%) to the state of mobilization of the Contractor achieved up to the satisfaction of the Engineer.

(ii) This Advance shall be recovered in equal installments (month-wise) and recovery shall start from first installment at the expiry of second month after the date of payment of first part of Advance and complete recovery two month before the date of completion of the Works as per Contract. However, the contractor has option to pay back more amount than the installment for early recovery.

14.3 Application for Interim Payment Certificate

Add the following paragraphs (h) after the paragraph (g) of Sub-Clause 14.3 of Part-I.

(h) For the imported equipment, materials (to be supplied for the Project), the payment conditions shall be as under:

(i) 15% (fifteen percent) of the quoted rates of items in schedule of prices shall be paid as advance against Bank Guarantee from Schedule bank in Pakistan, after the Contractor has obtained necessary approval of equipment and materials from the Engineer.

(ii) 40% (forty percent) of the quoted rates of items in schedule of prices shall be paid as advance on submission of negotiated shipping documents and arrival of equipment / material at Karachi Port / Port Qasim.

(iii) 25% (twenty five percent) of the quoted rates of items in schedule of prices shall be paid on delivery of equipment / material at site and issuance of inspection certificates and approval by the Engineer. The Bank Guarantee provided by the Contractor at (i) above would also be released.

(iv) 10% (ten percent) of the quoted rates of equipment / material in schedule of prices shall be paid on completion of installation to the satisfaction of the Engineer.

(v) 10% (ten percent) of the quoted rates of equipment / material in schedule of prices shall be paid on completion of testing and commissioning of the equipment and system.

The Text is added at the end of sub clause 14.3 as follows:

The Contractor shall submit a certificate signed and stamped certifying that the Contractor has paid all dues of the materials, suppliers, workmen and subcontractors for the works whose payment is claimed in this Application of Interim Payment.

14.5 Plants and Materials intended for Works (Secured Advance)

Add the following paragraph as sub-clause 14.5 (d) for Secured Advance on non – perishable materials and sub-clauses (a), (b) and (c) will be applicable for plants and materials :-

(I) The Contractor shall be entitled to receive from the procuring agency Secured Advance against an INDENTURE BOND in Public Works Account Form No.31 (Fin. R. Form No. 2) acceptable to the procuring agency of such sum as the Engineer may consider proper in respect of non-perishable materials brought at the site but not yet incorporated in the Permanent Works provided that:

(i) The materials are in accordance with the specifications for the permanent works;

(ii) Such materials have been delivered to the site and are properly stored and protected against loss or damage or deterioration to the satisfaction and verification of the Engineer/ Engineer's Representative but at the risk and cost of the Contractor;

(iii) The Contractor's records of the requirements, orders, receipts and use of materials are kept in a form approved by the Engineer, and such records shall be available for inspection by the Engineer;

(iv) 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 for the purpose of valuation of materials and providing evidence of ownership and payment therefore;

(v) Ownership of such materials shall be deemed to vest in the procuring agency and these materials shall not be removed from the site or otherwise disposed of without written permission of the procuring agency;

(vi) The sum payable for such materials on site shall not exceed 75 % of the (i) landed cost of imported materials, or (ii) ex-factory / ex-warehouse price of locally manufactured or produced materials, or (iii) market price of stands other materials;

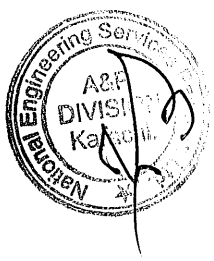
(vii) Secured Advance shall not be allowed unless and until the previous advance, if any (mobilization & securted), is fully recovered;

(viii) Detailed account of advances must be kept in part II of running account bill or a separate statement; and

(ix) Secured Advance may be permitted only against materials/quantities anticipated to be consumed / utilized on the work within a period of 3 months from the date of issue of secured advance and in no case for full quantities of materials for the entire work /contract.

(x) The words "non-perishable materials" occurring in this Clause is limited to the following materials only.

a) Steel reinforcement
b) Cement
c) Aluminum Works
d) Tiles (Any type)
e) Electrical Wires/Cables (sealed packing only



(II) Recovery of Secured Advance:

Secured Advance paid on non-perishable materials to the Contractor under the above provisions shall be recovered from the monthly payments on actual consumption basis, but not later than period specified in the rules not more than three months (even if unutilized)

14.7 Payment

For Payment of Interim Payment Certificates, delete and replace 56 days with 42 days, out of which 14 days shall be maximum time for Engineer's review and verification from the date it is submitted in complete with all supporting documents as per agreed format and 28 days' time for the payment to contractor by Procuring agency.

14.8 Delayed Payment

Second Para is replaced with following text:

In the event of the failure of the Procuring Agency to make the payment within the time stated, the procuring agency shall pay to the contractor, the compensation at rate of KIBOR+2% per annum in local currency and Libour+1% for foreign currency, upon all sums to be paid from the date of which the same would have been paid.

15.2 Termination by Procuring Agency

The following Para is added at the end of the sub-clause:

Provided further, that in addition to the action taken by the procuring agency against the Contractor under this Clause, the procuring agency may also refer the case of default of the Contractor to Pakistan Engineering Council for punitive action under the Construction and Operation of Engineering Works Bye- Laws 1987, as amended from time to time.

15.6 Corrupt and fraudulent Practices.

The following text is to be added as 3rd paragraph:

Successful Contractor has to provide Integrity Pact (for contracts worth Rs.10.0 million and above).

If the Contractor or any of his Subcontractors, agents or servants is found to have violated or involved in violation of the Integrity Pact signed by the Contractor as Appendix-L to his Bid, then the procuring agency shall be entitled to:

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

(b) terminate the Contract; and

(c) recover from the Contractor any loss or damage to the procuring agency as a result of such termination or of any other corrupt business practices of the Contractor or any of his Subcontractors, agents or servants.

The termination under sub-para (b) of this Sub-Clause shall proceed in the manner prescribed under sub-clauses 15.2 & 15.5 and the payment under Sub-Clause 15.4 shall be made after having deducted the amounts due to the procuring agency under Sub-Para (a) and (c) of this Sub- Clause.

16.4 Payment on Termination

Sub-paragraph (c) is deleted.

17.3 Procuring Agency's/ Procuring Agency's Risks

Sub-Clause 17.3 (h) is deleted.

The following text is added in Clause 18.1 (GCC):

18.1 General Requirements for Insurance

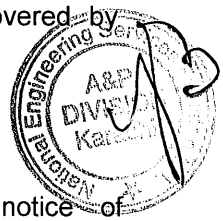
The contractor shall be obliged to place all insurances relating to the contract (including, but not limited to, the insurances referred to in Clauses 18.1,18.2,18.3,18.4) with Insurance Company having at least AA rating from PACRA/JCR in favour of the Procuring Agency/Procuring Agency valid for a period 28 days after the Bid Validity date. Costs of such insurances shall be borne by the contractor.

The Contractor shall insure with any one of the insurance companies approved for this purpose by the Procuring Agency. The insurance policies shall be in the joint names of the Procuring Agency, and the Contractor against all losses or damages as stated in the General Conditions of Contract Part I and as stated herein. Notwithstanding the responsibilities of the Contractor for indemnities and insurances as described in General Conditions of Contract Part I, the Contractor before commencing work on Site, must discuss fully with the Engineer and the Procuring Agency the insurance coverage provided under any general policies which are to be applied to this Contract to ensure that there are no contingencies left uncovered and to reduce, as far as practicable, duplication of coverage. Should any areas of omission be discovered that are not covered by definition of responsibilities set out in these conditions, the addition or reduction in premiums required to give such insurance coverage will be paid by the Contractor. Such policies shall be obtained by the Contractor with consent of the Engineer/Procuring Agency

The Contractor shall be responsible for deductibles and losses/damages not covered by insurances other than the excepted risks.

The insurance losses shall not affect the Procuring Agency's or the Contractor's rights and obligations under the Contract.

The Contractor shall be responsible for compliance by his sub-contractors of insurances specified in these Sub-Clauses. Before each sub-contractor starts work, the Contractor shall provide the Procuring Agency proof that the sub-contractor(s) are covered by insurances specified herein for the Contractor.



All policies shall state that:

i) The Procuring Agency shall receive at least 30 days written notice of intended Cancellation or change affecting coverage.

ii) The Contractor is fully protected so as to provide full indemnity to Procuring Agency in respect of liability against losses or damages assumed by the Contractor under the Contract.

iii) The inclusion of more than one insured shall not affect the rights of any other insured.

iv) If a loss occurs the Contractor and the Procuring Agency shall be paid in relation of their share of the loss.

v) The Insurer has no subrogation rights against any person, corporation, or organization including directors, officers, employees, servants' agents thereof which:

- is an insured under the policy or
- is Controlled by, Owned by, or associated with an insured, or
- is a sub-contractor on the works, or has, before or a loss occurs, been released from liability by an insured.

Hold harmless provisions: The Procuring Agency, the Engineer and the Contractor shall be indemnified against all losses.

Procuring Agency use or occupancy: If the Procuring Agency uses or occupies all or part of the works during the life of the insurance policy, the Contractor shall ensure that the policy continues in full force and the Procuring Agency shall pay any resulting extra cost of insurance.

Loss Procedure: If a loss occurs the Contractor shall, on behalf of the Procuring Agency and himself negotiate the value of the loss with the insurer. Unless directed otherwise by the Engineer, when agreement is reached the Contractor shall repair all damages and the Procuring Agency shall pay him in accordance with the Engineer's Certificates for that part of the repairs which is the Procuring Agency's responsibility.

If directed by the Engineer, instead of carrying out repairs, the Contractor shall pay to the party suffering the loss that part of the agreed value of the loss which is the Contractor's responsibility.

The provisions of this Sub-Clause shall be applicable to other insurance covered by Clauses 18 of General Conditions of Contract Part-I.

Automobile Liability Insurance: The Contractor shall also provide automobile liability insurance of all licensed vehicles owned, hired and operated by the Contractor at the Site and the risk insured shall be bodily injury, death of person and property damage or loss.

There shall be no obligation for the insurances to include loss or damage caused by the risks listed under Procuring Agency's risk.

19.6 Optional Termination, Payment and release by the Procuring Agency

Sub-clauses (c), (d) and (e) are deleted.

20.6 Arbitration

Text is replaced as under;

Any dispute in respect of which:

a. the decision, of the Dispute Board has not become final and binding pursuant to sub-clause 20.2, and

b. amicable settlement has not been reached within the period stated in sub-clause 20.5, shall be finally settled, under the provisions of the Arbitration Act, 1940 as amended or any statutory modification/Rules of Conciliation And Arbitration PEC Islamabad or re-enactment thereof for the time being in force.

The place of arbitration shall be Karachi, in Sindh Province.

Following Sub-Clause 21.1 is added;

21.1 Customs Clearance

Customs clearance shall be Contractor's responsibility.

22.1 Notice to Contractor

The following paragraph is added:

For the purposes of this Sub-Clause, the Contractor shall, immediately after receipt of Letter of Acceptance, intimate in writing to the Procuring Agency and the Engineer by registered post, the address of his principal place of business or any change in such address during the period of the Contract.

22.2 Notice to Procuring Agency and Engineer

For the purposes of this Sub-Clause, the respective addresses are:

a) The Procuring Agency:
The Project Director,
Sindh Forensic Science Laboratory, Karachi
P&D Department
2nd Floor, Tughluq House, Sindh Secretariat,
Karachi

b) The Engineer:

National Engineering Services Pakistan (Pvt.) Limited (NESPAK)
4th Floor, NICL Building,
Abbasi Saheed Road,
Karachi

The following Sub-Clauses 23.1 is added:

23.1 Payment of Taxes including GST

The Contractor, Subcontractors and their employees shall be responsible for payment of all their Income Tax, GST and other Taxes on income arising out of the Contract and the rates and prices stated in the Contract shall be deemed to cover all such taxes. As per Government of Pakistan (GoP) regulations, the income tax of the contractor will be deducted at source i.e. Procuring Agency.

The Contractor firm is required to provide details & all relevant documentation/evidence of its registration with relevant registration authorities like FBR &/or Sindh Revenue Board.

Annex PROCEDURAL RULES

Procuring Agency retains SPPRA rules without changes, in case of contracts under Project, Bank and donor's program.

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SPECIFICATIONS-
SPECIAL PROVISIONS
TECHNICAL PROVISIONS
(Please refer separate Volume II)

TENDER DRAWINGS
(Please refer separate Volume III)

HOME DEPARTMENT
GOVERNMENT OF SINDH

ESTABLISHMENT OF
FORENSIC SCIENCE LABORATORY IN SINDH AT KARACHI

CONSTRUCTION OF RECEPTION & EVIDENCE COLLECTION BLOCKS
(ARCHITECTURAL FINISHES & MEP WORKS ONLY)

BIDDING & CONTRACT DOCUMENTS

VOLUME - II

SPECIFICATIONS
SPECIAL & TECHNICAL PROVISIONS

APRIL 2023

National Engineering Services Pakistan Ltd. A&P DIVISION Karachi.

NATIONAL ENGINEERING SERVICES PAKISTAN (PVT.) LTD.
Architecture & Planning Division
4th Floor, N.I.C. Building, Abbasi Shaheed Road, Off. Shahrah-e-Faisal, Karachi
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http://www.nespak.com.pk

Clearance Code	4268/08B/BD/__(23)	Doc No.	4269/08B/BD/00	Rev No.	00

Establishment of Forensic Science Laboratory in Sindh at Karachi

CONSTRUCTION OF RECEPTION & EVIDENCE BLOCKS
(ARCITECTURAL FINISHES & MEP WORKS ONLY)

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National Engineering Services Pakistan (Pvt.) Ltd. P&P DIVISION Karachi.

SPECIAL PROVISIONS

SECTION - 0100

GENERAL REQUIREMENTS

01 GENERAL

The Conditions of Contract Part I & II shall form an integral part of these General Requirements.

The Contractor shall notify all sub-contractors of the provisions of the Conditions of Contract and the General Requirement of this Specification.

The arrangement and divisions of these Specifications is not to be construed as establishing the limits of responsibility of sub-trades.

The Contractor is responsible for delineating the scope of Sub-Contracts and for coordinating all the Works.

All works shall be carried out in accordance with the following specifications, supplemented by detailed specifications contained in the following sections. Any inconsistencies or ambiguities shall be brought to the notice of the Engineer for his clarification/decision. Decision and direction of the Engineer, in all such cases, shall be final and binding.

The Contractor shall make himself thoroughly familiar with the site conditions, foresee any and all problems likely to be encountered during execution of the works, and shall be able and ready to solve them effectively. Proposals for solutions to the problems shall be submitted to the Engineer for approval before proceeding with the work.

02 APPLICABLE CODES AND STANDARDS

In the absence of other Standards being required by the Contract Documents, all work and materials shall meet the requirement of the Uniform Building Code of the United States, and/or applicable American Society for Testing Materials (ASTM),American Association of State Highway and Transportation Officials (AASHTO) Specifications and the latest American Concrete Institute Manual of Concrete Practice and American Institute of Steel Construction (AISC) Manual relevant to the Works except in cases where the Pakistan Building Code requires a higher standard. In such cases the Pakistani Code shall govern. Where the abbreviations listed below are used, it refers to the latest code, standards, or publication of the following organizations:

AASHTO	American Association of State Highway and Transportation Officials.
ACI	American Concrete Institute
AISC	American Institute of Steel Construction
ANSI	American National Standards Institute
ASA	American Standard Association
ASCE	American Society of Civil Engineers
ASTM	American Society for Testing and Material
AWS	American Welding Society
BSI	British Standards Institute
ICAO	International Civil Aviation Organization

National Engineering Services Pakistan (Pvt.) Ltd. A&P DIVISION Karachi.

BSICP	British Standard Institute Code of Practice
PCA	Portland Cement Association
PSI	Pakistan Standard Institute
PSQCA	Pakistan Standard & Quality Control Authority.
UBC	Uniform Building Code
UPS	Uniform Plumbing Code

If the Contractor, at any time and for any specific reasons, wish to deviate from the above standards or desires to use materials or equipment other than those provided for by the above standards, then he shall state the exact nature of the change giving the reasons for making the change and shall submit complete specifications of the materials and descriptions of the equipment for the Engineer's approval, whose decisions shall be conclusive and binding upon the Contractor.

03 CODES, STANDARDS, CERTIFICATES

The Contractor shall supply and have at his site office:

Copies of all latest editions of codes and standards referred to in these specifications by number, or equivalent codes and standards approved by the Engineer.

Catalogues and published recommendations from manufacturers supplying products and materials for the project.

The Contractor shall provide manufacturer's or supplier's certificates to the Engineer for all products and materials which must meet the requirements of a specific code or standard as stated in these Specifications.

04 UNITS OF MEASUREMENTS

The FPS or SI System of Units shall be used throughout this Project.

05 MANUFACTURER'S RECOMMENDATIONS

Installation of manufactured items shall be in accordance with procedures recommended by the manufacturer or as approved by the Engineer.

06 EXISTING CONDITION AT SITE

Drawings and information pertaining to existing project conditions are available at Engineer's office for reference.

Neither the Employer nor the Engineer warrants the adequacy or correctness of these.

07 PROTECTION AND PRECAUTIONS

The Contractor and his sub-contractors shall afford all necessary protection to existing structures and will be required to make good at his own expense any damage done to such structures through his own or his representatives or subcontractors' fault and negligence.

The Contractor and his sub-contractors shall afford all necessary protection to existing roads in the area. He will clear and make good at his own expense any damage to or debris on these roads through his own fault and negligence. He must at all time ensure the free and normal flow of traffic and shall not cause obstruction to the traffic system. The Contractor and his sub-contractors shall provide and maintain necessary protection and precautionary measures such as warning signs, warning lamps and barricades etc. to prevent accidents.

The Contractor shall promptly correct all such damage to original condition at no additional expense to the Employer.

The Contractor shall cooperate with other Contractors performing work under other Contracts as necessary for completion.

08 SETTING OUT OF WORK

8.1 Verify accuracy of layout information shown on the Drawings, in relation to the property survey and existing benchmarks before proceeding to layout the Work. Locate and protect existing benchmarks and control points. Preserve permanent reference points during construction.

(a) Do not change or relocate benchmarks or control points without prior written approval from the Engineer. Promptly report lost or destroyed reference points or requirements to relocate reference points because of necessary changes in grade, location or conflicting construction.

(b) Promptly replace lost or damaged project control points with prior approval of the Engineer. Replacement of project control points shall be based on original survey control points.

(c) Establish and maintain the required number of permanent benchmarks on the job site as directed by the Engineer. Benchmarks shall be located from and referenced to data established from survey control points. Record benchmark location, with horizontal and vertical data, on Project Record Documents.

8.2 Existing utilities and equipment:

(a) The existence and location of underground and other utilities and construction indicated in the Construction Documents as existing are not guaranteed. Before beginning site work, investigate and verify the existence and location of underground utilities and other construction and record this information on the relevant plan.

(b) Prior to construction, verify the location and invert elevation at points of connection to sanitary sewer, storm drainage and water service piping. Verify the location of electrical power and communication utilities for interface.

8.3 PERFORMANCE

(a) Working from lines and levels established by the property survey, establish benchmarks and reference markers to set lines and levels at each story of construction and elsewhere as needed to properly locate each element of the Project. Calculate and measure required dimensions within indicated or recognized tolerances. Drawings shall not be scaled to determine dimensions.

(b) Maintain a Surveyor's Log of control and other survey work. Surveyor's Log shall be made available for The Engineer reference.

Record deviations from required lines and levels, and advise the Engineer when deviations that exceed indicated or recognized tolerances are detected. Contractor shall record on Project Record Drawings deviations that are accepted and not corrected.

8.4 Site Works:

(a) Locate and lay out works, fill and topsoil placement, slopes and invert elevations by instrumentation and similar appropriate means.

(b) Prior to Substantial Completion, prepare a final property survey showing significant features (real property) for the Project. Include on the survey a certification, signed by the Surveyor, to the effect that principal metes, bounds, lines and levels of Project are accurately positioned as shown on survey.

09 SEQUENCE OF CONSTRUCTION

The Contractor shall submit his proposal for approval of the Engineer the sequence of Construction, prior to starting the works. The works shall be executed as per approved sequence of construction.

10 PARTIAL POSSESSION

Whenever, as determined by the Employer any portion of work performed by the Contractor is in a condition suitable for use, the Employer may take possession of or use such portion.

Such use by the Employer shall in no instance be construed as constituting final acceptance, and shall neither relieve the Contractor of any of his responsibilities under the Contract, nor acts a waiver by the Employer of any of the conditions thereof, provided that the Contractor shall not be liable for the cost of repairs, re-work, or renewals which may be required due to ordinary wear and tear resulting from such use. However, if such use increases the cost or delays to the completion of remaining portions of work, the Contractor will be entitled to an equitable adjustment.

If, as a result of the Contractor's failure to comply with the provision of the Contract, such use proves to be unsatisfactory, the Employer will have the right to continue such use until such portion of the work can, without injury to the Employer, be taken out of service for correction of defects, errors, omissions, or replacement of unsatisfactory materials or equipment, as necessary for such

work to comply with the Contract; provided that the period of such operation or use pending completion of appropriate remedial action shall not exceed twelve months unless otherwise mutually agreed upon in writing between the parties.

11 EXISTING SERVICES

The Contractor shall search for, find, locate and protect any wiring, cable, duct, pipe work, etc., within or immediately adjoining the site area.

The Contractor shall take full responsibly for safety of existing service lines, utilities and utility structures uncovered or encountered during excavation and construction operations.

The Contractor shall take full responsibility for damaging any such service lines, utility/utility structure and any cost and/or expense that arises or issues from any such damage shall be borne directly by him. If damage to any such service occur the Contractor shall forthwith take remedial action, initiate safety precautions, install temporary services and carryout repair all at his own cost and expense and inform the Engineer and notify all relevant authorities.

Existing utilities which are to remain in service for or after the works are to be determined by the Contractor. If any existing service lines, utilities and utility structures which are to remain in service are uncovered or encountered during these operations, they shall be safeguarded, protected from damage, and supported.

12 PLANT AND EQUIPMENT

The Contractor shall submit a detailed list of plant and equipment which he shall undertake to bring to the site to carry out the work. The list shall satisfy the Engineer as to type, size and quantity. The list shall include for each piece of equipment the type, manufacturer, model, identification number and year of manufacture. The Contractor shall provide on the site of the work at his cost all of the equipment listed and all subsequent equipment required for approval of the detailed programme of work and such equipment which may be directed by the Engineer. The Contractor shall supply all plant and equipment necessary for the construction of each phase of the work and it must be on site, inspected and approved by the Engineer.

13 CONSTRUCTION AREA AND ACCESS

The Contractor shall confine his operations to the areas that are actually required for the Works and shall fence the area accordingly. Arrangements for access roads, storage areas and routes for haulage of materials are to be made by the Contractor at his own cost, subject to the approval of the Engineer.

14 STORAGE & HANDLING FACILITIES

The Employer will provide the Contractor possible space within or nearby the area of site of works for the storage of plant, equipment and materials and for Contractor's temporary office, during the currency of the Contract. In case the adjacent area as required by the Contractor is not available within the Project

boundary for storage of plant, equipment and machines then the Contractor shall arrange at his own expense possible space for storage of plant, equipment and machines at his own cost and expense. On no account shall such temporary installations conflict/interfere with any of the permanent installations, services and any operational function of Employer. The handling and storage of all plants, equipment and materials at site shall be the sole responsibility of the Contractor and at no risk and cost to the Employer.

The Contractor shall protect all material against corrosion, mechanical damage or deterioration during storage and erection on site. The protection methods shall be to the approval of the Engineer.

15 TEST LABORATORY AND TESTING

15.1 Testing, except as otherwise specified herein, shall be performed by an approved testing agency as proposed by the Contractor and at no extra cost to the Employer. The Engineer may require all testing to be carried out under his supervision only.

15.2 If suitable and adequate material testing laboratory is not available in the vicinity, then the Contractor shall provide and maintain a materials testing laboratory in the vicinity of the Contractor's Camp and the laboratory shall have sufficient working area and shall be equipped with all necessary facilities including a suitable store room.

15.3 The Contractor shall supply and maintain to the satisfaction of the Engineer or his representative complete testing equipment, apparatus, tools, gauges, instruments, etc. in sufficient number and adequate for all tests to be carried out as specified in these specifications. Valid calibration certificates of gauges / instruments / equipment shall be provided by the Contractor.

15.4 The Contractor, after the approval by the Engineer for the source of cement and steel shall make available at the site sufficient stock of the materials in advance in order to allow sample testing for quality control prior to use.

15.5 The quality control testing shall be performed by the Contractor's competent personnel in accordance with a site testing and quality control programme to be established by the Contractor and approved by the Engineer or his Representative. The Contractor shall keep a complete record of all quality tests performed on site and submit the same to the Engineer. All quality control and related tests shall be carried out in accordance with applicable standards and codes.

16 CONSTRUCTION & CHECKING AT SITE

The Contractor shall submit to the Engineer in due time for approval and discussion, his proposals and plans as to the method and procedure to be adopted for the temporary and permanent works involved.

The submitting to these suggestions and arrangements, and the approval thereof by the Engineer shall not relieve the Contractor of his responsibilities and duties under the Contract.

The carrying out of all work included in the Contract is to be supervised by a sufficient number of qualified representatives of the Contractor and full facilities and assistance are to be afforded by the Contractor for the Engineer or his Representative to check & examine the execution of the work.

The Engineer reserves the right to inspect all parts of the works but may at his discretion waive inspection on certain items. This shall in no way absolve the Contractor from his responsibilities. This particularly applies to the checking of materials, the accurate setting out of foundations, and to the levelling, setting and aligning of the various parts, and to the proper fitting and adjustment of manufactured and finished materials and fixtures in position.

If the Engineer or his Representative find that the work progress is slow in such a way that the works or parts thereof will not be completed in the time specified, then he shall order the Contractor to work overtime or in shifts and the Contractor shall comply. These arrangements will be free of all financial encumbrances and at no additional costs to the Employer.

In the event of night work, the Contractor shall provide sufficient and adequate lighting to the satisfaction of the Engineer or his Representative and shall supply the necessary manpower for satisfactory continuation of the work after normal hours.

17 BAR BENDING SCHEDULE

Bar bending (reinforcement bars) schedule of all drawings shall be prepared by the Contractor and submitted in triplicate to the Engineer for approval.

18 DRAWINGS

18.1 Bidding Drawings: The drawings listed in the General Conditions of Contract, Volume I and provided in Volume III are referred to as Bidding Drawings and these show the scope of work to be performed by the Contractor. Bidding Drawings shall not be used as a basis for fabrication or construction but may be used as a basis for placing preliminary order for materials, subject to corrections based on the future issue of Drawings as provided under sub-clause 18.2 Drawings Issued for Construction. Bidding Drawings are subject to be modified and supplemented by additional detail by the Engineer.

18.2 Drawings Issued for Construction: After Award of Contract, Bidding Drawings shall be replaced by Drawings Issued for Construction including supplementary Specifications as may be necessary. Such drawings and specifications shall be construed to be included in the expression Custody and Supply of Drawings under Sub-Clause 6.1 of Conditions of Contract Part I. Drawings Issued for Construction may include some of the Bidding Drawings with or without modification and additional drawings as required to express design intent in greater detail. Such drawings may also be modified from time to time. Drawings Issued for Construction will be the drawings from which shop, fabrication, erection, installation, concrete placing, formwork, or other construction detail drawings shall be prepared by the Contractor. The work shall be executed in conformity with Drawings Issued for Construction. The Contractor shall prepare a schedule of Drawings Issued for Construction of various parts of the Works based on

Construction programme approved by the Engineer for issuance to the Contractor from time to time.

18.3 Study of Drawings: The Contractor shall study all Drawings Issued for Construction carefully as soon as practicable after receipt thereof, and any errors discovered shall promptly be brought to the knowledge of the Engineer for his instructions.

18.4 Copies of Drawing: Drawings will be issued to the Contractor free of charge as follows:

Drawings Issued for Construction - Two copies as specified in sub-clause 6.1 of Conditions of Contract Part - I i.e. Custody and Supply of Drawings.

18.5 Drawings to be furnished by the Contractor:

(a) Shop Drawings.

All shop drawings required for the work including all kinds of fabrication, field erection, installation, placement and layout drawings shall be furnished by the Contractor for approval of the Engineer. If additional detail drawings are necessary to complete any part of the work, such as additional reinforcing steel, drawings shall be prepared by the Contractor and submitted to the Engineer for approval. All drawings shall be complete and shall be submitted in due time and in logical order to facilitate proper coordination.

(b) Lift and placement Drawings.

At least thirty calendar days prior to starting construction of any concrete lift or other placement, the Contractor shall submit lift or other placement drawings to the Engineer for approval. Lift or other placement drawings shall be submitted for each lift or other placement of concrete to be placed. These drawings shall be to such scale as to clearly show all recesses, openings, and embedded parts, including embedded structural steel, mechanical and electrical items, reinforcement placement in each lift in sufficient detail for proper execution of the work.

(c) Construction Plant Layout Drawings.

Three prints of drawings, showing the layout of construction plant and equipment the Contractor proposes to use on the work, shall be submitted by the Contractor for review to the Engineer. The drawings shall show the locations of the principal components of the construction plant, offices; storage areas and yards which the Contractor proposes to construct or use at the site of the work and elsewhere. The drawings shall also show the unloading facilities for materials and equipment at the work site.

18.6 Submissions and Approvals:

(a) Except as otherwise specified, three copies of each drawing for approval or review shall be furnished to the Engineer. Within thirty calendar days after receipt, the Engineer will send one copy to the Contractor marked Approved, Approved/Except as Noted, or Returned for Correction. The notations Approved and Approved/Except as Noted will authorize the Contractor to proceed with the fabrication of the materials and equipment covered by such drawings subject to the corrections, if any, indicated thereon. Drawings returned for correction will be resubmitted for approval in the same manner as for new drawings. Every revision made during the life of the Contract shall be shown by number, date and subject in a revision block.

(b) Upon receipt of prints which have been Approved or Approved Except as Noted, the Contractor shall furnish three prints plus one reproducible of each drawing to the Engineer. If revisions are made after a drawing has been approved, the Contractor shall furnish 3 additional prints and one reproducible subsequent to each approved revision.

(c) Shop drawings to be prepared by a Sub-contractor shall be submitted in the same manner as (a) & (b) above but they will be submitted through the Contractor.

(d) All of the applicable requirements of this Clause with reference to drawings to be prepared by the Contractor, including Sub-contractors, shall apply equally to catalogue cuts, illustrations, printed specifications, or other data submitted for approval.

(e) Any work done on Contractor's drawings shall be at the Contractor's risk. The Engineer will have the right to request any additional details and to require the Contractor to make any changes in the drawings which are necessary to conform to the provisions and intent of design and specifications without additional cost to the Employer. The approval of the drawings by the Engineer shall not be construed as a complete check but will indicate only that the general method of construction and detailing is satisfactory. Approval by the Engineer of the Contractor's drawings shall not be held to relieve the Contractor of his obligation to meet all the requirements of the Specifications or of his responsibility for the correctness of the Contractor's drawings or of his responsibility for correct fit of assembled parts in final position or of his responsibility for the adequacy of method of construction.

19 AS-BUILT DRAWINGS

The Contractor shall, at all times, keep on the site one copy of all drawings and approved samples together with copies of all building, mechanical, electrical and public safety codes and relevant standards applicable to the works. All such material shall be made available to the Engineer.

In addition, the Contractor shall, at all times, keep on site a separate set of prints on which shall be noted neatly, accurately and promptly as the work progresses all significant changes between the work shown on the drawings and that which is actually constructed. The sub-Contractors shall each keep on site, at all times,

a separate set of prints of the drawings showing their parts of the work on which shall be noted, neatly accurately and promptly as work progresses the exact physical location and configuration of the works as actually installed, including any revisions or deviation from the Contract Documents.

At the completion of the works, the Contractor shall at his expense, supply to the Engineer six copies and one reproducible copy of all drawings alongwith CD containing all as built drawings amended to comply with the work "As Built". The Contractor shall provide in the same format as the original drawings, any additional drawing required to record the work.

20 RESTORATION AND CLEANING

The Contractor shall do regular cleaning and clean away all rubbish and excess materials that may accumulate from time to time on completion and before handing over. Upon completion of the works he shall obliterate all signs of temporary construction facilities such as work areas, structures, foundations of temporary structures, stock piles of excess or waste materials, or any other vestiges of construction, unless otherwise directed by the Engineer. The works and site shall be left in a clean and satisfactory state for immediate use and occupation. Care shall be taken not to use any cleaning materials which may cause damage to the surface to be cleaned.

21 PROTECTION OF THE WORKS

The Contractor shall whenever necessary cover up and protect the works from weather and damage by his own or other workmen performing subsequent operation. He shall provide all necessary dust sheets, barriers and guard rails and clear away the same at completion.

The Contractor shall take all proper steps for protection at all places on or about the works which may be dangerous to his workmen or any other person or to traffic. The Contractor shall provide and maintain warning signs, warning lamps and barricades as necessary.

22 PRODUCT DATA

Manufacture's standard schematic drawings shall be modified or deleted to indicate only information which is applicable to the project. Such standard information shall be supplemented to provide all additional applicable information.

Manufacturer's catalogue sheets, brochures, diagrams, schedules, performance charts, illustrations and other standard descriptive literature shall be clearly marked to identify pertinent materials products or models. Dimensions and required clearances shall be indicated. Shop performance characteristics and capacities shall be noted.

23 SAMPLES

23.1 The Contractor shall furnish for approval of the Engineer with reasonable promptness all samples as directed by the Engineer or specifically called for in these Specifications. The Engineer shall check and approve such samples with reasonable promptness for compliance with the

requirements of Contract Documents. All work shall be in accordance with approved samples.

23.2 Duplicate final approved samples, in addition to any required for the Contractor's use, shall be furnished to the Engineer, one for office use and the other for the Site.

23.3 Samples shall be furnished so as not to delay fabrication, allowing the Engineer reasonable time for consideration of the sample submitted.

23.4 Each sample shall be properly labeled with the name and quality of the material, manufacturer's name, name of the project, the Contractor's name and the date of submission, and the Specifications Article number to which the sample refers.

23.5 The manufacturer's installation directions shall be provided with each sample. The Contractor shall pay all transportation costs and deliver samples to the Engineer's office, Site or testing laboratory as directed by the Engineer.

Samples will not be returned unless return is requested at the time of submission; all packing and transportation costs for the return of samples shall be paid by the Contractor.

23.6 Samples shall be of adequate size and number to permit proper evaluation of the material by the Engineer. Where variations in colour, texture, dimensions or other characteristics are to be expected, the Contractor shall submit samples showing the maximum range of variation. Materials exceeding the range of variation of the approved samples shall not be used on the Work.

23.7 If both Shop Drawings and samples are required for the same item, the Engineer may require both to be submitted before approving either.

23.8 No acceptance or approval of any Shop Drawings or sample, or any indication or directions by the Engineer on any Shop Drawings shall constitute an authorization for any increase in the Contract Sum.

24 PRODUCT QUALITY AND HANDLING

Suppliers of local and foreign products and installations specified shall have been regularly engaged in the business of manufacturing, fabricating, installing and / or servicing work required for a period not less than 5 years. In addition, the Engineer may request as appropriate a:

- list of similar installations that describes project, scope and date of completion.
- complete literature, performance data, and technical data.
- list of services record within Pakistan.
- location of service office from which this installation could be maintained.

For the actual fabrication, installation, and testing of the specified work, use only thoroughly trained and experienced workmen completely familiar with the items required and with the manufacturers recommended methods of installation. In acceptance or rejection, no allowance will be made for the lack of skill on the part of workmen.

Use all means necessary to protect materials before, during and after installation and to protect the installed work and materials of all other trades. In the event of damage, immediately make all repairs and replacement necessary for approval and at no additional cost to the Employer.

25 INSPECTION & TESTS REPORTS

All equipment and materials furnished under these specifications and all work performed in connection therewith will be subject to rigid inspection by the Engineer or the Engineer's Representative. Acceptance of equipment and material or the waiving off inspection thereof shall in no way relieve the Contractor of his responsibility for meeting the requirements of the Contract.

The Contractor shall furnish the Engineer with certified true copies of test reports of all materials used in the manufacture and fabrication of equipment and material. The result of these tests shall be in such form as to show compliance with the applicable Specifications, standards and codes for the material used.

26 ACCIDENT PREVENTION, PROTECTIVE EQUIPMENT

The Contractor shall in respect of safety, health and welfare matters abide by the applicable laws, legislation and regulations of the Pakistan and (to the extent the same are applicable therein) the laws and regulations of the Pakistan, Statutory Regulations published and best industry practice for the safety, health and welfare of any employee of the Contractor, the Employer or the Engineer.

The Contractor shall maintain such records and make such reports concerning safety, health and welfare of persons and damage to property as the Engineer or the Employer may from to time require.

The Contractor shall report to the Employer and the Engineer details of any accident as soon as possible after its occurrence. The Contractor shall in addition report all accidents to the appropriate authorities to the extent required by law. In the case of any fatality or serious accident, the Contractor shall, in addition, notify the Employer and the Engineer immediately by the quickest available means.

Safety Plan

The Contractor shall submit for approval by the Engineer a project specific safety plan within fourteen (14) days of having received the Notice to Commence.

Medical Facilities

Contractor shall at his expense:

- Arrange for medical attention to be available when necessary,
- Provide dressing stations complete with all adequate first-aid equipment on the site,

- Display in suitable places the names of his employees who are available from time to time to render first aid services,
- Provide for the transport of serious cases to the nearest hospital,

H.S.E Representative

The Contractor shall depute qualified HSE representative at Site with suitable number of supervisors to ensure 100% compliance of HSE requirements as specified in HSE Plan.

The representatives must be fully authorized and equipped to correct unsafe or excessively inconvenient conditions at short notice.

27 TEMPORARY FACILITIES

The Contractor shall provide, erect or install, maintain, alter as necessary and remove on completion except as otherwise directed by the Engineer all temporary facilities and services including access roads as described hereinafter and/or in the Contract Document.

The Contractor's temporary site office shall be available for use not later than one month after the date of the site handing over.

Installation of temporary services at the site shall be given priority over all other construction at the site.

27.1 Temporary Road

The Contractor shall prepare and maintain such temporary roads as may be necessary, from the site to the nearest road and also within the site. Such roads shall be positioned strictly in accordance with the Engineer's instructions and the Contractor shall reduce or control any dust nuisance by spraying with water as directed. The Contractor shall satisfy himself as to the locations and nature of the proposed access routes to the site and shall be responsible for preventing any damage whatsoever to adjacent property and vegetation and keeping the access road free from debris at all times.

27.2 Temporary Services

(a) Temporary Water Supply

The Contractor shall supply in sufficient quantity all necessary potable and other water for construction purposes for all trades at point within a reasonable distance of the work. He shall make arrangements and pay charges for water service installation, maintenance and removal thereof, and pay the costs of water for all trades.

When the permanent water supply and distribution system has been installed, it may be used as the source of water for construction purposes provided that the Contractor obtains the written approval of the Engineer and the Employer and assumes full responsibility for the entire water distribution system and pays all charges/costs for operation and maintenance of the system mutually agreed between the Employer and the Contractor.

Temporary pipe lines and connections from the permanent service line, whether outside or within the area of site of works but necessary for the use of Contractor and his sub-contractor shall be installed, protected and maintained at the expense of the Contractor.

At completion of the work or at such time as the Contractor makes use of the permanent water supply installation, the temporary water services equipment and piping shall be removed by the Contractor at his own expense.

(b) Temporary Electricity

The Contractor shall make all the necessary arrangements for a temporary electricity service, pay all expense in connection with the installation, operation and removal thereof and pay the costs of electricity consumed by all trades.

In the event that the site can not be connected to a local electricity network or where the available power is insufficient the Contractor has to make his own provision and maintain such installation.

A temporary lighting system shall be furnished, installed and maintained by the Contractor as required to satisfy the minimum requirements for safety and security. The temporary lighting system shall afford adequate general illumination to all building areas. Adequate outdoor lighting shall be provided to illuminate staging trenches and the like to the satisfaction of the Engineer and general illumination throughout adequate for watchmen and emergency personnel.

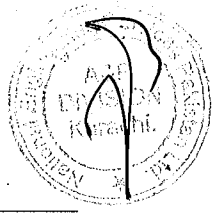
Temporary equipment and wiring for power and lighting shall be in accordance with the applicable provisions of governing codes. Temporary wiring shall be maintained in a safe manner and utilised so as not to constitute a hazard to persons or property.

When the permanent electrical power and lighting systems are in an operating condition, they may be used for temporary power and lighting for construction purposes provided that the Contractor obtains the written approval of the Engineer and the Employer and assumes full responsibility for the entire power and lighting system and pays all charges/costs for operation and maintenance of the system mutually agreed between the Employer and the Contractor.

Approval, license etc. if required under local laws will be obtained by the Contractor on his own responsibility and cost.

At completion of construction work, or at such time as the Contractor makes use of permanent electrical equipment and devices, temporary electricity services shall be removed by the Contractor as his own expense.

(c) Waste Disposal



The Contractor shall make such temporary provisions as may be required in order to dispose of any chemicals, fuels, grease, bituminous materials, waste and soil waste and the like without causing pollution to either the site or the environment. Disposal of any materials, wastes, effluents, garbage, oil, grease, chemicals and the like shall be in areas specified by the concerned local authority proposed by the Contractor and subject to the approval of the Engineer. If any waste material is dumped in unauthorized areas the Contractor shall remove the material and restore the area to the condition of the adjacent undisturbed area. If necessary, contaminated ground shall be excavated, disposed off as directed by the Engineer and replaced with suitable fill material compacted and finished with topsoil all at the expense of the Contractor.

(d) Fire Protection

The Contractor shall provide and maintain adequate fire protection in the form of barrels of water with buckets, fire bucket tanks, fire extinguishers, or other effective means ready for instant use, distributed around the project and in and about temporary inflammable structures during construction of the works.

Gasoline and other flammable liquids shall be stored in and dispensed from safety containers approved by the Engineer and storage shall not be within building.

Torch-cutting and welding operations performed by the Contractor shall have the approval of the Engineer before such work is started and a chemical extinguisher is to be available at the location where such work is in progress.

The Contractor shall follow the instructions and specifications of the Civil Defence Department and or other local authority.

28 CONSTRUCTION SCHEDULE

A Construction schedule shall be maintained in accordance with the provisions of the General Conditions of Contract.

The schedule shall be accompanied with sufficient data and information including all necessary particulars of constructional plant, equipment, machinery, temporary Works, arrival of plant, equipment at site and their installation, method of operation, work forces employed, etc., for activities of the Works.

Should the Engineer consider any alteration or addition in the programme and time schedule, the Contractor shall conform thereto without any cost to the Employer.

Whenever necessary and wherever the progress of the actual work shows departure, the programme and time schedule shall be undated and submitted to the Engineer for his approval.

29 NOTIFICATION TO THE ENGINEER

The Engineer's Representative shall be notified daily in writing of the nature and location of the Works the Contractor intends to perform the next day so as to enable necessary inspection and measurement to be carried out. The Engineer may, if necessary, direct that longer notice be given of certain operations.

30 NIGHT WORK

When work is done at night the Contractor shall maintain from sunset to sunrise such lights on or about his work and plant as the Engineer may deem necessary for the proper observations of the work and the efficient prosecution hereof.

31 WEATHER

No work is to be undertaken when, in the opinion of the Engineer, the weather is so unsuitable that proper protection of the work cannot be ensured.

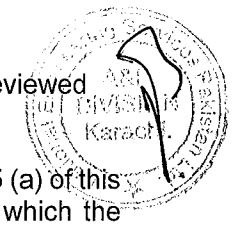
32 CO-ORDINATION WITH OTHER CONTRACTORS

The Contractor shall make all necessary coordination with other Contractor and shall make sure that all embedding components such as pipes, steel bases etc. (as required for completion of electrical and other works) are properly, accurately and timely installed.

The Contractor shall inform other contractors if any, the schedule of any construction activity well in advance giving him sufficient time to finish his part of job, before any compaction/concreting etc. The Contractor shall get the signature of the authorized representative of the other contractor, before carrying out any construction activity.
If any part of existing work is damaged or has to be dismantled or redone due to negligence/omissions/incorrect position of the embedding etc. on part of the Contractor, all such losses/expenses shall be borne by the Contractor.

All expenses incurred for the above works including coordination are deemed to be covered in his Bid cost and no separate/extra payment shall be paid against such item.

33 SUBMISSION REQUIREMENTS



33.1 Schedule submission at least sixty days before the dates when reviewed submittals will be needed.

33.2 Submit Shop Drawings as per provision given in Sub-Clause 18.5 (a) of this General Requirements and number of copies of Product Data which the Contractor requires for distribution plus four copies which will be retained by the Engineer.

33.3 Submit three samples unless otherwise specified.

33.4 Accompany submittals with transmittal letter, in duplicate, containing:

- Date
- Project title and number
- Contractor's name and address
- The number of each Shop Drawing, Product Data and the Sample submitted.
- Notification of deviations from Contract Documents.
- Other pertinent data.

34 RESUBMISSION REQUIREMENTS

Shop Drawings:

- Revise initial drawings as required and resubmit as specified for initial submittal.
- Indicate on drawings any changes which have been made by the Engineer.
- Product Data and Samples: Submit new data and samples as required for initial submittal.

35 SURVEY INSTRUMENTS

All the instruments, equipment, stakes and other material necessary to perform all work shall be provided by the Contractor. The survey work shall be carried out by competent staff consistent with the current practices. The Contractor shall maintain on site surveying instruments in perfect working conditions to enable the Engineer to check lines and level at all times.

Survey instruments and equipment shall include but not limit to the following:

- Electronic Total Station
- Electronic Data Recorder
- Disto Laser Meter
- Precision Level Invert Staff
- Automatic Levels
- Power level
- Compass, steel tape, ranging poles

36 MONTHLY PROGRESS REPORT AND PHOTOGRAPHS

36.1 During the continuance of the Contract, the Contractor shall submit monthly progress reports on forms as approved by the Engineer. Such monthly reports shall show the actual progress completed as of date of the report plotted against the schedule as given by the Contractor at the start of work and shall be broken down so as to indicate status of all activities associated with mobilization, design, material procurement, manufacture, surveys works, tests with regard to the agreed Contract programme.

36.2 The Employer and the Engineer reserve the right to coordinate the schedules of this Contractor and other contractors working at the Site, and to adjust and/or change any and all such schedules as required during the course of construction in order to achieve a coordinated project in harmony with the completion date.

36.3 Commencing after the first month of construction, and continuing every month until completion, the Contractor shall take and submit photographs to the Engineer's Representative, to show progress of his work and completion of each structure or major feature.

37 CONTRACTOR TO NOTIFY DELAYS ETC.

Any delay which will affect the completion of Works shall be detailed by the Contractor who shall state the action he is taking for effective completion of the Contract programme.

The Contractor shall submit a report in respect of the various sections of the Works, the equipment in use or held in readiness, a return of labour and supervisory staff, and details of any matters arising which may generally affect the progress of the work.

The Contractor shall give a summary of the detailed progress report giving the position with regard to the agreed Contract programme.

The progress reports shall be set out in a format to the approval of the Engineer, and forwarded promptly so that on receipt the information contained therein is not more than 21 days out of date.

If during execution of the Contract, the Employer considers the progress position of any section of the work to be unsatisfactory, or for any other reason relating to the Contract, he will be at liberty to convene a meeting and the Contractor's Representatives are to attend such meeting.

The Contractor's Site Office shall prepare and submit 6 copies of a monthly progress report along with the photographs to the Employer and Engineer's Site Office. This report shall summarize site activities and record and details where difficulties in maintaining the agreed programme are being experienced or are likely to cause subsequent delay.

The Contractor's Site Office shall also prepare and submit to the Engineer's Site Office 2 copies of Daily Activity Report summarizing the main activities to be undertaken each day, noting special activities such a tests, alignment checks, etc. The Contractor shall be responsible for submitting daily, manpower & equipment details deployed at site. The contractor shall also be responsible for expediting the delivery of all material and equipment to be provided by himself and his subcontractors if any.

38 PHOTOGRAPHS

As soon as work commences on Site, the Contractor shall provide photographs of the works from positions to be selected by the Engineer. Each photographic /

digital print shall not be less than 100mm x 100mm and shall bear a printed description, serial number and date when taken.

The negatives/soft copies of all photographs shall be held at the Contractor's Site Office, numbered and handed over to the Employer at the completion of the Contract.

39. SITE FACILITIES FOR THE EMPLOYER AND THE ENGINEER

39.1 Site Office

The Contractor shall construct, provide and maintain 02 Site offices for the Employer and the Engineer's Site Team of about 1000 square feet covered area each. The Contractor will submit drawing for the Site Office showing details &requirements for approval of the Engineer within 15 days after receipt of Letter of Award.

The Site Office shall be furnished and equipped with new and unused furniture and equipment as per the list given below:

S. No.	Description of furniture / equipment	Qty for Engineer's Office
01	Office table with drawers and side racks (6x3ft.size)	3
02	Officer's table with drawers and side racks (6x4ft. size)	3
03	Revolving sitting chairs with arms (standard size)	3
04	Sitting chairs (visitor's) with arms (standard size)	10
05	Steel filing cabinet (Standard size)	4
06	Wooden filing cabinet (Standard size)	3
07	Wooden pigeon hole rack for drawing (3x4x2ft.)	3
08	Laptop latest model & internet connection, UPS along with A4-A3 Laser Printer or latest model	2
09	Spilt Type A.C (1-1/2 ton)	2
10	Mobile Phone (android) with usage of maximum Rs. 2000/Month each	4
11	Water Dispenser with maintenance	1
12	Electric Kettle with maintenance	1
13	Conference Table with 15 chairs	1
14	Office/Tea Boy	2
15	Back-up Generator sets for office	1

However, if any equipment, furniture and installations become unserviceable for any reason whatsoever the Contractor shall promptly replace the same as and when directed by the Engineer. The Site Office shall be connected to the Electrical System, potable water supply system, sewage disposal system and un-interrupted supply of utilities during the Contract period. The Contractor shall arrange professional cook and all

time consumables for making tea, coffee and refreshments for both the Employer's and the Engineer's offices.

All monthly utility bills pertaining to the Site office would be borne by the Contractor. Failure of the contractor to do so shall make him liable to deduct utility bills cost from his due monies under the Contract and would be paid by the Employer directly to the concern department.

The Site Office including fittings, fixtures and furnishing shall be the property of the Contractor on completion of the Contract.

39.2 **Transport Facility**

The Contractor shall provide, operate and maintain following brand new (latest model) vehicle for the Engineer's site supervision team to meet their transportation needs for the entire duration of actual construction period as well as for the duration of subsequent defects liability period. The vehicles are listed as under;

S. No.	Description of Vehicle with Model (Brand New and Latest Variants)	For the Engineer& his Staff Use
01	Changan Alswin 1.3L Blue Core	1

The use of such transport facility shall be under the control of the Engineer as above. The Contractor shall be wholly responsible for providing at all times satisfactory operating services for the Engineer. The Contractor shall furnish, supply and provide, as may be necessary without specific direction of the Engineer, all fuels (up to a limit of 300 Liters), lubricants, tires and other supplies, all maintenance, repairs and running costs and suitably qualified drivers at all times.

Prior to ordering the Vehicles, the Contractor shall furnish to the Engineer for approval, detailed specification, name of manufacturer and model no. of the vehicle to be supplied. These data shall be presented within one week from the date of Engineer's Order to proceed with the works and the vehicles shall be furnished to the Engineer upon approval within two weeks from the date of Engineer's Order to supply the Vehicle.

The vehicle shall be right hand drive, and shall be of brand approved by the Engineer, properly serviced and ready for use. The Contractor shall provide vehicle to replace any such motor vehicle that is temporarily or permanently rendered unserviceable for any reason or declared to be beyond repair by the Engineer, at no additional cost to the Employer. Failure of the Contractor to do so shall make him liable its cost/expense up to Rs. 500,000/- per month for vehicle payable directly to Employer/Engineer for the entire Contract period or till such time that transport as stipulated above is provided by him.

The vehicle shall be right hand drive, and shall be of brand approved by the Engineer, properly serviced and ready for use. The Contractors hall provide vehicle to replace any such motor vehicle that is temporarily or permanently rendered unserviceable for any reason or declared to be beyond repair by the Engineer, at no additional cost to the Employer. **The vehicle shall become the property of the Contractor on completion of the Contract.**

40 Safety & Security of Personnel & Equipment

The Contractor shall, throughout the execution and completion of the Works and the remedying of any defects therein:

(a) Will solely responsible for the safety of all persons entitled to be upon the Site and keep the Site (so far as the same is under his control) and the Works (so far as the same are not completed or completed or occupied by the Employer) in an orderly state appropriate to the avoidance of danger to such persons,
(b) the Contractor should visit the Site and get conversant with situation in this regard, and
(c) provide and maintain at his own cost all lights, guards, fencing, warning signs and watching, when and where necessary or required by the Engineer or by any duly constituted authority, for the protection of the Works or for the safety and convenience of the workers/personnel at site.

(d) Contractor shall arrange all such safety measures regarding Covid-19 as per Instructions of provincial & Federal Governments for his staff/workers and for staff of Employer/Consultants.

41 MEASUREMENT &PAYMENT OF WORK

No payment shall be made for the works involved within the scope of this section of specification 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 other items of the Bill of Quantities.

*** End of Section 0100 ***

TECHNICAL PROVISIONS

CIVIL WORKS

National Engineering Services Pakistan Ltd.
DIVISION
Karachi.

SECTION - 0120

CONTRACTOR'S CAMP

1. SCOPE

The work to be done under this item consists of construction, erection, installation and maintenance of the Contractor's Project Site Offices or main camp and the Contractor's sub-camps or temporary camps, if any, and shall include all offices, shops, warehouses, and other operational buildings; all housing and related facilities including accommodations for the Contractor's personnel.

2. GENERAL

The location of the Contractor's camps, including all buildings, utilities and facilities therefor, and of the camps or establishments of all persons/parties in the vicinity operating or associated with the Contractor shall be subject to approval of the Engineer.

The work to be done under this item will terminate upon the actual Completion Date. However, if directed by the Engineer or the Employer, the Contractor shall continue such work to the extent required by the Contractor's personnel during the Defects Liability Period. No compensation shall be paid for the continued operation and maintenance of the Contractor's Camps during the Defects Liability Period.

Upon completion of the Works, or at such time within the Defects Liability Period as directed by the Engineer, the Contractor shall remove all buildings, utilities and other facilities from the Site and restore all camp areas to a neat and clean condition. The Employer may opt to retain any or all of the above mentioned facilities for his use after the completion of the works, in which case the Contractor shall have no claim on these facilities.

Contractor shall protect the environmental interests and HSE (Health, safety & Environmental) regulations at camp and works sites during execution of the contractual work.

3. CODES AND STANDARD

The construction, operation and maintenance of all camps of the Contractor shall comply with all applicable provisions of current Pakistan Labour Camp Rules.

4. MAINTENANCE

The Contractor shall furnish, make arrangements for, and carry out proper and adequate maintenance of the Contractor's Camp areas at such camp to provide a neat, well-kept camp in all respects with pleasant and healthy surroundings and conditions for all occupants of their camp. The Contactor's camp shall be kept clean, well-graded, free from under growth and bush and adequately drained. Roads and streets shall be kept in good condition. All utilities shall be adequately and properly operated and maintain to provide services and conditions meeting the requirements of these specifications in all respects.

Adequately equipped and properly staffed portable first aid stations or dispensaries shall be provided by the Contractor at camps and other strategic locations to administer first aid treatment at any time required and free of charge to all persons on the Site, including employees of the Engineer and the Employer.

5. MEASUREMENT AND PAYMENT

No payment shall be made for the works involved within the scope of this section of specifications unless otherwise specifically stated in the Bill of Quantities or herein.

The cost thereof shall be deemed to have been included in the quoted unit rate of other items of the Bill of Quantities.

*** End of Section 0120 ***

SECTION - 0130

STAKE-OUT SURVEY

1. SCOPE

The work to be done under this item the Contractor shall make the stakeout survey for construction purposes with competently qualified men, consistent with the current practices. The work shall proceed immediately upon the award of the Contract and shall be expeditiously progressed to completion in a manner and at a rate satisfactory to the Engineer. The Contractor shall keep the Engineer fully informed as to the progress of the stakeout survey. The scope of this section of specifications is covered by detailed specifications as laid down herein.

2. MATERIAL AND EQUIPMENT

All instruments, equipment, stakes and other material necessary to perform all work shall be provided by the Contractor. These instruments and equipment shall be available to Engineer at all times for the purpose of checking the work of the Contract.

All stakes used shall be of a type approved by the Engineer, clearly and permanently marked so as to be legible at all times. It shall be the Contractor's responsibility to maintain these stakes in their proper position and location at all times. Any existing stakes or markers defining property lines and survey monuments which may be disturbed during construction shall be properly tied into fixed reference point before being disturbed and accurately reset in their proper position upon completion of the work.

3. CONSTRUCTION

The Contractor shall trim trees, bushes and other interfering objects, not consistent with the plan, from survey lines in advance of all survey work to permit accurate and unimpeded work by his stake-out survey crews and the Engineer's survey crews. The exact position of all work shall be established from control points, which are shown on the plans or modified by the Engineer. Any error, apparent discrepancy in or absence of data shown or required for accurately accomplishing the stakeout survey shall be referred to the Engineer for interpretation or furnishing when such is observed or required.

The Contractor shall be responsible for the accuracy of his work and shall maintain all reference points, stakes, etc. throughout the life of the Contract. Damaged, destroyed or inaccessible reference points, bench marks or stakes shall be replaced by the Contractor. Existing or new control points that will be or are destroyed during construction shall be re-established and all reference ties recorded thereon shall be furnished to the Engineer. All stakeout survey work shall be referenced to the centerlines shown on the Plans. All computations necessary to establish the exact position of the work from control points shall be made and preserved by the Contractor. All computations, survey notes and other records necessary to accomplish the work shall be kept neatly and made available to the Engineer upon request and furnished to the Employer upon Contract completion.

The Engineer may check all or any portion of the stakeout survey work or notes made by the Contractor and any necessary correction to the work shall be immediately made. Such checking by the Engineer shall not relieve the Contractor of any of his responsibilities for the accuracy or completeness of his work.

Reference points, base lines, stakes and benchmarks for borrow pits shall be established by the Contractor.

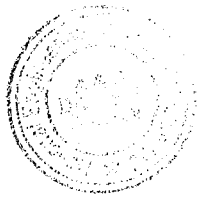
All required right-of-way and easement limits shall be established, staked and referenced by the Contractor concurrent with the construction stakeout survey.

The Contractor shall place at least two offset stakes or references at each centre lines station and at such intermediate stations as the Engineer may direct. From computations and measurements made by the Contractor, these stakes shall be clearly marked with the correct centre line, station number, offset and cut or fill so as to permit the establishment of the true centre line location during construction. He shall locate and place all cut, fill, slope, line grade or other stakes and points as the Engineer may direct to be necessary for the proper progress of the work.

4. MEASUREMENT AND PAYMENT

No payment shall be made for the works involved within the scope of this section of specifications unless otherwise specifically stated in the Bill of Quantities or herein. The cost thereof shall be deemed to have been included in the quoted unit rate of other items of the Bill of Quantities.

*** End of Section 0130 ***



SECTION – 1100

EARTHWORKS

1. SCOPE OF WORK

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 earthworks of all underground services and structural units, stock piling of suitable excavated material, compaction as per standard mentioned herein, disposal of unsuitable and surplus excavated material in accordance with this section of specifications, the applicable drawings and subject to terms and conditions of the Contract.

2. GENERAL

2.1 The Contractor shall be deemed to have made local and independent inquires as to, and shall take the whole risk of, the nature of the ground subsoil or material to be excavated or penetrated and the Contractor shall not be entitled to receive an extra or additional payment nor to be relieved from any of his obligations by reasons of the nature of such ground subsoil or material.

2.2 All excavations, cut and fills shall be constructed to the lines, levels and gradients specified with any necessary allowance for consolidation, settlement and drainage so that at the end of the Period of Maintenance the ground shall be at the required lines, levels and gradients. During the course of the Contract and during the Period of Maintenance any damage or defects in cuts and fills, in structures and other works, caused by slips, falls of wash-ins or any other ground movement due to the Contractor's negligence shall be made good by the contractor at his own cost.

3. SITE PREPARATION

3.1 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 positions, levels, dimensions and alignments 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 such error, to the satisfaction of the Engineer.

3.2 The Contractor shall construct and maintain accurate bench marks so that the Lines and Levels can be easily checked by the Engineer.

3.3 The Contractor shall perform a joint survey with the Engineer's Representative, of the area where earth work is required, plot the ground levels on the drawings and obtain approval from the Engineer before starting the earth work and shall supply a copy to the Employer duly checked, signed and authenticated by the Engineer before start of work.

4. EXCAVATIONS

4.1 Excavation shall include the removal of all material of every name and nature.

It is expected that rock and other hard material will be encountered during excavation. The rate of excavation shall include the removal of all sub-surface material of every name and nature and no classification of sub-surface material shall be made nor any additional payment shall be made.

4.2 The major portion of excavations shall be carried out by mechanical excavators and excavated materials disposed off to stock on spoil as directed by the Engineer. The excavation may be done by normal means. Unless otherwise specified by the Engineer, leveling, trimming and finishing to the required levels and dimensions shall be done manually. The material suitable for fill and backfill if approved by the Engineer shall be stockpiled within the limits of whole of the Site as directed by the Engineer.

Excavated material unsuitable for use as fill and backfill shall be disposed off by the Contractor at locations approved by the Engineer within specified free haulage limit.

4.3 The Contractor shall give reasonable notice that he intends to commence any excavation and he shall submit to the Engineer full details of his proposals. The Engineer's approval shall not relieve the Contractor of his responsibility with respect to such work.

4.4 The Contractor shall preserve the completed excavation from damage due to slips and earth movements, ingress of water from any source whatsoever and deterioration by exposure to the sun and the effects of the weather.

All excavations shall be kept free of water and shall be maintained dry to the satisfaction of the Engineer. Prevent surface water and sub-surface water and sub surface ground water from flowing into the excavation and flooding the project site and surroundings.

Do not allow water to accumulate in excavations, remove water from excavations to present softening of foundation bottoms, under cutting footings and soil changes determined to the stability of sub-grades and foundations. Provide and discharge lives necessary to convey the water away from the excavations convey water removed from excavation and rain water to outside the limits in manner that no damages is caused to the surrounding services properties.

4.5 Excavation for pits, cable trenches, equipment-foundations and other structures shall be taken out to the levels and dimensions shown on Drawings or such other levels and dimensions as the Engineer may direct.

4.6 Excavation shall extend to adequate distance from walls and footings to allow for placing and removal of forms, installations of services and for inspection, except where the concrete for walls and footings is authorized to be deposited directly against excavated surfaces. Undercutting will not be permitted. The additional excavation for placing and removal of forms, installation of services, for inspection and generally for working area on slopes for stability shall not be measured for payment and shall be deemed to be included in the rates for excavation as measured net.

4.7 All excavations in foundations shall be taken to 6 inch above the final excavation elevations shown on the drawings and the last 6-inch shall be trimmed carefully to a smooth and level surface. All excavations for foundations which have been trimmed and disturbed shall be compacted and covered by lean concrete by the end of the day.

4.8 No excavation shall be refilled nor any permanent work commenced until the foundation has been inspected by the Engineer and his permission to proceed is given.

4.9 If excavation for sub-structures are carried below the required level, as shown on the Drawings or as directed by the Engineer, the surplus depth shall be filled in with concrete of same grade as of blinding concrete at the sole cost of the Contractor.

4.10 All excavation shall be performed in the dry. The placing of blinding concrete, placing of reinforcement and casting of the permanent works in the excavation shall be carried out in the dry.

4.11 Shoring, where required during excavation, shall be installed to protect workmen and the bank, adjacent paving, structures and utilities. The term shoring shall also be deemed to cover whatever methods the Contractor elects to adopt, with prior approval of the Engineer, for upholding the sides of excavation and also for planking and strutting to excavation against the side of roadways and adjoining properties in existing hardcore of any other material. The Contractor will be held responsible for upholding the sides of all excavations and no claim for additional excavation, concrete or other material will be considered in this respect.

4.12 Existing utility lines that are shown on the drawings or the locations of which are made known to the Contractor prior to excavation and that are to be retained, as well as utility lines constructed during excavation and backfilling, and if damaged, shall be repaired by the Contractor at his own expense. Any existing utility lines which are not known to the Contractor in sufficient time to avoid damage, if inadvertently damaged during excavation, shall be repaired by the Contractor and adjustment in payment will be made as approved by the Engineer. When utility lines which are to be removed, are encountered within the area of operations the Contractor shall notify the Engineer in ample time for the necessary measures to be taken to prevent interruption of the service.

4.13 Where applicable the excavation work shall include the excavation in above water table and excavation below water table. The Contractor shall provide all plant, equipment, pumps, sheeting, well points as required to keep the water table 3.0 feet below the deepest foundation as shown on the drawings till the completion of foundation works.

4.14 Before starting the excavation for pipelines, the Contractor shall ensure the correct alignment of the pipeline on the ground the depth and width of excavation of the trench, all in accordance with the Drawings and instructions of the Engineer. The Contractor shall make profile with cement concrete pillars.

Excavation shall be carried out true to lines, levels, grades and widths as shown on the drawings or as directed by the Engineer ensuring proper laying of the pipe line, the bedding fill, construction of chambers for appurtenances and any other structures. The trench bottom shall be graded to provide even and substantial bearing over the specified bedding and of the structure.

Without the written permission of the Engineer, not more than 600 feet of the trench shall be opened in advance of the completed pipeline.

4.15 The Engineer may require the Contractor to excavate below the elevations shown on the drawings or he may order him to stop above the elevations shown depending upon the suitable foundation material encountered.

4.16 If for any reason, the levels, grades or profiles of the excavations are changed adversely by the Contractor, the Contractor shall at his own cost, be liable to bring the excavations to the required levels and profiles as shown on the drawings or as directed by the Engineer.

4.17 The work shall consist of the formation of the roadbed, under subbase or base course as the case may be, with an approved blend of materials, uniformly mixed, compacted, shaped and finished to the lines, grades and typical cross-sections shown on the Drawings, or in thickness as directed by the Engineer.

Improved subgrade as herein referred to may be defined as material suitable for embankment to which better quality of material is blended in proper proportion to improve its strength properties or performance.

The major component of improved subgrade shall be soil that classifies as A-3 or superior material according to AASHTO M-145.

When compacted to ninety five (95) percent of the maximum dry density determined by AASHTO T 180-D Method, shall exhibit a laboratory soaked CBR (96 hours) of not less than 10, or as specified in the drawings.

5. EXCAVATION TOLERANCES

Excavation shall be performed within the tolerances for excavation limits indicated on the drawings. Where no tolerance limits are indicated excavation shall be performed to tolerances established by the Engineer as acceptable for the design and type of work involved.

6. EMBANKMENT CONSTRUCTION

6.1 General

It shall consist of construction of select embankment for paved areas and common embankment for unpaved, areas. Only approved material shall be used in the construction of embankments.

All embankment construction shall be made to the lines, levels, profiles and grades as shown on the drawings or established by the Engineer. During progress of the work it may be found necessary or desirable by the Engineer to vary the levels, elevations and grades from those shown on the drawings. The Contractor shall perform the embankment construction to the revised levels, elevation as established by the Engineer.

Where embankments are to be placed in water logged areas and which are inaccessible to heavy construction equipment, a working platform shall be first established, consisting of a blanket of fill material placed on the water logged area. The thickness of the working platform shall be about 0.5 metre unless directed otherwise by the Engineer and the width shall be that of the embankment. The placement and compaction of the working platform shall be performed by use of light equipment as directed by the Engineer. No density requirements are specified for the working platform, however, subsequent layers above shall be compacted to densities specified in the relevant items.

Benching of sufficient width for slope stability and movement of equipment and machinery shall be carried out for embankment formation in areas of steep slopes.

6.2 Select Embankment

The select embankment shall be constructed under all paved areas. The area shall be prepared (after stripping of top soil) by scarifying the surface to a minimum depth of 150 mm and compacting it to required densities.

6.2.1 Material

The suitable subsurface material obtained from excavation (except stripping of top soil) shall be used in the construction of select embankment. The material shall be A-4 or superior as per AASHTO soil classification. The soaked CBR of the material shall be equal to or greater than 6. In the top 30 cm the material shall be A-4 or superior and the PI $\leq$ 8. When excavated material consists predominately of rock fragments of such size that the material can not be placed in layers of the prescribed thickness without crushing, pulverizing or further breaking down the pieces, such material may be placed in layers not exceeding 60 cm in thickness. Each layer shall be leveled and smoothed with suitable leveling equipment and by distribution of spalls and finer fragments of rock. These type lifts shall not be constructed above an elevation (150 cm) below the finished sub-grade.

6.2.2 Formation of Embankment

Embankment shall be formed in successive horizontal layers of not more than (200 mm) in loose depth for the full width of the cross-section, unless otherwise approved by the Engineer.

The material placed in layers and the sub-grade scarified shall be compacted to the density specified below:

Depth (cm) Below Subgrade Level		Percent of Max. Dry Density as per ASTM D1557	
Cohesive Soil	**Non-Cohesive Soil**	**Cohesive Soil**	**Non-Cohesive Soil**
0 to 30	0 to 60	95%	100%
30 to 75	60 to 100	93%	95%
Over 75	Over 100	90%	90%

Sub-grade level is the surface on which the pavement structure will be placed.

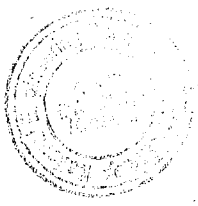
The maximum density of sand (granular) material (if used) shall also be determined as per ASTM D4253. The higher of the two values obtained from ASTM D1557 and ASTM D4253 shall be used to check the relative compaction of the in place material.

The moisture content of the material should be controlled to within $\pm$2% of the optimum moisture content. In order to achieve a uniform moisture content throughout, the wetting and drying of the material, and manipulation shall be required when deemed necessary. Also, the California Bearing Ratio test (ASTM D1883) may be conducted on soil if instructed by the Engineer.

The embankment formed by rock fragments of such size that the material cannot be placed in layers of thickness prescribed without crushing, pulverizing or further breaking down the pieces, such material may be placed in layers not exceeding 60 cm of loose measurement and compacted by vibratory roller with mass as specified hereunder:

Mass per meter width of Vibratory roll (kg/m)	Depth of fill layer cm	Number of passes of the roller on each layer
2300 - 2900	40	5
2900 - 3600	50	5
3600 - 4300	60	5

The material shall be carefully placed in layer so that all larger stones will be well distributed and voids completely filled with smaller stones, small spall and soil to form a solid mass. After placing the rock material, surface shall be covered with fine material having thickness less than 20 cm.



Material for each layer should be consolidated with heavy weight vibratory roller until settlement as checked between two consecutive passes of roller is less than 1% of the layer thickness. When rock to be incorporated in fill is composed largely of weak or friable material, the rock shall be reduced to a maximum size not exceeding 50% of the thickness of the layer being placed.

6.2.3 **Common Embankment**

6.2.3.1 Material

The area requiring common embankment, i.e. graded strip, and other unpaved areas shall be constructed from the excavated soil and rock. The top soil obtained from stripping may be used at deeper level with the approval of the Engineer.

6.2.3.2 Formation of Embankment

Before placing and compacting the fill material the ground shall be scarified to a depth of 15 cm and compacted to a dry density of 90% as per laboratory compaction test method ASTM D1557. The moisture content of soil during compaction of scarified layer and successive layers shall be within $\pm$2% of optimum moisture content before rolling to obtain the desired density results. The successive horizontal layers shall be formed in loose depth (200mm) for the full width of the cross section unless otherwise approved by the Engineer. Each layer will be compacted to dry density of 90% as per laboratory compaction test method ASTM D 1557.

The layer thicknesses and compaction requirements shall be the same as specified under 'Select Embankment' for embankment formed by rock fragments.

No rock larger than 8 cm in any dimension shall be placed in top thirty (30 cm) of embankment unless allowed by the Engineer.

6.2.4 **Tolerances**

Select Embankment

The grade surface of each layer excluding final layer, shall be smooth and even and tolerance from required grade shall not be more than 20 mm.

Common Embankment

The grade surface of each layer including the final layer, shall be smooth and even and tolerance from required grade shall not be more than 20 mm.

6.3 **Fill and Backfill**

6.3.1 After completion of foundations, walls, trenches and other construction below the elevation of the final grades and prior to start of back filling, forms shall be removed and the excavation shall be cleaned of trash and debris.

6.3.2 The backfilling shall include filling under the floors, around the foundation and in trenches.

6.3.3 The backfilling shall include loading, unloading, transporting, placing, stacking, spreading of earth, watering, rolling, ramming and compacting, etc., complete as specified herein.

6.3.4 Filling under floor/trenches shall be done with approved selected material obtained from required excavation or outside sources. It shall be predominantly granular material and free from slurry mud, organic or other unsuitable matter and capable of compaction by ordinary means.

6.3.5 The Contractor shall provide the approved quality of backfill and fill material required to complete the fill and backfill from the places designated by the Engineer.

6.3.6 Filling in foundations/trenches shall be placed in 200 mm layers and compacted at optimum moisture content by mechanical means or other means as approved by the Engineer.

6.3.7 Material for backfilling shall be as approved by the Engineer and shall be placed in layers not exceeding 200 mm measured as compacted material and saturated with sufficient water and compacted to produce in-situ density not less than 95% of the maximum dry density at optimum moisture content, achieved.

6.3.8 All fill areas shall be left neat, smooth and well compacted, the top surface consisting of the normal site surface soil, unless otherwise directed.

6.3.9 Depending on the capacity of the compacting equipment the Engineer may instruct increased thickness of successive layers to be placed.

6.3.10 Fill shall not be placed against foundation walls prior to approval by the Engineer. Fill shall be brought up evenly on each side of the walls as far as practicable. Heavy equipment for spreading and compacting the fill shall not be operated closer to the wall than a distance equal to the height of the fill above the top of footing.

6.3.11 In case the Contractor has to arrange the fill material from outside source the quality of the fill material will be subject to the approval of the Engineer. The Engineer shall require the Contractor to carry out various tests of the fill material. All such tests shall be made at an approved laboratory at the cost of the Contractor.

6.3.12 Backfilling of foundations / trenches shall be carried out only after the structural works within the excavations have been inspected, tested and approved by the Engineer.

6.3.13 Layers upto an elevation of 300 mm above the top of the bedding shall not be more than 150 mm in loose thickness and the remainder of the layers above that elevation shall not be more than 150 mm of compacted thickness.

6.3.14 If it is found necessary to alter the moisture content of the fill material in any way, then, very strict control shall be exercised over the wetting and/or the drying process and frequent moisture content tests shall be carried out.

6.3.15 The stabilization of compacted fill/backfill surfaces shall be smooth and even and shall not vary more than 10mm in 3 meters from true profile and shall not be more than 12.5mm from true elevation.

7. FILL AND BACKFILL

7.1 The backfilling shall include filling under the floors, around the foundation trenches, pipes, conduits, ducts and channels.

The backfilling shall include loading, unloading, transporting, placing, stacking, spreading of earth, watering, rolling, ramming and compacting, etc., complete as specified herein.

7.2 The excavated material if found suitable shall be stockpiled within the free haulage limit of the Project Boundary. This material shall be used for filling/back-filling if approved by the Engineer and shall be transported by the Contractor anywhere required for the purpose of filling/back-filling work in this Contract.

7.3 The Contractor shall provide the approved quality of backfill and fill material required to complete the fill and back- filling work from the places /borrow areas as designated by the Engineer. All necessary permissions from any authority for excavation within Borrow areas/ designated places shall be of contractor's responsibility.

Deep filling shall be predominantly granular material and free from slurry mud, organic or other unsuitable matter and capable of compaction by ordinary means.

7.4 Material for backfilling shall be as approved by the Engineer and shall be placed in layers not exceeding 6 inches (150mm) measured as compacted material with sufficient water and compacted to produce in-situ density not less than 95% of the maximum dry density at optimum moisture content.

Depending on the depth of fill the Engineer may instruct increased thickness of successive layers to be placed. The filling shall be compacted by mechanical means as approved by the Engineer.

7.5 Filling around pipes and cables shall be carefully placed with fine material to cover the pipe or cable completely before the normal fill is placed.

7.6 Backfilling of trenches/foundations shall be carried out only after the pipe line/structural works within the excavations have been inspected, tested and approved by the Engineer.

7.7 Fill shall not be placed against foundation walls prior to approval by the Engineer. Fill shall be brought up evenly on each side of the walls as far as

practicable. Heavy equipment for spreading and compacting the fill shall not be operated closer to the wall than a distance equal to the height of the fill above the top of footing.

7.8 Before the start of fill and backfill, the Contractor shall satisfy himself as to the levels and slopes of the fills and backfill shown on the Drawings, the requirements of compaction, the possibility of settlement & all other particulars whatsoever in connection with the filling works.

7.9 All filled areas shall be left neat, smooth and well compacted, the top surface consisting of the normal site surface soil, unless otherwise directed.

7.10 The frequency of in place density testing for accepting the compacted area shall one set of three tests in every 200 sq. meter

8. TOLERANCES

The stabilization of compacted backfill/fill surface shall be smooth and even and shall not vary more than 3/8 inch in 10 feet from true profile and shall not be more than 1/2 inch from true elevation.

9. DISPOSAL OF SURPLUS EXCAVATED MATERIAL

9.1 The rejected unsuitable material and surplus excavated material shall be disposed off at designated place or as directed by the Engineer. No compensation of any lead/lift is admissible and rates quoted shall be deemed to include the same.

9.2 The disposal of surplus/unsuitable excavated material shall include loading, unloading, transporting, stacking, spreading and leveling as directed by the Engineer.

10. MEASUREMENT AND PAYMENT

10.1 General

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

10.1.1 Timber shoring, planking, strutting and providing slope for upholding the sides of excavations.

10.1.2 Any fill with approved material necessitated by over excavation due to fault or convenience of the Contractor except under structural members.

10.1.3 Stockpiling the excavated material at approved location within free haulage limit of the Project Boundary and transporting back suitable material to places requiring fill or backfill.

10.1.4 Specified foundation bed preparation.

10.1.5 Excavation involved in providing adequate working space around sides of foundation and service line trenches.

10.1.6 Providing approved quality fill/backfill material obtained from excavated material as designated by the Engineer.

10.1.7 Rolling, leveling, watering & compacting the fill and backfill to required density.

10.1.8 All laboratory and field tests stipulated in these specifications.

10.1.9 Disposal of rejected surplus and unsuitable excavated material at designated place or as directed by the Engineer. No compensation of any lead/lift is admissible and rates quoted shall be deemed to include the same.

10.1.10 De-watering where required to keep the excavated areas dry for pavements, structures and foundations during construction.

10.1.11 All costs of every nature required to complete the job inclusive of borrow area's royalty charges.

10.1.12 Scarifying & compaction of ground.

10.1.13 Maintaining environmental conditions of the areas. Any damages to the local environmental interest shall be repaired by the Contractor at his own expense / cost.

10.2 Excavation

10.2.1 Measurement

Quantities of excavation shall be calculated / measured from the pre-work levels of leveled and graded ground taken jointly by the Contractor and the Engineer before commencement of the work.

The quantities set out for excavation and its subsequent disposal shall be deemed to be the bulk quantity before excavating and no allowance shall be made for any subsequent variations in bulk or for any extra excavation.

Unless otherwise shown on the Drawings quantities of excavation shall be measured of acceptably completed works on the basis of vertical excavations required in accordance with lines of concrete.

Quantities of excavation for laying service line trenches shall be measured for payment on the basis of vertical excavation faces for the specified width for the trench as shown on the drawings.

Measurement for acceptably completed excavation works shall be made on the basis of number of cubic feet of material excavated for

foundation and service trenches as shown on the Drawings or as directed by the Engineer.

10.2.2 **Payment**

Payment will be made for acceptably measured quantity of excavation on the basis of unit rate per cubic feet quoted in the Bill of Quantities and shall constitute full compensation for all the works related to the item, including but not limiting to back filling.

10.3 **Backfill/Fills (for Structures)**

10.3.1 **Measurement**

Measurement for acceptably completed backfill/fill works will be made on the basis of number of cubic feet of compacted backfill/fill in position in accordance with the lines, levels and grade as shown on Drawings or as directed by the Engineer.

10.3.2 **Payment**

Payment will be made for acceptably measured quantity of backfill/fill on the basis of unit rate per cubic feet quoted in the Bills of Quantities and shall constitute full compensation for all the works related to the item.

10.4 **Embankment (Road)**

10.3.1 **Measurement**

Measurement for acceptably completed work of constructing embankment will be made on the basis of actual volume of compacted embankment in position in accordance with the lines, levels and grade as shown on Drawings or as directed by the Engineer.

10.3.2 **Payment**

Payment will be made for acceptable measured quantity of compacted fill for formation of embankment on the basis of unit rate per cubic feet quoted in the Bills of Quantities and shall constitute full compensation for all the works related to the item.

*** End of Section 1100 ***

SECTION – 1600

TERMITE CONTROL TREATMENT

1. SCOPE

The scope of work for anti termite treatment includes injection of insecticide in sides and bottom of foundation trenches, spraying on stockpiled backfill material and injections of the insecticide in floor sub-grade of the building. The scope also covers treatment of all wood works with insecticides before installation in position.

2. MATERIAL

2.1 An emulsible concentrate insecticide shall be used for dilution with water, specially formulated to prevent infestation by termites. Fuel oil will not be permitted as a diluent. Provide a working solution of the following chemical element and concentrations.

HEPTACHLOR emulsifiable to 0.5% with clean water.
Or
TERMIDOR 25EC containing FIPRONIL
Or
BIFLEX with Bifenthrin Tech 25.1%
Or
Approved Equivalent

2.2 All mixing shall be done at site and mixing proportion of insecticide with water shall be in accordance with the approved manufacturer's recommendations and shall be verified by the Engineer.

2.3 Pure turpentine shall be used for dilution of insecticide, in approved proportion for application to woodwork.

3. QUALITY ASSURANCE

3.1 In addition to the requirements of these specifications, comply with manufacturer's instructions and recommendations for the work, including preparation of substrata and application.

3.2 A professional operator shall be engaged who shall have license in accordance with regulations of governing authorities for application of soil treatment solution.

4. EXTENT OF APPLICATION

4.1 Insecticide solution shall be applied with approved pressure spraying equipment maintaining a pressure of 150 psi to all applications to, on or in earth.

4.2 Soil treatment shall begin after all work of preparation of earth prior to installation of concrete has been done. After application, no additional earth moving or work upon sub grade should be done. No covering of earth or concrete should be applied over soil treatment until at least 24 hours after treatment has been made.

4.3 Insecticide solution should not be applied during wet weather, or when the earth surface is excessively wet. Application should be made to all areas

beneath concrete slabs-on-grade, including sidewalks and paving abutting buildings for distance of at least 6 feet beyond building line. Solution shall be applied in amounts of not less than 5 lit./ Sq.M or 5 lit./10.76 Sq.ft. of area. If applied over gravel or sand fill, application shall not be less than 7 lit./ Sq.M or 7 lit./10.76 Sq.ft. of area. Insecticide shall penetrate to a depth of 1-inch minimum in porous earth at bottom and 2 inch to 3 inch at sides of excavations.

4.4 Sides of foundation excavations, grade beam, and similar areas shall be treated with solution at a rate of 0.5 lit per square foot/meter upon inner sides of such excavations, and at all locations where concrete slabs for platforms and similar work abut the building. Similar treatment shall be made at all locations where expansion joints, control joints, column bases and similar work occur at or below grade slabs.

4.5 In the areas of application signs shall be fixed to show that soil treatment has been applied. Such signs shall be removed when areas are covered by other construction.

4.6 Care shall be exercised to insure that no marks or damage occurs to the finished structure as a result of the work under this section.

4.7 All woodwork for the entire project is to be insecticide treated (before application of solignum). Insecticide shall be sprayed on all surfaces of all the wooden work viz., door frames, blocking, furring, planks, boards etc. before installation. Spraying is to be done at the site, after delivery and before installation. No spraying shall be necessary after field sawing, jointing or installation of such material.

5. STANDARDS

All methods of termite protection used herein shall be in accordance with the standard practices of National Pest Control Association, U.S.A and the British Wood Preserving Association.

6. SAMPLES AND TESTS

The Contractor shall supply samples of all the materials to be used for insecticide control for approval of the Engineer and testing in accordance with the specified standards. Rejected materials shall be removed from the site immediately.

7. GUARANTEE

The Contractor is to guarantee that the building shall be free from termites (white ants), wood bores and other pests, which cause damage to wood or other organic material for 10 years from the date of acceptance of the building.

In the event of any damage caused within the guaranteed period, the Contractor shall replace at his own cost such damaged material, finishes affected and suitably preserve and treat the entire premises with the best method known to the trade to prevent the spreading of termites.

8. MEASUREMENT & PAYMENT

8.1 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 there of shall be deemed to have been included in the quoted unit rate of the respective items of the Bills of Quantities.

8.1.1 Termite control treatment on wood works.
8.1.2 Turpentine & Water required for mixing insecticide solution.
8.1.3 Transportation of material and storage at site.
8.1.4 Anti-termite treatment on stock piled backfill material.
8.1.5 Termite control treatment to vertical surfaces.
8.1.6 Treatment of bed and sides of excavated foundation trenches.
8.1.7 Treatment of backfill.
8.1.8 Treatment of filled up earth.
8.1.9 Treatment of timber to be used.
8.1.10 Treatment of surrounding areas within 10 feet of the building.
8.1.11 Any other operation which the specialized firm may deem necessary in context to their guaranteed obligations.

8.2 Termite Control Treatment

8.2.1 **Measurement**

Measurement of acceptably completed works of termite control treatment will be made on the basis of plinth area in square foot / meter of termite control treatment provided and sprayed/applied, complete, as specified herein, as shown on the drawings and/or as directed by the Engineer.

8.2.2 **Payment**

Payment will be made for acceptable measured quantity of termite control treatment on the basis of unit rate per square foot / meter quoted in the Bill of Quantities and shall constitute full compensation for all the works related to the item.

*** End of Section 1600 ***

SECTIONS – 3000

STRUCTURAL STEEL WORKS

1.0 SCOPE

The work under this section of the Specifications consists of furnishing all material, labour, plant, equipment and appliances, fabricating, erecting, installing, testing, painting and all other items incidental to Structural steel work for a complete job as shown on the drawings, specified herein and/or as directed by the Engineer.

2.0 APPLICABLE CODES AND STANDARDS

Latest edition of the following codes and standards are applicable to the work of this section:

AISC	Specifications for the design, fabrication and erection of structural steel for buildings.
ANSI / AISC 360	Specification for Structural Steel Buildings.
AISC 303	Code of Standard Practice, for Steel Buildings and Bridges.
AISC	Specifications for structural joints using ASTM A325 or A490 bolts.
AISC	Guide to shop painting of Structural Steel.
ASTM A6	Standard specifications for general requirements for rolled structural steel bars, plates, shapes and sheet piling.
ASTM A36	Standard Specification for Carbon Structural Steel.
ASTM A53	Standard Specification for Pipe, Steel, Black & Hot Dipped, Zinc Coated, Welded and Seamless
ASTM A307	Standard Specification for Carbon steel bolts and studs, 60000 PSI tensile strength. Carbon steel externally and internally threaded Standard fasteners.
ASTM A325	Standard Specification for Structural bolts, Steel, Head treated. 120/105 kg minimum tensile strength (galvanized).

ASTM A653	Specifications for steel sheet zinc coated (galvanized) or zinc iron alloy coated by the hot dipped process.
ASTM A490	Standard Specification for heat treated steel structural bolts, 150 kg minimum tensile strength.
ASTM A354	Standard Specification for quenched and tempered alloy Steel bolts, studs and other externally threaded fasteners.
ASTM A501	Standard Specification for Hot formed welded and seamless carbon steel structural tubing.
ANSI / NAAMM MBG 531	Metal Bar Grating
ASTM A563	Standard Specification for Carbon and alloy steel nuts.
ASTM A572	Standard Specification for High - Strength Low - Alloy Columbium – Vanadium Structural Steel
ASTM E109	Dry powder magnetic particle inspection.
ASTM A653	Standard Specification for sheet steel, Zinc coated (Galvanized) or zinc alloy coated (Galvanized) by hot dip process.
AWS D1.1	Specifications for welding of steel structures.
ASCE/SE-1	Minimum Design Load for Buildings and other Structures.
ANSI/AISC 358	Prequalified Connections for Special and Intermediate Moment Frames In Seismic Applications.
ANSI B 18.2.2.1	Plain Washers.
AISI	American Iron and Steel Institute (Relevant Standards)
SSPC – SP6	Steel structures painting council – surface preparation specifications.
NACE	For Corrosion Control

3.0 MATERIALS

Except otherwise stated on the drawings, the material specifications shall conform to the following standards. Wherever necessary the Contractor may use equivalent alternative material subject to approval of the Engineer.

3.1 Structural Steel

- Structural steel shall conform to the requirements of ASTM A-36, or ASTM A-572.

- Steel pipes shall conform to the requirements of ASTM A 53 Class B, ASTM A501 or shall be made of plates spirally welded.

- All material shall be supplied chirpy V-Notch testing in accordance with ASTM A6, Supplementary Requirement S5.

- Grating shall conform to ANSI / NAAMM MBG 531.

3.2 Welding

Welding electrodes shall match the base metal and shall conform to the requirements of AWS D1.1 specifications.

3.3 High Strength Bolts

All shop connections, except as noted herein or on the drawings, shall be made with High Strength Bolts in friction type connections, or by welding.

High strength bolts, heavy hexagonal nuts and hardened washers shall conform to the requirements of ASTM A325. All field connections, except noted, shall be made with high strength bolts in friction type connection.

3.4 Washers

Washers shall conform to the requirements of ANSI B18.2.2.1 and shall be of structural grade steel appropriate for the type of bolts for which they are used. For oversized holes, the washers shall be large enough to cover the entire hole by at least 6mm or as directed by the Engineer.

3.5 Studs

Steel Studies Shear Connectors shall conform to the requirements of Structural Welding Code-Steel, AWS D1.1.

3.6 Paints

3.6.1 All material shall be acceptable, proven first grade products and shall meet or exceed the minimum standards of specified manufacturers like Jotun, SIPCO, PATSA and ICI paints.

During painting works an approved Quality Control inspector or a technical representative shall be provided by the manufacturer to oversee the painting and coating application. The Quality Control Inspector shall be liable to confirm in writing to the Consultant / Architect of the correct use of their product and the DFT by approved Thickness Gauge Meter, on job site as per Specification.

3.6.2 High solid, aliphatic polyurethane Topcoat by JOTUN or equivalent.

3.6.3 Anti-corrosive Surface tolerant epoxy primer by JOTUN or equivalent.

3.7 Copper Slag Abrasive

Copper Slag abrasive Omgritor equivalent

4.0 CONNECTIONS

All connections shall be designed and detailed for 75% of the effective capacity of the member. A minimum of two bolts or equivalent welding shall be used per connection.

Shop connection may be welded or bolted. Field connections shall be bolted unless noted otherwise on design drawings or approved by the Engineer.

5.0 ALLOWABLE STRESSES

Allowable design stresses for structural steel members and their connections, including temporary bracings and shorings shall be in accordance with AISC Specifications.

6.0 SHOP DRAWINGS

6.1 Shop drawings shall be submitted by the Contractor, for structural steel works, for acceptance in accordance with the requirements or the Contract Documents.

6.2 Shop drawings furnished for this section shall conform to the best standards of the construction industry. Shop drawings shall be prepared by and under the supervision of competent engineering

personnel. Prior to submittal, the Contractor shall check each shop drawing for compliance with the requirements of the Contract Documents.

6.3 Shop drawings shall include plans, elevations, sections and complete details to describe clearly, at an ample scale, all work to be provided. Drawings shall be accurately dimensioned and shall be noted clearly.

6.4 All connections shall be designed and detailed as, per sub-section 4 above, by the Contractor on the shop drawings. Design calculations for connections shall be made as per AISC specifications and shall be submitted along with the shop drawings after checking and signing by the Contractor for approval of the Engineer.

6.5 The shop drawings shall include

(i) An erection scheme, in suitable size, having the following information:

- Location of erection elements in respect of axis and Marks as well as picking points of these elements with respect to each other or with the existing steel or reinforced concrete structures.
- Joints showing erection welding sizes and lengths, bolts diameter and numbers.
- Chart showing list of assembling marks having columns such as Mark, Description, Quantity, Weight of each Mark, total weight and Remarks with grand total in the end.
- Chart showing List of Erection Bolts, Nuts and Washers in tabulated form, detailing information such as size, quantity, weight and their grand totals.
- Quality of materials.
- Quality and type of welding electrodes.
- Measures to be adopted against unscrewing of bolts.
- Painting instructions.
- Erection sequence.
- References to relevant drawings.

- Except in special cases all scheme drawings shall be made in single fairly thick lines.

- The recommended scale of erection scheme is 1:50, 1:100, 1:200, for joints 1:5, 1:10 or 1:20.

(ii) Fabrication drawings in suitable size shall contain the following information:

- Each Shop Assembly (Mark) shall be drawn separately showing necessary lines, elevations, sections with reference to axis, center lines, location of holes, cleats, plates, lugs etc. fully dimensioned with part numbers.

- Bolts and holes sizes.

- Welding symbols and welded joints requirements, in accordance with AISC manual of steel construction and AWS specifications.

- Geometrical Setting out dimensions necessary for the assembly of an element. Location and details of joints as calculated by the Contractor.

- Instruction for welding, dimensions of weld, edge preparations methods of welding, and methods for control of distortions.

- List of symbols for bolts and holes used.

- List of symbols for welds used.

- Edge distance (general).

- Welding sizes and lengths (general).

- Standards and quality of materials.

- Type and quality of welding electrodes.

- Tests for welding.

- Reference to related erection scheme drawings.

- Reference to design and working drawings.

- Parts list.

- Instructions for surface preparation, painting, primer and finish coats.

- Recommended scales for fabrication drawings are preferably 1:10 or 1:20, and for joints and details 1:1, 1:2, or 1:5.

7.0 FABRICATION

The Contractor shall notify the Engineer about any problems or doubts/errors, if any, in the drawings for clarifications/rectification well in time to prevent any fabrication errors. Fabrication shall not be commenced until approval has been obtained from the Engineer.

7.1 Straightening of Material

Rolled material, before being worked upon shall be straightened within tolerances as per ASTM specifications A6. Straightening necessarily shall be done by mechanical means or by the application of a limited amount of localized heat. The temperature of heated areas, as measured by approved methods, shall not exceed 1200 ^{0} F.

7.2 Cutting

As far as practicable cutting shall be done by shearing. Oxygen cutting shall be done where shear cutting is not practicable and shall preferably be done by Machine. All edges shall be free from notches or burs. If necessary, the same shall be removed by grinding.

7.3 Holes Punching/Drilling

Holes shall be punched where thickness of the material is not greater than the diameter of bolt + 3mm. Where thickness of the material is greater, the holes shall either be drilled or sub-punched and reamed to size. Die for all sub-punched holes and drill for all sub-drilled holes shall be at least 2mm smaller than the nominal diameter of the rivet or bolt.

7.4 Welding

7.4.1 All execution and inspection of welding shall be done in accordance with the provisions of the American Welding Society Specifications. No welding for piping/electrical supports shall be made transversely to any tension flanges or beams or columns.

7.4.2 Maximum and minimum size and lengths of fillet welds shall be in accordance with AISC specifications, or as mentioned on drawing.

7.4.3 Surface to be welded shall be free from loose scale, slag, rust, grease, paint or any other foreign matter.

7.4.4 Butt welds shall be full penetration welds, unless otherwise specified and permitted.

7.4.5 Avoid the use of temporary welded attachments during fabrication as much as possible. After fabrication is completed, remove flush with the base material without encroaching on the minimum required base material thickness. After the surface has been restored, examine all areas from which temporary attachments have been removed by the same methods required for permanent fillet welds.

7.4.6 Do not begin structural welding until joint elements are tacked in intimate contact and adjusted to dimensions shown with allowance for any weld shrinkage that is expected. Weld heavy sections and those having a high degree of restraint with low hydrogen type electrodes. No member shall be spliced without approval.

7.4.7 For notch-toughness specified material, all weld metal, processes and preheat requirements shall be compatible to assure notch-tough composite weld metal.

7.4.8 Shop splices of webs and flanges in built-up girder shall be made before the webs and flanges are joined to each other.

7.5 Tolerances

Tolerances for Structural Steel shall be as per AISC Specifications unless noted otherwise.

8.0 WELDER QUALIFICATIONS

8.1 All welders contracted to perform work shall be required to show written evidence that they have been properly tested in compliance with the approved welding procedures.

8.2 Welders shall have been qualified in the proposed procedure by an established laboratory acceptable to the Engineer within the preceding 90 days.

8.3 All welders shall be qualified for the type of weldment, grade of steel, thickness of steel, welding process and welding position that they are employed to weld. Welders and welding operators that have not been performance qualified, for all material and thickness ranges used on

the job, shall be restricted to welding only that portion of the work for which they are qualified.

8.4 Engineer reserves the right to have welders or welding operators prequalified or removed from the job as he deems necessary during the progress of work. Engineer's decision regarding the qualifications of any welder shall be final.

9.0 WELDERS IDENTIFICATION

9.1 Each welder shall be assigned a unique identifying number or symbol that he shall use to identify all welding resulting from his skills.

9.2 Stenciled markings shall be applied within 40mm of the weld using low stress concentration dies. Written symbols are also acceptable.

9.3 A record shall be kept of these symbols by the Contractor. The records shall show welder's name, symbol assigned, procedures to which qualified, employment and test dates. This record shall be available to the Engineer's Representative at all times.

10.0 TEST ASSEMBLY

10.1 Fabricated components such as Beams, Girders, Bracing, as and where required by planning, shall be test assembled in the shop prior to transportation to site.

10.2 Test assembly work and procedure should be planned during fabrication process.

10.3 Each test assembly shall be got inspected from the Engineer's Representative and shall be dismantled only after his approval in writing.

11.0 SURFACE PREPARATION / PAINTING

11.1 Surface Preparation

- These Specifications and NACE standard RP-01 shall govern the procedures and materials required for surface preparation and coating of the specified structures.

- All fabrication and assembly of a particular section shall be completed before surface preparation begins.

- All blast cleaning on metal surface should be carried out by Copper Slag abrasive and grit should not be recycled to avoid contamination of surface in accordance with the SSPC specification

required for that particular area. Blasting anchor profiles shall be consistent with manufacturer's recommendations.

- All blasting should be scheduled in a manner which enables paint to be applied in accordance with the manufacturer's recommendations and on the same day as blasting Occurs.

- All welded area and appurtenances shall be given special attention for removal of welding flux in crevices. Welding splatters, slivers, laminations and under laying mill scale exposed during blasting shall removed or repaired. Bolt holes shall be drilled and de-burred prior to blasting. Sharp edges shall be ground or filed to provide a visible radius.

- The abrasives used for blasting will be sized to give the specified anchor profile as determined by this specification. A mesh size will be used as prescribed for thickness of paint to be applied. The maximum particle size shall be no larger than that passing a 16 mesh screen.

- No acid washes or other cleaning solutions or solvents may be used on metal surfaces after being blasted. This includes any inhibitive washes intended to prevent rusting.

- All oil and/or grease contamination shall be removed by water based degreaser before starting to blast like glo-flo heavy duty degreaser or equivalent.

- No intermediate or finish coating shall be applied prior to fabrication without prior approval from Engineer.

- Blasting shall be done is an area removed from painting operations and freshly coated surfaces to prevent contamination. Contaminated coatings shall be re-blasted by Contractor to bare metal and reapplied.

- After blasting Contractor shall thoroughly clean all blast grit and dust from both internal and external surfaces, including removal from crevices, recesses etc.

11.2 **Coating Application**

- Coating application will be done according to paint manufacturer's recommendations included with the materials and will be subject to inspection by Engineer.

- The blast-cleaned surfaces shall be coated with primer during the same day as blasted and at least one hour prior to sundown of the

day, and also before any rusting occurs. A minimum of 150mm (6 inches) around edges of sand blasted area will be left un-primed unless adjoining a coated surface. Any steel/metal that is not primed and is wet by rain or moisture shall be re-blasted prior to application of primer.

- All coating shall be allowed to dry thoroughly, but not less than the manufacturer's specified time, prior to application of a succeeding coat.

- The surface shall be clean, dry and free from dust before application of any coat of paint.

- All coating materials furnish by Contractor shall be furnished in unopened, clearly identifiable containers. Mixing of different coatings shall not be permitted. Containers shall remain closed until required for use. No paint shall be used that has expired its shelf life.

- All coating film thickness shall be as specified and shall be checked by the Engineer or his Representative.

- Damage to intermediate coats, prior to application of the next coat, shall be repaired by Contractor to provide the coating sequence and film thickness as specified.

- After the prime coat has been applied to all hard-to-spray areas, such as corners. Edges and welds, may be brush painted with the same paint and film thickness.

- The finished job shall not contain sags, runs, wrinkles, spots. blister or other application flaws.

- Holidays in the final coat at edges, corners, welds and inaccessible areas may be protected by spraying or hand brushing an additional layer of topcoat provided excessive build up does not occur.

- All components shall be thoroughly stirred before, during and after mixing. The mixed coatings shall be continuously stirred by mechanical spray pot agitators or other approved means. The volume to be mixed shall be accurately measured. All mixing shall be done in clean containers, free from traces of grease, other type paints, or other contaminates. All containers shall be kept covered to prevent contamination by dust, dirt or rain.

- Coating may be brushed on all areas, which cannot be properly spray coated using brushes of style and quality that will enable proper application of materials.

- Paint shall be worked into all crevices and corners, and all runs or sags shall be brushed out in order to insure no air pockets, solvent bubbles, voids, or areas of excessive build up.

11.3 Repair of Damaged Area (Touch-UP)

- All external surfaces where coating is damaged during fabrication, transportation and erection shall be repaired as follows:

- Top coat damaged, but base coat undamaged, will be repaired by removing damaged coating with sand paper or other means acceptable to the Engineer (wire brushing will not be acceptable) and applying top coat as specified.

- Coating damaged to base metal where blasting is not approved shall be mechanically cleaned as specified in other Section and applying a three coats system as specified in relevant sections.

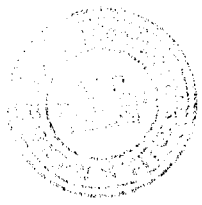
- Care will be taken to avoid damaging the coatings surrounding repaired areas and to assure complete tie-in of the coating with surrounding areas.

- Remove damaged areas by spot blast and feather into surrounding coating with sandpaper. Clean all loose materials from surface.

- Contractor shall repair the coating on all damaged areas prior to final acceptance of the Engineer.

11.4 Galvanizing (Zinc Coating)

Galvanizing, wherever specified, shall be applied in a manner and of a thickness and quality conforming to the requirements of ASTM A123 standard specifications for zinc (Hot dipped galvanized) coating on products fabricated from rolled, pressed and forged steel shapes, plates, bars and strips.



Components shall be galvanized i.e. zinc coated after complete fabrication i.e. welding, drilling etc. the process shall consist of removal of rust and mill scale by pickling in hydrochloric acid or sulphuric acid followed by water wash and prefluxing in tanks containing zinc ammonium chloride and then fluxing with ammonium chloride. The fluxed components shall then be passed through a drying oven prior to immersion in a bath of virtually pure molten zinc.

12.0 PAINT AND COATING SYSTEMS FOR STEEL GATE AND STEEL METAL WORKS

The paints and coating systems have been specified hereunder for steel/ metal works like pipe support, angle iron support in trenches, manufactured by Jotun paint or equivalent as approved by the Engineer and all such

surfaces as shown on the Drawings and/or as directed by the Engineer. All paint applications to be carried out by airless spray.

12.1 **Exterior Paint System for Steel Structures**

12.1.1 **Surface Preparation**

Abrasive blasting to Near White with copper slag in accordance with SSPC-SP10 and SSPC-AB1 to provide 40 to 60 microns anchor profile.

12.1.2 **Paint System**

1st Coat: Surface tolerant epoxy mastic to be applied at 1000 microns DFT. JOTAMASTIC 87 or equivalent.

2nd Coat: Two components polyurethane to be applied at 1000 microns DFT. HARDTOP XP AS or equivalent.

13.0 INSPECTION AND TESTS

13.1 Manufacturer's Test Certificate for all material used shall be furnished by the Contractor for Engineer's scrutiny and approval.

13.2 Rolling tolerance of all shapes and profile according to AISC shall be in accordance with the provisions of ASTM A6 specifications. These shall be checked by the Contractor before commencing work and shall be rejected if found not within limits.

13.3 Materials shall be tested for conformance with the specified standards at an approved testing laboratory as and when directed by the Engineer.

13.4 Contract surfaces of connections using high strength bolts in friction type connections shall be got inspected and approved from the Engineer before bolting.

13.5 All bolted connections shall be got inspected and approved from the Engineer for types, size, number of bolts and installation including tightening.

13.6 Inspection and Testing - Welding

13.6.1 General

Welding shall be inspected and tested by an approved testing laboratory during fabrication and erection of structural steel as follows:

The testing laboratory shall be responsible for conducting and interpreting the tests. It shall state in each report whether or not the test specimens conform to all requirements of the Contract Document and shall specifically note any deviations therefrom.

Certify all welders and make 100 percent visual inspections and tests as follows:

- Record types and locations of all defects found in the welding work.
- The measures required and performed to correct such defects.

In addition to the requirements of AWS D 1.1, paragraph 8.15, each weld shall be visually free of slag, inclusions and porosity.

In addition to visual inspection of all welds magnetic particle, ultra-sonic and radiographic inspection shall be made of all welds as specified below. Magnetic particle tests shall be made on the root pass and finished weld.

The method of magnetic particle test shall be in accordance with ASTM E109. Any type of crack or zone of in-complete fusion or penetration shall not be acceptable.

Radiographic testing technique and standards of acceptance shall be in accordance with AWS D 1.1.

Ultra-sonic testing shall be performed in accordance with AWS D 1.1.

Welding inspection and test report showing evidence of the quality of welding shall be submitted by the Contractor. For each section of weld inspected and tested, furnish a report which clearly identifies the work, the welder's identification, the areas of inspections and test, the acceptability of the welds, and signature of the inspector or laboratory incharge. Each report shall be completed at the time of inspection or test. For radiographic examination, furnish a complete set of radiographs in addition to the reports. All inspection and testing shall be carried out in presence of the Engineer or his representative.

13.6.2 Test Methods

Use the following test methods as specified. The following list is in descending order. When a particular test method is specified

for a joint and the method is impractical to use, use the next highest method practicable. The alternative method will be subject to approval, NDT procedures and techniques shall be in accordance with AWS D 1.1, section 6.7.

a) Radiographic Method: In addition to the requirements of AWS D 1.1, comply with ASTM E94.

b) Ultrasonic method.

c) Magnetic particle method.

d) Liquid Penetration Method: Visible-dye, solvent removable method only.

13.6.3 Members Designated for Tests

a) Built – up Members:

Examine 100 percent of flange-to-flange and web-to-web welding by the radiographic method. For all web-to-flange and pipe column seam welding, examine ten percent of each welder's work as follows:

- Full penetration groove welds by the ultrasonic.

- fillet welds and partial penetration groove welds by the magnetic particle method.

b) Moment Connection Joints:

- Examine 100 percent of all flange-to-flange and web-to-web welding as follows:

  Full penetration groove welds by the ultrasonic method or other method as designated by the Engineer.

  Fillet welds and partial penetration groove welds by the magnetic particle method.

- For all web-to-flange welding, examine ten percent of each welder's work as follows:

  Full penetration groove welds by the ultrasonic method or radiographic method as approved by the Engineer.

Fillet welds and partial penetration groove welds by the magnetic particle method.

c) Column Base Plates.

Examine 100% of all welding for connection of base plate to column.

d) Bracing Connections: Examine 100 percent of all welding for connection of diagonal bracing as follows:

- Groove welds by the ultrasonic method.

- Fillet welds by the magnetic particle method.

13.6.4 Requirement for ten percent Examination

a) Examine a 300mm section of weld in each 3m increment of each welder's work as directed by the Engineer. If the examination meets the acceptance standards of AWS D 1.1, the 3m of weld represented will be accepted.

b) if the examination fails to meet the acceptance standards, examine two additional 300mm sections in the 3m increment as directed by the Engineer. If both of these examinations meet the acceptance a standards, the 3m of weld represented will be accepted. Repair the defects detected in the first examination and re-examine.

c) If one or both of the examinations fails to meet the acceptance standards, examine the remaining weld of the 3m increment. Repair the areas that do not meet the acceptance standards and re-examine.

13.6.5 Repair and Re-Testing of Welds

Repair defective welds in accordance with AWS D 1.1, or replace the weld, and Re-test repaired and replaced welds by the same method and acceptance standard used to examine the original weld. In addition, when defective welds are found, the testing laboratory shall determine the cause of the defective welding and institute immediate corrective action.

All defective welding shall be repaired or replaced at the Contractor's expense.

13.7 Rejection

Neither the fact that the materials have been tested nor that the manufacturers test certificates have been furnished shall affect the liberty of the Engineer to reject material found not according to these specifications.

Materials or workmanship not in conformance with the provisions of these specifications shall be rejected at any time, after delivery or during the progress of the work or the completion and erection at site.

14.0 ERECTION

14.1 Bracing

All steel structures shall be carried up true and plumb within the limits defined in the AISC code of standard practice and temporary bracing shall be introduced wherever necessary to take care or all construction 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 materials, erection equipment and other loads are carried during erection, proper provision shall be made by the Contractor to take care of the stresses resulting form such loads.

14.2 Alignment

No 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 and approved by the Engineer.

14.3 Joints Using High Strength Bolts

All structural joints using high strength bolts shall be executed and inspected in accordance with "AISC Specification for structural joints using ASTM A325 or A490 bolts". High strength bolts and nuts, loosened after tightening, shall be discarded and replaced with unused bolts and nuts.

15.0 MEASUREMENT AND PAYMENT

15.1 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 Bill of Quantities. The cost there of shall be deemed to have been included in the quoted unit rate of the respective items of the Bill of Quantities.

15.1.1 Nuts, bolts, screws, washers, weld metal and welding rods.

15.1.2 Testing of materials and welds, and repair of defects.

15.1.3 Surface preparation including cleaning with blasting.

15.1.4 All Painting works. (Epoxy, Anticorrosive primer, Enamel)

15.1.5 Galvanizing, Powder coating

15.1.6 Fabrication

15.1.7 Erection

15.1.8 Hardware and fixing accessories etc.

15.1.9 All embedded parts unless otherwise specified in the Bill of Quantities

15.2 Structural Steel Works

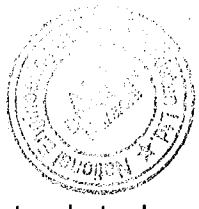
15.2.1 Measurement

Measurement of acceptably completed works of structural steel will be made on the basis of weight in tonnes (1000 kg), according to approved shop drawings, after verification at site to the satisfaction of the Engineer that the items fabricated, supplied and erected in position conform with the contract and approved shop drawings.

15.2.2 Payment

Payment will be made for acceptable measured quantity of structural steel works on the basis of unit rate per tonne quoted in the Bill of Quantities and shall constitute full compensation for all the works related to the item.

15.3 Epoxy Coating on Structural Steel Works



15.3.1 Measurement

Measurement of acceptably completed works of structural steel will be made on the basis of Square Feet/ Meter, according to approved shop drawings, after verification at site to the satisfaction of the Engineer that the items fabricated, supplied and erected in position conform with the contract and approved shop drawings.

15.3.2 Payment

Payment will be made for acceptable measured quantity of structural steel works on the basis of unit rate per Square Feet/ Meter quoted in the Bill of Quantities and shall constitute full compensation for all the works related to the item.

*** End of Section 3000 ***

SECTION - 4100

CONCRETE BLOCK MASONRY

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.

2. APPLICABLE STANDARDS

Latest editions of following Pakistan, ISO, ASTM, British and ACI Standards are relevant to these specifications wherever applicable.

2.1 Pakistan Standards

232 Ordinary Portland Cement.

419 Properties & Specifications of blocks

2.2 ISO (International Standardisation Organisation)

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.

2.3 ASTM (American Society for Testing and Material)

C.90 Solid/Hollow Load bearing Concrete Masonry units.

C.129 Solid/Hollow non Load bearing Concrete Masonry units.

C.140 Sampling and Testing of Concrete Masonry Unit.

C.144 Aggregate for Masonry Mortar.

C.145 Solid load bearing concrete masonry units.

C.149 Bond Strength of Mortar to Masonry Units.

C.150 Portland cement.

C.270 Mortor for Unit Masonry.

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.

2.4 **BSI (British Standards Institution)**

743 Materials for Damp-proof Courses.

1243 Specification for Metal Ties for Cavity wall Construction.

3148 Tests for water for making concrete.

4887 Mortar Plasticiser

121 Pt-1 Brick and Block Masonry

122 Pt-2 Walls and Partitions of Blocks and Slabs.

2.5 **ACI (American Concrete Institute)**

ACI.530 Building code requirement for masonry structures.

ACI.531 Specifications for Concrete masonry structures.

3. PRODUCT, DELEIVERY, STORAGE AND HANDLING

3.1 Deliever concrete masonry units stacked on pallets.

3.2 Store units above ground level plateform allowing air circulation under stacked units. Cover and protect units against wetting prior to use.

3.3 Handle units on pallets of flat bed barrows. Do not permit free discharge from coveyor unit or transporting in mortor trays.

4. MATERIALS

4.1 For Block

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

4.2 For Mortar

4.2.1 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. Sand that has been in contact with seawater shall not be used unless it has been thoroughly washed to the satisfaction of the Engineer.

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 .0025 inch shall not be more than 8% by weight of the total.

4.2.2 **Cement:**

Cement shall be Ordinary Portland Cement conforming to BS-12.

4.2.3 **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.

4.2.4 **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.

4.2.5 **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.

4.2.6 **Reinforcement and Anchors:**

For reinforcement refer specification section no. 2200.

5. **CONCRETE BLOCK MAKING**

5.1 The Solid and Hollow blocks shall 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.

5.2 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.

5.3 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.

5.4 Care shall be exercised in the handling of all concrete blocks. No damaged blocks shall be used in the work.

5.5 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.

5.6 The blocks cast on different dates shall be stacked separately and must be labelled showing the date on which they were cast.

5.7 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.

6. PROPERTIES OF BLOCKS

6.1 All blocks shall be of the size and shape required to complete the work shown in the Drawings or as instructed by the Engineer.

6.2 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 Sub-Clause 5.4 of the section 'Plain and Reinforced Concrete'.

6.3 All blocks shall comply with ASTM latest edition. The comppressive strength of various solid and hollow block, shall be as follows:

S.No.	Type of Concrete Masonry ASTM latest Edition	Compressive Strength Psi (MPa) Average of 3 Units	Individual Unit	Location
1.	Solid/Hollow load bearing masonry units (ASTM-C-90)	1900 (13.1)	1700 (11.7)	Exposed to frost action, weather & moisture.
2.	Solid/Hollow non Load bearing masonry units (ASTM-C-129)	600(4.14)	500 (3.45)	Partitions walls not exposed to moisture and boundary walls.

6.4 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.

6.5 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.

6.6 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.

7. 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.

8. 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.

9. REINFORCING AND ANCHORS OF BLOCK MASONRY

Unless otherwise stated reinforcing and anchors shall conform to undermentioned sizes:

9.1 For Hollow Blocks

Two # 3 bars shall be provided at every third course for anchoring of block masonry to columns. 1 # 3 bar, shall be provided for anchoring masonry walls to plinth beams/floor beam, as shown on the drawings.

9.2 For Solid Block

Two # 3 bar shall be provided at every sixth course for anchoring of block masonry to columns. One # 3 bars at every fifth block length shall be provided for anchoring masonary walls to plinth beam / floor beam, as shown on the drawings.

9.3 Dovetail anchors and slots (if used as an alternate anchorage) shall be not less than 18 gauge galvanized steel.

10. ERECTION

10.1 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.

10.2 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.

10.3 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.

10.4 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 their weight. Toothing into load-bearing walls shall not be permitted.

10.5 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.

10.6 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.

11. 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.

12. JOINTING

Jointing is the forming of joints as work proceeds. Joints shall be as follows :

12.1 Exterior exposed joints shall be tightly formed to a weather joint with the point of the trowel.

12.2 Interior / exposed joints shall be tightly formed to a concave joint.

12.3 Joints which are subsequently covered with plaster or other finish materials shall be struck flush.

13. 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.

14. 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.

15. 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.

16. REINFORCED HOLLOW BLOCK MASONRY

Where specified on the Drawings, reinforced hollow block masonry shall be provided. Horizontal and vertical reinforcement shall be deformed, hot rolled billet steel bar. Two # 3 bars shall be provided at 600mm centers. While the vertical reinforcement shall be one # 3 bar at 800mm centers. Bars shall be anchored and held firmly in respective beams and columns in the manner shown in 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.

17. CURING AND REPAIRS

17.1 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.

17.2 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.

18. 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 will be paid for under the item of 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.

19. MEASUREMENT AND PAYMENT

19.1 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.

19.1.1 Chiselling of masonry, wherever required.

19.1.2 Providing and fixing all joint reinforcing bars and dovetail anchors.

19.1.3 Cement sand mortar used in laying blocks, curing of masonry works and making of weep holes.

19.1.4 Providing and filling Class 'D' Concrete in the cavity of hollow block masonry.

19.1.5 Providing and laying damp proof courses including damp proof materials and G. I sheet flashing within cavity wall.

19.1.6 Providing and forming all types of joints, pointing etc.

19.2 Block Masonry

19.2.1 Measurement:

Measurement for acceptably completed works of respective type of block masonry will be made on the basis of actual volume in cubic feet of masonry provided and installed in position as shown on the drawings or as directed by the Engineer. Each measurement shall be taken to the nearest 12mm. All openings left in the masonry wall shall be deducted.

19.2.2 Payment:

Payment will be made for acceptable measured quantity of respective type of block masonry work on the basis of unit rate per cubic feet qoted in the Bills of Quantities and shall constitute full compensation for all the works related to the item.

*** End of Section 4100 ***

SECTION - 4600

CARPENTRY AND JOINERY

1. SCOPE

The work covered under this section of Specifications consists of providing all material, labour, plant, equipment, appliances and performing all operations in any floor and at any height connected with the fabrication and erection of all woodwork, regarding doors including surface finish treatment, procuring and applying preservatives, installation of "Finish Hard Ware" in connection with finish woodwork as per details shown on the Drawings or as directed by the Engineer.

2. APPLICABLE CODE AND STANDARDS

Latest editions of following ASTM,ANSI,AWPA,AWPB,USDC, ISO and British Standards are relevant to these specifications wherever applicable.

2.1 ASTM - American Society for Testing and Materials:

ASTM A 36 Specification for Structural Steel.

ASTM D 4442 Test Method for Direct Moisture Content Measurement of Wood and Wood-Base Materials.

2.2 ANSI - American National Standards Institute:

A199.1 Construction and Industrial Plywood.

2.3 AWPA - American Wood Preservers Association:

AWPA C1 Timber Products-Pressure Treatment (General Requirements).

AWPA C2 Lumber, Timbers, Bridge Ties and Mine Ties-Pressure-Treatment.

AWPA C9 Plywood-Pressure Treatment.

AWPA C20 Structural Lumber, Fire Retardant-Pressure Treatment.

AWPA M4 Care of Pressure-Treated Wood Products.

2.4 AWPB - American Wood Preservers Bureau:

AWPB LP-2 Standard for Softwood Lumber, Timber and Plywood Pressure Treated with Water-Borne Preservative for above Ground Use.

AWPB LP-3 Standard for Softwood Lumber, Timber and Plywood Pressure Treated with Light Petroleum Solvent-Penta Solution for above Ground Use.

AWPB LP-4 Standard for Softwood Lumber, Timber and Plywood Pressure Treated with Volatile Petroleum Solvent (LPG) - Penta Solution for above Ground Use.

AWPB LP-22 Standard for Softwood Lumber, Timber and Plywood Pressure Treated with Water-Borne Preservative for Ground Contact Use.

AWPB LP-44 Standard for Softwood Lumber, Timber and Plywood Pressure Treated with Volatile Hydrocarbon Solvent-Penta Solution for Ground Contact Use.

AWPB LP-55 Standard for Softwood Lumber, Timber and Plywood Pressure Treated with Creosote or Creosote Coal tar Solution for Ground Contact Use.

2.5 USDC - United States Department of Commerce:

USDC PS-1 Softwood Plywood, Construction and Industrial.

USDC PS-20 American Softwood Lumber Standard.

2.6 ISO (International Organisation for Standardisation)

1891 Bolts, screens, nuts and accessories-Terminology and nomenclature.

1097 Plywood - Measurement of dimensions of panels.

1098 Veneer Plywood for general use-General Requirement

2427 Veneer Plywood with rotary cut veneer for general use-Classifications by appearance of panels with outer veneer of beech.

2429 Ply wood - Veneer plywood with rotary cut veneer for general use-Classifications by appearance of panels with outer veneers of brand leaved species of tropical Africa.

3804 Plywood-Determination of dimension of test pieces.

3805 Plywood-Determination of density.

3806 Plywood-Determination of moisture content.

6442 Door leaves-Measurement of defects of general flatness.

6443 Door leaves-Measurement of dimensions and of defects of squareness.

6444 Door leaves-Test of behavior under humidity variations.

2.7 BSI (British Standards Institution)

459 Wooden doors.

1186 Quality of timber and workmanship in joinery.

1127 Hinges.

1331 Builder's Hardware for housing.

1567 Wood door frames and lining nails.

1202 Nails

1203 Specifications for synthetic resin adhesive for plywood.

1204 Synthetic resin adhesives for wood.

1282 Guide to choice, use and application of wood preservatives.

1494 Fixing accessories for building purposes.

1579 Connectors for timer.

3842 Treatment of plywood with preservatives.

3. SUBMITTALS

3.1 Wood Treatment Data:

a. Submit chemical treatment as well as manufacturer's instructions for the proper use of each type of treated material.

b. For pressure treatment and each type specified, include certification by treating plant stating chemicals and process used,

net amount of salts retained and conformance with applicable standards.

c. For water-borne preservatives, include statement that moisture content of treated materials was reduced to the levels indicated prior to shipment to project site.

d. For fire-retardant treatment, include certification by the treating plant that the treated material complies with the specified requirements and that treatment will not bleed through finished surfaces.

3.2 Provide manufacturer's literature completely describing products.

a. Provide shop drawings showing door types, details and locations, referred to the door type and hardware group shown on door and hardware schedules.

b. Provide certificates stating that doors were constructed with timber of the species specified having moisture content and meeting equilibrium and relative humidity requirements.

c. Submit samples of plywood for selection of colour and grain.

d. Procurement of materials shall be made only after the shop drawings and samples have been approved by the Engineer.

4. TRANSPORTATION, HANDLING AND STORAGE

4.1 Delivery and Storage:

a. Keep materials dry, stack products off the ground on level platforms, fully protected from weather, including direct sunlight during delivery and storage.

b. Protect against exposure to weather and contact with damp or wet surfaces. Stack lumber and plywood while providing air circulation within stacks during storage.

c. Deliver and store products in waterproof, protective containers with seals unbroken and labels intact until time to use.

d. Identify type, size and location of each door before delivery in order to permit installation at correct location.

5. QUALITY ASSURANCE

5.1 This Work shall be executed and tested in accordance with the current editions of applicable codes and standards specified herein.

5.2 Lumber Standards: Comply with US Department of Commerce Standard PS-20 **American Softwood Lumber Standards** for each indicated use, including moisture content and actual sizes related to the indicated nominal sizes.

5.3 Factory Markings and Certificates:

a. Factory-mark each piece of lumber with type, grade, mill, and grading agency identification, except omit marking from surfaces to receive transparent finish, and submit mill certificate that material has been inspected and graded in accordance with requirements if it cannot be marked on a concealed surface.

b. Certificate of inspection and grading by a recognized agency may be submitted with each shipment, in lieu of factory-marking, at Contractor's option.

c. Fire-Retardant Marking: Fire-retardant treated wood shall be tested in accordance with ASTM E 84, maximum flame spread of 25. Label materials with Underwriters' Laboratory Seals, showing grade and rating.

d. Shop-fabricate carpentry work to the greatest possible extent, using equipment and workmanship control methods which will result in work of better quality than is feasible for on-site fabrication.

e. Lumber and wood carpentry materials shall be preservative pressure treated.

6. JOB CONDITIONS

6.1 Examine the substrates and supporting structure and the conditions under which the carpentry work is to be installed, and remedy any conditions detrimental to work. Do not proceed with installation until the satisfactory conditions have been corrected in a manner acceptable to the Installer.

6.2 Fit carpentry work to other works scribe and cope as required for accurate fit. Correlate location of furring, nailers, blocking, grounds and similar supports to allow proper attachment of other work.

7. MATERIALS

7.1 Timber

a. Hard Wood :

Hard wood shall comprise of Oak, beech, Walnut, Mahogany, Teak, Iroko and Sheesham.

b. Soft Wood :

All soft wood shall consist of pines, spruce, hemlock and douglas fir or cedrous deodar (referred in the document as deodar), wood locally known as 'Partal' to be used in shutter core where specified.

c. General Characteristics :

All the timber shall be in accordance with the requirements of BSI No: 1186, 'Quality of Timber and Workmanship in Joinery'.

The whole of the timber shall be from the heart of sound and fully grown tree, uniform in substance, straight in fibre, first class quality properly seasoned, free from large or loose dead-knots, open shakes and excessive sapwood. The scantlings of all timbers shall be bright, sound and square edged. The moisture content of timber shall not be more than 10 (ten) percent in case of soft wood and 7 (seven) percent in case of hard wood.

d. Preservation of Wood:

Prior to installation of all finish wood works in their respective positions, preservatives shall be applied to safeguard the wood work against fungus, termite and bores.

The preservatives shall be of the best available quality as approved by the Engineer. The method of application shall be strictly in accordance with the manufacturer's instructions. The treatment and application of all the preservatives shall comply with the requirements of BS-CP 98:1964.

e. Adhesive:

The adhesives shall conform to the requirements of BSI No. 745 "Animal Glues for Wood" by approved manufactured or as directed and approved by the Engineer.

f. Nails and Screws:

All nails and screws shall comply with requirements of BSI NO. 1202 and BSI NO. 1210 respectively.

7.2 Ply Wood

The ply wood shall comply in all respects with BSI No. 1455:1963. All the ply wood shall only be obtained from manufacturers approved by the Engineer. All plywood shall be manufactured with phenol pharamaldihide

or any other approved water proof adhesive but not with urea pharamaldihide.

Ply wood used for doors, and other similar works shall be to the thickness and size as shown on the Drawings or as directed by the Engineer. The grade shall be first quality and the face and back shall be free from end joints, dead knots, overlaps, patches and other similar defects. The surfaces shall be free, smooth for painting or polishing.

7.3 Medium Density Fibre (MDF) Board

Medium density fibre board to be used on the project shall be LASANI of approved manufacturers of required thicknesses as specified in the drawings/details. Board shall be manufactured with water proof resinous glues and shall be guaranteed by the manufacturer. All boards required for the exterior surfaces of cabinets shall be laminated with formica in approved colour and texture in factory as specified elsewhere.

8. SAMPLES

All samples of the material used for the work under this Section of Specification shall be approved by the Engineer and same type of material shall be used throughout the work. If the Engineer desires to get the material tested, this will be got done by the Contractor at his own cost from a laboratory approved by the Engineer.

9. FABRICATION

`Unwrought' timber shall be used. Sawing shall be done with sufficient oversize margin to finally meet the requirements of specified sizes and dimensions of the finished work.

All framing shall be joined and glued properly as shown on the Drawings or as directed by the Engineer. All joints shall be secured with sufficient number of nails. The Contractor shall perform all necessary mortizing, tenoning, grooving, matching, tangoing, housing, rebating and all operations required for the correct jointing. The Contractor shall also provide all metal plates, screws, nails and other fixing material that may be ordered by the Engineer for the proper execution of the joinery work. Fabrication that develop defects due to bad workmanship or unsound materials not conforming to these specifications and the directions of the Engineer, shall be cut out and replaced at Contractor's own expense before the expiry of the maintenance period.

10. WOODEN DOORS

10.1 Materials

a. Door frame shall be of approved Mahogany wood 2"X7" in size.

b. Door shutter main & lock frame shall be of approved Mahogany wood 4"X1", Inner core shall be of 1"X1" Partal wood.

c. 3mm thick plain commercial ply shall be pasted on pressed shutter both side.

d. At top 5mm thick Mahogany veneer pannel ply shall be pasted/pressed on both sides.

d. The core of shutter shall be ½" Mahogany wood lipping all around.

f. Architraves, beads, lippings shall be of Mahogany wood of specified sizes and fixed as per details shown on Drawings.

10.2 Ground, Blocking & Nailing Strips

Ground, blocking and nailing strips shall be provided as necessary to receive the work included herein and as required for the work of other trades.

Except as otherwise shown or specified, ground blocking and nailing strips shall be secured in place as follows:

a. To steel--- by means of 3/8" diameter bolts spaced not over 900mm.

b. To block wall ---- by the use of cut nails spaced not more than 1500 mm apart and driven directly into the block.

c. To poured concrete ---- by means of 6 mm diameter galvanized expansion bolts spaced not more than 1500 mm part or by any approved method.

10.3 Exterior and Interior Door Frames

All exterior and interior door frames shall be Mahogany wood as approved by the Engineer shall be used for door frames as shown on drawings.

All exposed surfaces of frames and architraves/beads shall be lacquer polished with of approved shade as per the instructions of the Engineer.

The door frames shall be fixed in block masonry/concrete wall/columns with heavy duty holdfast as shown on drawings.

10.4 Door Shutters

The shutters will be fixed to the frames with approved quality fittings as per hardware schedule.

a. All doors, shutters shall be fabricated in a workman like manner strictly to the correct sizes and shapes as shown on the Drawings or as directed by the Engineer.

b. The door shutters shall be built in sections, properly jointed and glued together. The surfaces shall be prepared for painting or polishing.

c. All door shutters shall be engineered, fabricated from first class Mahogany wood as shown on drawings.

d. Each door shall be constructed so as to permit the installation of hinges, knobs and locks in the position shown on the Drawings.

e. Completed doors shall be sound, rigid and free from defects and warp. All edges shall be aligned and smooth, joints shall be close fitting, hard wood doweled or mortised framed and of a strength to maintain frame and of strength to maintain the structural properties of the member connected. All adjoining faces and edges shall be flush and smooth. Edges shall be rectangular and solid.

f. All exposed surfaces of wooden frames and wooden shutters shall be polished of approved shade as per the instructions of the Engineer.

g. Chamfers shall be made as shown on the drawings or as directed by the Engineer.

10.5 Fitting, Hanging and trimming

All the doors shall be fitted, hung and trimmed as hereinafter specified and as indicated on the Drawings.

Doors shall have a clearance of 3 mm at sides and top unless otherwise directed by the Engineer and shall have 5 mm clearance at bottom. Doors shall be hung and trimmed with hardware as specified. All the locks shall be installed at the same height and shall be located at height as directed by the Engineer. Where directed by the Engineer margin for carpet shall be incorporated in the door shutter.

10.6 Hardware

Hardware shall be of best quality extra heavy duty and first class finished material except door locks and door closures which shall be imported of as per attached hardware schedule from recommended list of vendors. The Contractor shall obtain prior approval from the Engineer for quality,

shape, pattern, and brand of all the hardware materials by providing samples and catalogues, etc., and shall provide and fix only the approved hardware materials.

Hardware shall be carefully and securely fitted. Upon handing over the work, hardware shall be demonstrated to operate freely. Keys shall be placed into respective locks and upon acceptance of the work keys shall be tagged and delivered to the Engineer.

10.7 Quality Assurance

a. Tolerances: Doors shall be fabricated to following tolerances

- Size: Plus or minus 1.5 mm in overall dimensions
- Maximum Warp: 3 mm
- Squareness: Maximum diagonal difference 3 mm of (between length of diagonal measured on face of door from upper right corner to lower left corner and length of diagonal measured from upper left corner to lower right corner).

b. Manufacturer's Qualifications: The manufacturer of doors herein specified shall have been in business of manufacturing doors of type specified for minimum period of five years.

10.8 Installation

a. Discard units of material which are unsound, warped, bowed, twisted, improperly treated, not adequately seasoned or too small to fabricate the work with a minimum of joints or the optimum jointing arrangement.

b. Fit carpentry work to other work. Scribe and cope as required for accurate fit. Set carpentry work accurately to required levels and lines with members plumb and true.

c. Shim with metal or slate for bearing on concrete and masonry substrate. Where indicated, provide with 1-3 Portland cement-sand grout for full-bearing.

d. Securely attach carpentry work to substrates by anchoring and fastening as shown and as required by recognized standards. Provide washers under bolt heads and nuts in contact with wood. Countersink nail heads on exposed carpentry work and fill holes.

e. Fasteners: Use common wire nails, except as otherwise shown or specified herein. Use finishing nails for exposed work. Do not wax or lubricate fasteners that depend on friction for holding power. Select fasteners of size that will not penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting of

wood; pre-drill as required. Do not drive threaded friction-type fasteners; turn into place. Tighten bolts and lag screws at installation and retighten as required for tight connections prior to closing in or at completion of work.

f. Wood Grounds, Nailers, Blocking, and Sleepers: Provide wherever shown and where required for screeding or attachment of other work. Form to shapes as shown and cut as required for true line and level of work to be attached or screeded. Coordinate location with related carpentry work; refer to shop drawings for such work when required.

g. Wood Furring: Install plumb and level with closure strips at edges and openings. Shim with wood as required. Fire stop furred spaces on walls at each floor level, with wood blocking or incombustible materials, accurately fitted to close furred spaces. Comply with governing regulations.

h. Plywood: Where required, shall be complying with the recommendations of the American Plywood Association (APA) for the fabrication and installation of plywood work.

i. Install doors at correct openings and assure smooth swing and proper closer with frames.

j. Install finish hardware in accordance with manufacturer directions.

11. LAVATORY/VANITY COUNTERTOPS

11.1 Countertop: Shall be ¾" thick granite with ¾" thick backsplash and apron, constructed to profiles and dimensions shown on Drawings.

Type, Color, Texture and Finish: As approved by the Engineer.

12. ADJUSTMENT, CLEANING, FINISHING AND PROTECTION

12.1 Repair damaged and defective woodwork wherever possible to eliminate defects functionally and visually; where not possible to repair properly, replace woodwork. Adjust joinery for uniform appearance.

12.2 Clean hardware, lubricate and make final adjustments for proper operation.

12.3 Clean woodwork on exposed and semi-exposed surfaces. Touch up shop-applied finishes to restore damaged or soiled areas.

12.4 Complete the finishing work specified as work of this section, to whatever extent not complete at the shop or prior to installation of woodwork.

12.5 Protection: Protect architectural woodwork and maintain conditions necessary to ensure that the work will be without damage or

deterioration at the time of acceptance.

12.6 Anti-Corrosion Measure:

a. Incompatible materials are to be isolated with approved materials which can withstand compression.

b. Use only non-ferrous fixing where applicable.

c. Use approved rust inhibitors as pre-primers after primary preparation.

13. SURFACE PREPARATION

The surfaces of all wood works shall be prepared in the manner as directed by the Engineer for polishing.

14. MOCK-UP SAMPLE

After approval of shop drawings and tests etc., the Contractor shall submit at his own cost one mock-up sample of each type of wood works complete with all fixing, fixtures accessories prior to the actual fabrication of the bulk.

The samples shall be returned to the Contractor for incorporation in the works after installation of at least 80% of the works.

15. MEASUREMENT & PAYMENT

15.1 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 Bill 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.

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

a. Glazing where required and all finished hardware fittings in carpentry and joinery works, including locks, hydraulic door closers, kick and push plate, architrave, beading, handles, locking arrangements etc.

b. lacquer polish in carpentry and joinery works.

c. Anti termite treatment to wood works and adhesives.

d. Mahogany and Partal wood blocking, shipping & base frame work in cabinets.

e. Mock-up sample.

f. M.S. Ribs covered with Dossai wood.

g. Marble and Granite counter tops.

h. Concrete and structural steel supports.

i. Doors, Drawers, Shelves and Panels.

15.2 Wooden Door

15.2.1 Measurement

Measurement of acceptably completed works of all types of wooden doors will be made on the basis of net actual area in square meter/foot fabricated/making and installed in position as shown on the Drawings or as directed by the Engineer. Net area will be measured in accordance with plastered masonry opening in between jambs and plastered head and bottom of shutter.

15.2.2 Payment

Payment will be made for acceptable measured quantity of all types of wooden doors on the basis of unit rate per square meter/foot quoted in the Bill of Quantities against respective item and shall constitute full compensation for all the works including all hardware & fittings like locks, hydraulic door closers, tower bolts, push plates etc. as per details mentioned in Bidding & Contract Document related to the item.

15.3 Kitchen Cabinets (Floor & Wall Mounted)

15.3.1Measurement

Measurement of acceptably completed works of Kitchen Cabinets will be made on the basis of net actual length in running meter/foot fabricated and installed in position as shown on the Drawings or as directed by the Engineer.

15.3.2 Payment

Payment will be made for acceptable measured quantity of Kitchen Cabinets on the basis of unit rate per meter/foot quoted in the Bill of Quantities against respective item and shall constitute full compensation for all the works related to the item.

15.4 Wardrobes & Laundry Wardrobes

15.4.1 Measurement

Measurement of acceptably completed works of Wardrobes & Laundry Wardrobes will be made on the basis of the unit rate in square meter/foot fabricated and installed in position as shown on the Drawings or as directed by the Engineer.

15.4.2 Payment

Payment will be made for acceptable measured quantity of Wardrobes & Laundry Wardrobes on the basis of unit rate per square meter/foot quoted in the Bill of Quantities against respective item and shall constitute full compensation for all the works related to the item.

15.5 M.S. Ribs with wooden cladding

15.5.1 Measurement

Measurement of acceptably completed works of M.S. Ribs with wooden cladding will be made on the basis of entire job fabricated and installed in position as shown on the Drawings or as directed by the Engineer.

15.5.2 Payment

Payment will be made for acceptable measured quantity of M.S. Ribs with wooden cladding will be made on the basis of entire job quoted in the Bill of Quantities against respective item and shall constitute full compensation for all the works related to the item.

15.6 Lavatory/Vanity Countertops

15.6.1 Measurement

Measurement of acceptably completed works of Lavatory/Vanity Countertops will be made on the basis of net actual area in square meter/foot fabricated and installed in position as shown on the Drawings or as directed by the Engineer.

15.6.2 Payment

Payment will be made for acceptable measured quantity of Lavatory/Vanity Countertops rooms on the basis of unit rate per square meter/foot quoted in the Bill of Quantities against respective item and shall constitute full compensation for all the works related to the item.

15.7 Door Locks

15.6.1 Measurement

Measurement of acceptably completed works of Door Locks (Handle Type) will be made on the basis of number installed in position as shown on the Bill of Quantities, Drawings or as directed by the Engineer.

15.6.2 Payment

Payment will be made for acceptable measured quantity of Door Locks (Handle Type) will be made on the basis of number quoted in the Bill of Quantities against respective item and shall constitute full compensation for all the works related to the item.

** End of Section 4600 ***

SECTION - 6220

ALUMINIUM WORKS

1. SCOPE

The work covered under this section of the specifications consists of providing all material, labour, equipment, performing all operations required for providing and installation of powder coated aluminum doors, windows, ventilators & louvers doors and Partitions including all related items such as sealants, gasket, netting, rollers, hinges, latches, fastenings, anchor bolts, door locks, locking devices and glass complete in strict accordance with this section of specifications, the applicable drawings and as scheduled. Any additional information required in this connection and not stated in these specifications, shall be obtained from the Engineer's Representative.

2. APPLICABLE STANDARDS

Latest editions of following ISO and British Standards are relevant to these Specifications wherever applicable.

2.1 ISO (International Organisation for Standardisation)

1804	Doors	-	Terminology
6442	Door Leaves	-	Measurement of defects of general flatness.
6443	Door Leaves	-	Measurement of dimensions and defects of squareness.
6444	Door Leaves	-	Test of behaviour under humidity Variations (successive uniform climates)
6612	Windows & Doors	-	wind resistance tests.
6613	Windows & Door	-	Air permeability test.

2.2 BSI (British Standard Institution)

1227 Hinges

4873 Aluminum alloy windows.

6696 Powder coated Aluminium.

2.3 AAMA (American Architectural Manufacturer Association)

AAMA 101 Aluminum Prime windows and Sliding Glass Doors

AAMA 603.8 Pigmented Organic Coating on Extruded Aluminum

AAMA 605.2 High Performance Organic Coatings on Architectural Extrusions and Panels

AAMA 606.1 Color Anodic Finishes for Architectural Aluminum

AAMA 607.1 Clear Anodic Finishes for Architectural Aluminum

AAMA 701.2 Voluntary Specification for Pile Weather Stripping

AAMA 2605 Powder coating Process

2.4 **AA - Aluminum Association**

Aluminum Association Designation System for Aluminum Finishes

2.5 **ANSI - American National Standards Institute**

A134.1 Specification for Aluminum Prime windows.

2.6 **ASTM - American Society for Testing and Materials**

ASTM B 136 Stain Resistance of Anodic Coatings on Aluminum

ASTM B 137 Weight of Coatings on Anodically Coated Aluminum

ASTM B 209 Aluminum and Aluminum-Alloy Sheet and Plate

ASTM B 211 Aluminum and Aluminum-Alloy Bars, Rods and Wire

ASTM B 221 Aluminum-Alloy Extruded Bars, Rods, Wire, Shapes and Tubes

ASTM B 244 Thickness of Anodic Coatings on Aluminum with Eddy-Current Instrument

ASTM D 2287 Non-Rigid Vinyl Chloride Polymer and Copolymer Molding and Extrusion Compounds.

ASTM D 3656 Insect Screening and Louver Cloth Woven From Vinyl-Coated Glass fiber Yarn

ASTM E 283 Rate of Air Leakage Through Exterior Windows, Curtain Walls and Doors

ASTM E 330 Structural Performance of Exterior Windows, Curtain Walls and Doors Under the Influence of Wind Loads.

ASTM E 331 Water Penetration of Exterior Windows, Curtain Walls and Doors by Uniform Static Pressure Difference Loads

ASTM E 547 Water Penetration of Exterior Windows, Curtain Walls and Doors by Cyclic Static Air Pressure Difference Loads

ASTM F 468 Nonferrous Bolts, Hex Cap Screws, and Studs for General Use

2.7 DIN - Deutsches Institute fuer Normung

DIN 4108 Heat Insulation in Buildings

DIN 18055 Windows; Air Permeability of Joints, Water Tightness and Mechanical Strain

2.8 AWS - American Welding Society:

D1.1 - Structural Welding Code, Steel

D1.2 - Structural Welding Code, Aluminum

3. SUBMITTALS

3.1 Product Data: Submit Manufacturer's specifications, standard details, and installation recommendations for components of aluminum doors, windows, ventilators, louvers and framing required for project, including data that products have been tested and comply with performance requirements.

3.2 Shop Drawings: Submit shop drawings for fabrication and installation of aluminum doors , windows, ventilators, louvers and framing, including elevations, detail sections of typical composite members, anchorages, reinforcement, expansion provisions, and glazing

3.3 Certification: Submit statement certified by registered structural engineer that systems including glass will withstand specified wind-loads.

3.4 Samples: Submit samples of each type and color of aluminum finish, on 300 mm long sections of extrusions or formed shapes and on 150 mm square sheets.

4. TRANSPORTATION, HANDLING AND STORAGE

Deliver aluminum entrance material to the site in packages or containers, labeled for identification with the Manufacturer's name, brand and contents. Store aluminum entrance material in weather tight and dry storage facility. Protect from damage from handling, weather and construction operations

before, during and after installation.

5. WARRANTY

Submit 2 copies of written guarantee signed by the Manufacturer, Installer and Contractor, agreeing to replace aluminum doors, windows, ventilators, louvers and framing units that fail in material or workmanship within 2 years of date of substantial handing over.

Such guarantee shall be in addition to and not in lieu of all other liabilities which manufacturers and the Contractor may have by law or by other provisions of the Contract Documents.

6. QUALITY ASSURANCE

6.1 Standards: Comply with applicable provisions of **Powder coated aluminum partitions, doors, louver doors, windows and ventilators Guide Specifications Manual - AAMA.**

6.2 Performance and Testing:

6.2.1 Thermal Movement: Fabricate exterior components from Manufacturer's stock systems which have been designed to provide for expansion and contraction resulting from ambient temperature range of 48°C.

6.3 Wind Loading: Fabricate exterior components from Manufacturer's stock systems which have been tested in accordance with ASTM E 330 to withstand at least the following loadings:

6.3.1 Uniform Pressure: 97.6 kg/m² inward; 97.6 kg/m² outward.

6.3.2 Maximum Deflection: 1/175 of clear span any framing member.

6.4 Weather Resistance: Fabricate exterior components from Manufacturer's stock systems which have been tested to demonstrate permanent resistance to leakages as follows with test pressure differential of 10 percent of design loading (excluding operable door edges).

6.4.1 Air Infiltration: Tested in accordance with ASTM E 283 and shall have a minimum of 0.6 m^3/min/m of crack.

6.4.2 Water penetration and leakage shall not be allowed when tested in accordance with ASTM E 331 at a water application rate 10 percent more than the design rate.

7. GENERAL

7.1 Doors, Windows, ventilators, louvers doors, partitions and other items to be provided shall be aluminum, of profile pattern and design shown on drawings and shop drawings manufactured by reputable manufacturer approved by the Engineer. The Contractor shall provide manufacture literature completely describing the product instructions for installation and maintenance.

7.2 All sections used for doors, windows, ventilators, louvers and fly screens shall be of best quality aluminum products such as equal and unequal angles, channels, tubes, corrugated strips, mouldings etc., in accordance with International standards conforming to ASTM B 308 & B 221.

7.3 All doors, windows, ventilators and louvers shall be of type and size indicated on drawings and shall conform to the requirements shown and specified herein.

7.4 Contractor shall arrange tests and analysis if directed by the Engineer of scaled models of each door, window, ventilator and louvers type at the maker's works or any laboratory specified by the Engineer for the material supplied by him to be tested in the presence of the Engineer's Inspector, to whom test certificates, proof sheets, etc. shall be furnished. The models shall be submitted to the Engineer for approval prior to testing. Nevertheless, neither the fact that the materials have been tested in the presence of the inspector nor that the Engineer may have been furnished with test certificates in lieu of sending an inspector to the works shall affect the liberty of the Engineer to reject, after delivery of materials found not in accordance with these specifications.

7.5 The Contractor shall submit shop drawings conforming to design concept which shall show full construction details, quantities and locations, fastenings, stiffening members and attachments to adjacent construction and materials. Shop drawings and calculations shall be submitted at the proper time to allow for checking, revisions, and agreement and to permit manufacturer's product delivery and start of site work to suit the building programme. The Contractor shall submit representative samples of finished doors, windows, anchoring mechanism, embedded parts, fastenings, glass panes, accessories and other materials for the Engineer's approval.

After approval of shop drawings and tests etc., the Contractor shall submit at his own cost one mock-up sample of each type of aluminum works complete with glazing, all components assembly method and required fittings and accessories prior to the actual fabrication of the bulk. The samples shall be returned to the Contractor for incorporation in the works after installation of at least 80% of the works.

Fabricate and assemble all work in the shop of the approved manufacturer to reduce field fabrication to a minimum unless otherwise directed by the Engineer.

7.6 The glass shall conform to specification laid down under chapter 'Glazing' and shall be free from all blemishes, bubbles, distortions and other flaws of any kind and shall be properly cut to size as shown on drawings, so as to fit the grooves in window members.

7.7 The structural shape of the Aluminium members shall be of uniform quality, colour and temper, clean, round, commercially straight and free from injurious defects.

7.8 All doors, windows, ventilators and louvers shall be fabricated as a complete unit, fully airtight and watertight, including rubber gasket for glazing, hinges, stays, rollers, latch, locking arrangement, handles, etc anodized in specified colour, inclusive of glass sheet, necessary holes for fixing, door locks, door closures and window locking requirements, all as approved by the engineer.

7.9 Contractor shall, provide certificate signed by the manufacturer stating that each lot has been sampled, tested and inspected and has met the requirements in accordance with these specifications and the same shall be furnished to the Engineer.

7.10 The shop drawings shall clearly show that there shall be no penetration of rainwater from the exterior to the interior in case of severe wind and rainstorm. This has to be specially ensured in sill section.

8. MATERIALS AND ACCESSORIES

8.1 Aluminum Members:

8.1.1 Extrusions of Bars, Rods and Tubes: 6063-T6 Alloy conforming to ASTM B 221.

8.1.2 Sheets and Plates: 5005-H14 alloy conforming to ASTM B 209.

8.1.3 Doors, windows, ventilators, louvers and frames shall be manufacturer standard systems of extrusions not less than 2mm thick.

8.1.4 Use manufacturer's standard thermal-break sections for all aluminum doors, windows, ventilators and louvers unless otherwise shown on Drawings.

8.2 Fasteners: Aluminum, or non-magnetic stainless steel, or other materials warranted by Manufacturer to be non-corrosive and compatible with

aluminum components.

8.2.1 Do not use exposed fasteners except where unavoidable for application of hardware. Match finish of adjoining metal.

8.2.2 Provide Phillips flat-head machine screws for exposed fasteners.

8.3 Glazing Gasket: Manufacturer's standard vinyl glazing gasket.

8.4 Brackets and Reinforcements: Manufacturer's high- strength aluminum units where feasible; otherwise, non-magnetic stainless steel or hot-dip galvanized complying with ASTM A 386.

8.5 Concrete/Masonry Inserts: Cast iron, malleable iron, or hot-dip galvanized steel complying with ASTM A 386.

8.6 Bituminous Coatings: Cold-applied asphalt mastic complying with SSPC - Paint 12, compounded for 20 mil thickness per coat.

8.7 Glass: Glass and glazing materials shall be as specified in Section 6250 - GLAZING and as indicated on Drawings with all doors , windows, ventilators and louvers factory glazed.

8.8 Hardware: Provide aluminum doors, windows, ventilators and louvers with Manufacturer's standard, factory-installed hardware. Finish of hardware shall be satin stainless steel, as approved by the Engineer.

9. FINISH

Powder coating Finish: Conform to AAMA 2605; coating thickness 70~90 micron. Color shall be as approved by the Engineer.

10. DESIGN REQUIREMENT

The Contractor shall design the installation to meet the following requirements.

10.1 Tolerances

The Contractor shall be responsible for agreeing to all dimensions with the Engineer before proceeding with the manufacture and for making provision to allow for building tolerances required by the Engineer. Contractor shall also take site measurements of the structure completed before manufacturing.

10.2 Thermal & Seismic Movements

The window and glazing assemblies are to be constructed and installed in the openings with sufficient tolerance and, where necessary, to

provide for joints incorporated in couplings, to provide for expansion and contraction as will be caused by the local seismic and climatic conditions and temperature changes, winter to summer - day to night without buckling, distortion of joints, or other harmful effects.

11. FABRICATION

11.1 Door Types: Types include double leaf swing doors and sliding doors, as shown on drawings. Provide manufacturer's standard electric door operator for motor-operated sliding doors.

11.2 Sizes and Profiles: Required sizes for door, windows, ventilators, louvers and frame units including profile requirements shall be as shown on Drawings. Variable dimensions shall be indicated, together with maximum and minimum dimensions required to achieve design requirements and coordination with other work.

11.3 Prefabrication: Complete fabrication, assembly, finishing, hardware application, and other work before shipment to project site. Disassemble components only as necessary for shipment and installation.

11.4 Sequence: Complete cutting, fitting, forming, drilling, and grinding of metal work prior to cleaning, finishing, surface treatment, and application of finishes. Remove arises from cut edges and ease edges and corners.

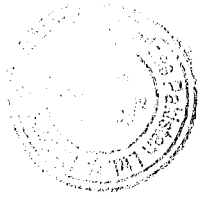
11.5 Welding: Comply with AWS recommendations to avoid discoloration; grind exposed welds smooth and restore mechanical finish.

11.6 Reinforcing: Install reinforcing as necessary for performance requirements; separate dissimilar metals with bituminous paint or other separator which will prevent corrosion.

11.7 Provide continuous steel reinforcing stiffening members within jambs and heads of all doorframes, except omit at jambs that are secured to adjacent fixed walls.

11.8 Cut vertical reinforcing 50 mm less than mullion height and cut horizontal reinforcing 75 mm less than door head framing member.

11.9 Securely fasten in a manner so that fasteners will not be visible in finished work. Fasten aluminum sections to steel reinforcing 150 mm from each end and intermediately at a maximum spacing of 600 mm on centers.



11.10 Doorframes shall be free of vibration and distortion when doors are used.

11.11 Maintain accurate relation of planes and angles, with hairline fit of contacting members.

11.12 Fasteners: Conceal fasteners wherever possible.

11.13 Weather stripping: For exterior doors, windows, ventilators, louvers and frames provide compression weather stripping against fixed strip; at other edges, provide sliding weather stripping retained in adjustable strips mortised in other edge.

12. WORKMANSHIP

The Contractor shall be responsible for the protection and installation of all items furnished. All items shall be installed plumb and square and shall be solidly anchored in a good workman like manner in accordance with the manufacturer's instruction and as specified herein. The Contractor shall be responsible for the protection of installed items from damage by other trades. All items shall be left in operating, neat and clean condition, free from dirt, finger marks, etc. The Contractor shall be responsible for final cleaning before the final acceptance.

The glass panes shall firmly be secured in the rebates with the rubber gasket. Ensure that the beads and grooves are clean, dry and unobstructed at the time of glazing. The complete unit shall be airtight and watertight on completion. No doors, windows and ventilator shall be considered complete until and unless the fingerprints and other stains and marks have been removed from the surface of glass and aluminum.

13. ERECTION

13.1 Comply with Manufacturer's instructions and recommendations for installation of aluminum doors and frames.

13.2 Set units plumb, level, and true to line, without warp or rack of framing members, doors, windows, ventilators, louvers and frames or panels. Anchor securely in place, separating aluminum and other corrodible metal surfaces from sources of corrosion or electrolytic action at points of contact with other materials with bituminous coating.

13.3 Set sill members and other members in bed of compound as shown, or with joint fillers or gaskets as shown to provided weather-tight construction.

13.4 Expansion and Contraction: Allow for expansion and contraction due to temperature and building movement, and for practical building tolerances in connections to basic structure and in connections to work by others. At no place should window wall grid or framing impart any expansion or contraction forces on panels or glass.

13.5 Hardware Preparation and Installation: Cut, reinforce, drill and tap

aluminum work for application of finish hardware. Provide cover boxes in frames back of cutouts for hardware also install finish hardware in accordance with hardware Manufacturer's instructions and template requirements also use concealed fasteners wherever possible.

13.6 Caulking: Seal joints between metal members and between metal and adjacent surfaces.

13.7 Refer to Section 6250 - GLAZING for installation of glass and glazing requirements.

13.8 Rawal plugs and anchoring bolts shall be embedded into the concrete or block masonry for holding the doors windows, ventilators and louvers in their correct positions.

13.9 Should any scale or scratch appears on the surface of doors, windows and ventilators the contractor shall at his own expense and at the Engineer's direction have all exposed surfaces cleaned to bare bright specified colour.

14. 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 of items.

Damage to existing works from scaffolding or from any other object shall be repaired by the Contractor at his own cost.

15. ADJUST PROTECTION AND CLEANING

15.1 Temporary protection shall be achieved by applying water-soluble protective coating capable of withstanding the action of lime mortar.

15.2 Apply coating in the manufacturer's plant to the exposed surfaces of all components.

15.3 Before application of coating, remove all fabrication compounds, moisture and dirt accumulations.

15.4 Adjust operating hardware to function properly, without binding, and to provide tight fit at contact points and weather stripping.

15.5 Clean completed systems, inside and out, promptly after erection and installation of glass and sealants. Remove excess glazing and sealant compounds, dirt, and other substances from aluminum surfaces.

15.6 Remove protective coating when completion of adjoining works and construction activities no longer requires its retention.

15.7 Institute protective measures and other precautions required to assure that aluminum doors, windows, ventilators, lovers and frames will be without damage or deterioration, other than normal weathering, at time of acceptance.

16. DEFECTIVE WORK

In the event of non-conformance to specifications and drawings the aluminium works shall be rejected by the Engineer and the Contractor shall remove and replace the rejected works by new work of same specifications.

17. MEASUREMENT AND PAYMENT

17.1 General

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

17.1.1 Aluminium extrusions tubular frame and sash member as per drawings.

17.1.2 Polyurethane thermal break material.

17.1.3 Rawal plugs, brackets, rubber gasket, sealants, rollers, heavy duty hinges, stays, concealed type floor mounted double action door closures, hinges, heavy duty stays, vetting latches and any other embedded fixture required for fixing the doors windows and ventilator.

17.1.4 Providing and fixing fly screens, weather stripping, backer rods, locks, stays, latches, push/pull bars, handles and door closures where ever required in the aluminum works as approved by the engineer.

17.1.5 Cleaning of aluminum after installation.

17.1.6 Sealing all around both from inside and outside and also of the screw holes with silicone sealant to avoid water leakage.

17.1.7 Fly screen including wire/fly mesh etc. in windows and ventilators.

17.1.8 Powder coating of Aluminum works.
17.1.9 Providing and fixing glazing

17.1.10 All samples & tests

17.1.11 Scaffolding/Plat-form to work at Height.

17.2 **Aluminum Works**

17.2.1 Measurement

Measurement of acceptably completed works of aluminum doors, windows, ventilators, louvers doors and partitions will be made on the basis of net actual area in square foot/meter provided and installed in position as shown on drawings or as directed by the Engineer.

17.2.2 Payment

Payment will be made for acceptable measured quantity of all finished anodized aluminum doors, windows, ventilators, louvers doors and partitions on the basis of unit rate per square foot/meter quoted in the Bill of Quantities and shall constitute full compensation for all the works related to the item including all reinforcing/stiffening arrangements.

*** End of Section 6220 ***

SECTION - 6250

GLAZING

1. SCOPE

The work under this section of the Specifications consists of furnishing all labour, equipment, tools, appliances, scaffolding and providing in any floor and at any height glass, gaskets, sealants, compound and other materials required for performing all operations in connection with the installation and setting of all types of glass and glazing complete in every respect in accordance with the Drawings or as directed by the Engineer. The scope of this section of Specifications is covered with detailed Specifications as laid down herein.

2. APPLICABLE STANDARDS

Latest editions of following American Society of Testing and Materials, Flat Glass Marketing Association, Federal Specifications, American National Standard Institute, National Fire Protection Association and British Standards are relevant to these Specifications wherever applicable.

2.1 ASTM - American Society of Testing and Materials

ASTM C 920	Elastomeric Joint Sealant
ASTM C 1036	Flat Glass
ASTM C 1048	Heat-Treated Flat Glass – Kind HS, Kind FT Coated and Uncoated Glass
ASTM C 1172	Laminated Architectural Glass
ASTM E 774	Sealed Insulating Glass Units

2.2 FGMA - Flat Glass Marketing Association

Glazing Sealing Systems Manual

Glazing Manual

2.3 FS - Federal Specifications

DD-G-451	Glass, Float or Plate, Sheet, Figured (Flat, for Glazing, Mirrors and other Uses)
DD-G-1403	Glass, Plate (Float), Sheet, Figured, and Spandrel (Heat Strengthened and Fully Tempered)
DD-M-411	Mirrors, Plate, Glass, Framed

2.4 ANSI - American National Standards Institute, Inc.

Z97.1	Performance Specification and Methods of Test for Safety Glazing Material Used in Buildings

2.5 NFPA - National Fire Protection Association

Glazing Manual

2.6 **BSI (British Standards Institution)**

952 Glass for glazing

5051 Security glazing part I & II

CP.152 Glazing

3 SUBMITTALS

3.1 Product Data: Submit manufacturers technical data for glazing material and fabricated glass product required, including installation and maintenance instructions.

3.2 Samples: Submit 300 mm x 300 mm samples of each type of glass to be used.

3.3 Certificates: Submit certificates from manufacturer attesting that glass and glazing materials furnished for the project comply with requirements.

4 TRANSPORTATION, HANDLING AND STORAGE

4.1 Protect glass and glazing materials during delivery, storage and handling to comply with manufacturer's written directions and as required to prevent edge damage to glass, and damage to glass and glazing materials from effects of moisture including condensation, of temperature changes, of direct exposure to sun, and from other causes, including high altitude limitations for insulating glass.

4.2 Contractor shall deliver materials in manufacturer's original, unopened containers clearly labeled with manufacturer's name and address, material, brand, type, class and rating as applicable.

4.3 Contractor shall store the materials in original unopened containers with labels intact/protected from ground contact and from elements which may damage glass.

5 WARRANTY

5.1 Submit a written guarantee signed by Manufacturer and Installer of glazing for a period of 1 year from the date of substantial completion. The Guarantee shall cover the replacement of defective materials and workmanship as directed by the Engineer.

6 QUALITY ASSURANCE

6.1 Glazing Standards: Comply with recommendations of Flat Glass Marketing Association (FGMA) - **Glazing Manual** and **Sealant Manual** except where more stringent requirements are indicated. Refer to those publications for definitions of glass and glazing terms not otherwise defined in this Section or

other referenced standards.

6.2 Safety Glazing Standard: Where safety glass is indicated, provide type of products which comply with ANSI Z97.1.

6.3 Provide insulating glass units permanently marked either on spacers or at least one component pane of unit with appropriate certification label of inspecting and testing organizations.

7 PROJECT CONDITIONS

7.1 Do not proceed with glazing when ambient and substrate temperature conditions are outside limits permitted by glazing material manufacturer or when joint substrates are wet due to rain, frost, condensation or other cause.

7.2 Install sealant at ambient and substrate temperatures permitted by sealant manufacturers.

8 GLASS PRODUCTS - GENERAL

8.1 Primary Glass Standard: Provide primary glass which complies with ASTM C 1036 requirements, including those indicated by reference to type, class, quality, and if applicable, form, finish, mesh and pattern.

8.2 Heat-Treated Glass Standard: Provide heat-treated glass, kind HS (heat-strengthened) and kind FT (fully tempered), complying with the requirements of ASTM C 1048, including those indicated by reference to kind, condition, type, quality, class, and if applicable, form, finish, and pattern.

8.3 Laminated Glass: Two panes of annealed glass bonded with an interlayer material for use in building glazing, all complying with the requirements of ASTM C 1172. Provide 24 mm thick double glazed clear laminated window complying with Section 13090 – RADIATION PROTECTION as shown on drawings.

8.4 Sizes: Fabricate tempered glass to sizes required for glazing openings indicated, with edge clearances and tolerances complying with recommendations of glass manufacturer. Provide thicknesses indicated or, if not otherwise indicated, as recommended by glass manufacturer for application indicated, but not less than 6 mm thick for windows and 13 mm for doors (single glazing).

9 GLASS

9.1 Tempered Float Glass:

9.2 Grade B (fully tempered), Style I (uncoated surfaces), Type I (transparent glass, flat), Class 1 (clear), quality q^3 (glazing select), 12 mm thick for frameless windows, and for fully glazed doors, unless otherwise indicated on Drawings.

9.3 Provide tempered float glass for doors and windows indicated on Drawings to have single glazing.

10 SEALED INSULATED GLASS UNITS:

10.1 Provide pre-assembled units consisting of organically sealed panes of glass enclosing a hermetically sealed dehydrated air space and complying with ASTM E 774 for performance classification indicated as well as with other requirements specified for glass characteristics, air space, sealing system, sealant, spacer material, corner design and desiccant. Units shall have a U-Value of 2.5 $W/m^2/K$ and an overall Shading Coefficient of 0.3. Spacer material shall be manufacturer's standard aluminum or stainless steel. Desiccant shall be either molecular sieve or silica gel or blend of both. Provide insulated laminated glass units with reflective coating on outer pane and clear laminated inner pane for vision panels; and reflective single tempered glass for spandrel panels. Thickness of glass shall be as indicated on drawings. Color of reflective coating shall be as selected by the Engineer from manufacturer's full range of color.

10.2 Provide sealed insulating glass units for entrance doors indicated on Drawings to have double-glazing.

10.3 MIRRORS

Type I, Class I, Quality q^2, Clear float mirror, fully silvered electrically copper-plated, 6 mm thick, exposed edges ground and face corners cased, guaranteed against silver spoilage for 15 years.

Size and location of mirrors shall be as indicated on Drawings.

11 GLAZING MATERIALS AND ACCESSORIES

11.1 Glazing Gaskets: Dense elastomeric seal gaskets shall be continuous neoprene or polyvinyl chloride extrusions, of 50 Shore A durometer hardness plus or minus 5 complying with ASTM C 864.

11.2 Lock-Strip Gaskets: Conform to ASTM C 542, neoprene extrusions of required size and shape. Frames fabricated with injection molded corners. Provide with separate lock (zipper) strips, Shore A durometer 10 points harder than gasket body.

11.3 Setting Blocks: Neoprene, EPDM or silicone blocks as required for compatibility with glazing sealants, 80 to 90 Shore A durometer hardness.

11.4 Spacers: Neoprene blocks, 40 to 50 Shore A durometer hardness, self-adhesive on one face only; compatible with sealant used. Use EPDM spacers for units set with silicone glazing sealant.

11.5 Joint Cleaner, Primer and Sealer: As recommended by the glazing manufacturer.

11.6 Compressible Filler Rod: Closed-celled or a waterproof-jacketed rod stock of synthetic rubber or plastic foam, compatible with sealants used, flexible and resilient, with 34.5 to 68.9 kPa compression strength for 25 percent deflection.

11.7 Preformed Butyl-Polyisobutylene Glazing Tape: Provide manufacturer's standard solvent-free butyl-polyisobutylene formulation with a solids content of 100 percent; complying with AAMA A 804.1; in extruded tape form; non-staining and non-migrating in contact with nonporous surfaces; packaged on rolls with a release paper on one side; with or without continuous spacer rod as recommended by manufacturers of tape and glass for application indicated.

11.8 **Solar Control Film/ Glass**

The approved Solar Control film shall be applied on all sun-facing glasses of doors and windows as indicated on the Drawings. It shall consist of aluminium vapour coated polyester film with water activated adhesive thereon. Color shall be soft grey. The film shall be optically clear from the inside. Total thickness shall be 0.025 mm to 0.033 mm. The film shall transmit 18% of visible light and shall have reflectance of 18%.

12. INSTALLATION OF GLAZING

12.1 General: Unless otherwise shown or specified, comply with recommendations and requirements of the FGMA **Glazing Sealing Systems Manual** and **Glazing Manual**. For the installation of all glass comply with glass manufacturers and glazing materials manufacturer's written instructions and recommendations. Provide watertight and airtight installation of each piece of glass, so as to withstand temperature changes and wind loading normal at the site. Operating sash and doors shall withstand impact loading without failure of any kind including loss or breakage of glass, failure of sealants or gaskets to remain watertight and airtight, and deterioration of glazing materials. Install butt-joint glazing according to the glass manufacturer's recommendations.

12.2 Inspection: Inspect each piece of glass immediately before installation. Do not install any pieces which are improperly sized or have damaged edges, scratches or abrasion or any other evidence of damage. Use suction cups to shift glass units within openings; do not drift glass with pry bars. Remove labels from glass immediately after installation.

12.3 Setting Blocks: Locate setting blocks at sill rabbet one-quarter in from each end of the glass, unless otherwise recommended by the glass manufacturer. Use blocks of proper size to support the glass in accordance with manufacturer's recommendations. Set blocks in thin course of sealant that is acceptable for heel bead use.

12.4 Spacers: Provide spacers for all glass sizes larger than a combined total of 1.27 m or more for any two adjacent sides to separate glass from stops, except where continuous glazing gaskets are provided. Locate spacers no farther than 600 mm apart and no closer than 300 mm to a corner. Place spacers opposite one another. Make bite of spacer on glass a nominal 6 mm or greater.

12.5 Set units of glass in each series with uniformity of pattern, draw, bow and similar characteristics.

12.6 Provide compressible filler rods or equivalent back-up material, as recommended by sealant and glass manufacturers, to prevent sealant from extruding into glass channel weep systems and from adhering to joints back surface as well as to control depth of sealant for optimum performance, unless otherwise indicated.

12.7 Sealants: Force sealants into glazing channels to eliminate voids and to ensure complete "wetting" or bond of sealant to glass and channel surfaces. Tool exposed surfaces of sealants to provide a substantial "wash" away from glass. Install pressurized tapes and gaskets to protrude slightly out of channel, so as to eliminate dirt and moisture pockets.

12.8 Glazing Gaskets: Miter-cut and seal joints of glazing gaskets in accordance with manufacturer's written instructions.

12.9 Lock-Strip Gaskets:

Comply with gasket manufacturer's written instructions and recommendations. Miter-cut corners of loose zipper strips slightly longer to provide permanent compression at joints. Use special tool to install and remove filler strips; lubricate in accordance with manufacturer's instructions.

Comply with glass manufacturer's written instructions for the use of setting blocks, liquid or tape sealants, and weep holes in the glazing recess of lock strip gaskets.

12.10 Examine each piece of glass and discard and replace glass with edge damage or face imperfection. All glazing shall be wind tight and fully water tight on completion.

12.11 Clean glazing channels and other framing members indicated to receive glass. Remove coatings which are not firmly bonded to the substrate, Remove lacquer from metal surfaces wherever elastomeric sealants are to be used. Apply primer and sealer to joint surfaces wherever recommended by the sealant manufacturer and as shown on the drawings.

12.12 Trim and clean excess glazing materials from surrounding surfaces immediately after installation and eliminate stains and discolorations.

12.13 Cure glazing sealants and compounds in compliance with manufacturer's instructions to obtain high early bond strength internal cohesive strength and surface durability.

12.14 While glazing operation is in progress great care shall be taken to avoid breakage or damage to the glass and adjoining glazing. The Contractor shall make good at his own cost, all glass broken by his workmen while cleaning or carrying out other operations. On the

completion of the glazing work, all glass that has been set by the Contractor shall, if it becomes loose, within the maintenance period, be refixed at Contractor's expense.

12.15 No glazing shall be considered complete until and unless paint and other stains have been removed from the surface of the glass ad checked by the Engineer for water tightness.

13. PROTECTION AND CLEANING OF GLAZING

13.1 Protect glass from breakage immediately upon installation by use of crossed streamers or ribbons attached to framing and held away from glass. Do not apply markings to surfaces of glass. Remove nonpermanent labels and clean surfaces.

13.2 Protect glass from contact with contaminating substances resulting from construction operations. Cover glass as required to protect it from additives that might abrade the glass surface. If, despite such protection, contaminating substances do come into contact with glass, remove immediately by method recommended by glass manufacturer.

13.3 Remove and replace glass which is broken, chipped, cracked, abraded or damaged in other ways during construction period, including natural causes, accidents and vandalism.

13.4 Maintenance: Maintain glass in a reasonably clean condition during construction.

13.5 Cleaning: Wash glass on both faces not more than 4 days prior to acceptance. Comply with instructions and recommendations of the glass manufacturer and glazing materials manufacturer for cleaning in each case.

14. MEASUREMENT AND PAYMENT

No payment shall be made for the works involved within the scope of this section of specifications unless otherwise specifically stated in the Bill of Quantities or herein. The cost there of shall be deemed to be included in the quoted unit rate of the relevant item of the Bill of Quantities.

*** End of Section 6250 ***

SECTION - 6411

WATER PROOFING AND BUILT-UP ROOFING

1.0 SCOPE

The work under this section of the Specifications consists of furnishing all plant, labour, equipment, appliances and materials and in performing all operations in any floor and at any height in connection with water-proofing, expansion joint filling including pre-fabricated cover assemblies and built-up roofing, with water proof treatment to foundations and basement structures complete in strict accordance with this section of the specifications and the applicable drawings and subject to the terms and conditions of the Contract.

2.0 SUBMITTAL

2.1 Shop Drawings: Shop drawings shall be submitted showing layout and all the details for construction.

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

3.0 MATERIALS

3.1 Cold applied emulsified Bitumen of approved quality & brand shall be according to BSS.

3.2 Bitumen priming oil shall be of the approved manufacturer.

3.3 Two part acrylic polymer modified cementitious waterproofing coating (Ultra seal or approved equivalent)

3.4 Waterproofing admixture ULTRA Powder 2000 or approved equivalent.

3.5 Non-Shrink Cementitious Grout ULTRA Grout or approved equivalent.

3.6 Super high Elastic waterproofing membrane ADVSEAL 2000 or approved equivalent.

3.7 Cement and aggregates shall be in accordance with specifications for "Plain and reinforced concrete".

4.0 DELIVERY STORAGE AND HANDLING

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

5.0 PREPARATORY WORK

5.1 All scuppers and roof drains shall be placed and metal flashing flanges etc. shall be provided in time to be installed alongwith the roofing assembly.

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

6.0 WATER PROOFING TREATMENT IN FOUNDATIONS AND SURFACES IN CONTACT WITH EARTH

All surfaces to be bitumen painted shall be thoroughly cleaned of any accretion, dust, dirt etc. by scraping, wire brushing or as directed by the Engineer. The surface shall be primed with a coat as per recommendations of the manufacturer or as approved by the Engineer. Two coats of cold bitumen paint shall be applied at the rate recommended by the manufacturer or as approved by the Engineer. The first coat shall be allowed to dry before applying the second coat. During operation of painting great care shall be taken to avoid air bubbles. The manufacturer's advice/ recommendations shall be taken to avoid air bubbles. The manufacturer's instructions and Engineer's directions shall be followed.

7.0 APPLICATION OF WATER PROOFING TO UNEDERGROUND WATER RETAINING STRUCTURES

7.1 Water proofing shall not be applied during rain or while surfaces are damp, it shall be applied only to surfaces that are clean and dry.

7.2 Two coats of cementitious coating UTRA SEAL or approved equivalent with prime coat shall be applied as per manufacturer's recommendations.

8.0 MEASUREMENT AND PAYMENT

8.1 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.

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

8.1.1 All preparatory work, scrapping, scratching, cleaning, cant strips, gravel strips, etc.

8.1.2 Formwork

8.1.3 Roof treatment including Class 'C' cement concrete mixed with waterproof admixture

8.1.4 Additional Coats of waterproofing membrane if the surface found failed in water testing.

8.1.5 Supply & arrangement of water for testing of waterproofing membrane / coating at any height or and depth.

8.1.6 Class 'C' cement concrete cant strip.

8.1.7 Waterproofing of vertical & horizontal joints of parapet wall, equipment foundations etc

8.2 Bitumen Painting/Coating

8.2.1 Measurement

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

8.2.2 Payment

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

8.3 Cementitious Waterproofing coating

8.3.1 Measurement

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

8.3.2 Payment

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

8.4 Waterproofing and Built-Up Roofing

8.4.1 Measurement

Measurement of acceptably completed works of Waterproofing and Built-Up Roofing will be made on the basis of net actual area in square feet as shown on the Drawings or as directed by the Engineer.

8.4.2 Payment

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

*** End of Section 6411 ***

SECTION – 6521

CEMENT PLASTER

1. SCOPE

The work under this section of the Specifications consists of furnishing all plant, labour, equipment, appliances, and materials and in performing all operations in any floor and at any height connection with providing and installation of cement plaster, and specified external rendering complete in strict accordance with this section of the Specifications and the applicable drawings and subject to the terms and conditions of the Contract.

2. APPLICABLE STANDARDS

Latest editions of following American Society of Testing and Materials, American National Standard Institute and Metal Lathing/Steel Framing Association are relevant to these Specifications wherever applicable.

2.1 ASTM - American Society for Testing and Materials

ASTM A 109 - Specification for Steel, Carbon, Cold-Rolled Strip

ASTM A 570 - Specification for Steel, Sheet and Strip, Carbon, Hot-Rolled, Structural Quality

ASTM C 28 - Specification for Gypsum Plasters

ASTM C 29 - Test Method for Unit Weight and Molds in Aggregate

ASTM C 35 - Specification for Inorganic Aggregates for Use in Gypsum Plaster

ASTM C 61 - Specification for Gypsum Keene's Cement

ASTM C 150 - Specification for Portland Cement

ASTM C 206 - Specification for Finishing Hydrated Lime

ASTM C 472 - Test Method for Physical testing of Gypsum Plasters and Gypsum concrete

ASTM C 841 - Specification for Installation of Interior Lathing and Furring

ASTM C 842 - Specification for Application of Interior Gypsum Plaster

ASTM C 847 - Specification for Metal Lath

ASTM C 926 - Specification for Application of Portland Cement-Based Plaster

2.2 ANSI - American National Standards Institute Inc.

ANSI A42.1 - Gypsum Plastering

ANSI A42.3 - Lathing and Furring for Portland Cement and Portland Cement-line, Exterior (Stucco) and Interior

ANSI A42.4 - Specification for Interior Lathing and Furring

2.3 ML/SFA - Metal Lathing/Steel Framing Association

ML/SFA - Specification for metal lathing and furring

3. SUBMITTALS

3.1 Manufacturer's Certificates: Submit manufacturer's certificates showing compliance with the specified material requirements and installation and workmanship instructions.

3.2 Samples: Submit 300 mm long samples of the proposed accessories.

4. TRANSPORTATION, HANDLING AND STORAGE

4.1 Except for sand and water, deliver materials to the site in sealed containers or bags fully identified with manufacturer's name, brand, type and grade. Store materials in a dry, well-ventilated space, under cover, off the ground, and away from surface subject to dampness or condensation.

4.2 Deliver accessories in their original containers bearing the name of the manufacturer and item identification.

5. QUALITY ASSURANCE

5.1 Allowable Tolerance for Finished Work: For flat surfaces, do not exceed 3 mm in 3 meters for bow or warp of surface and for plumbness or level.

5.2 Mock-up Installation: Prior to installation of plaster work, provide sample mock-up panels using materials specified for final work. Build sample panels at site, of full thickness and approximately 1.2 x 1.2 m. Demonstrate the proposed range of color, texture and workmanship to be expected in the completed work, and submit to Engineer for review. Retain sample panels construction as a standard for judging completed plaster work. Do not alter, move or destroy sample panel until plastering work is completed. Provide a sample panel for interior and exterior Portland cement plaster and plaster on metal lath.

6. JOB CONDITIONS

6.1 Protection: Protect contiguous work from moisture deterioration and soiling, which may result from plastering operations. Provide temporary covering and whatever other provisions may be necessary to minimize harmful spattering of plaster on other work.

Finished door and window frames and other surfaces which do not receive a plaster finish shall be well protected during plaster application.

6.2 Environmental Conditions:

General: Protect plaster against uneven and excessive evaporation and from strong flows of dry air, both natural and artificial. Apply and cure plaster as required by climatic conditions to prevent rapid dry-out. Provide suitable coverings, moist curing, barriers to deflect sunlight and wind, or combination of these as required.

Ventilation: Provide adequate ventilation to properly dry interior plaster during and subsequent to its application.

7. GENERAL

7.1 Except as may be otherwise shown on surfaces specified, all plaster work, both internal and external shall be ordinary Portland Cement plaster of the required thickness as shown on the drawings.

7.2 Plastering shall not commence until all electric conduits, drainage and sanitary pipes, inlets to tanks, brackets, clamps, doors and window frames and all sorts of inserts and embedded items are fixed in position. It shall be the responsibility of the Contractor to make sure that all such work is carried out by other contractors before starting of plaster work. Chiseling and repairing of cement plaster shall not be permitted without the approval of the Engineer.

8. MATERIAL

8.1 PLASTER ACCESSORIES

8.1.1 Galvanized steel furring, lathing and other plaster accessories shall conform to the material provisions of ASTM C 841 and ANSI A42.3. Plaster accessories shall include but not limited to the following:

a. Metal Corner Beads: Fabricated from galvanized sheet, 5 mm radius bead with 38 mm wide expanded type flanges.

b. Strip Reinforcement: Smooth edge strips of expanded metal lath fabricated from galvanized steel sheet, with uncoated steel painted after fabrication.

c. Casing Beads: Square-edged style, with short or expanded flanges to suit kinds of plaster bases galvanized steel.

d Curved Casing Beads: Square-edged style, fabricated from aluminum coated with clear plastic, preformed into curve of radius indicated on the Drawings.

e Control Joints: Prefabricated, galvanized steel one-or two-piece type as required. Provide removable protective tape on plaster face of control joints.

f. Metal Corner Reinforcement: Expanded large mesh diamond lath fabricated from welded wire mesh from 1.2 mm diameter

galvanized wire, specially formed to reinforce corners of Portland cement plaster where exposed while allowing full plaster encasement.

g Expanded Metal Lath: Galvanized steel diamond mesh complying with ASTM C 847 and shall have a minimum weight of 1.85 kg/m^2.

8.1.2 Coordinate the depth of accessories with the thickness and number of plaster coats required in accordance with the manufacturer's recommendations and as directed by Engineer.

8.2 PORTLAND CEMENT PLASTER

8.2.1 Portland cement plaster shall have a minimum thickness of 20 mm in a double coat provided using but not limited to the following materials:

a. Base Coat Cement: Portland cement, conforming to ASTM C 150, Type I.

b. Finish Coat Cement: Portland cement, conforming to ASTM C 150, Type I.

c. Factory-Prepared Finish Coat: Manufacturer's standard product requiring only the addition of water; white in color unless otherwise indicated.

d. Lime: Special hydrated lime for finishing purposes, conforming to ASTM C 206, Type S.

e. Sand Aggregate for Base Coat: Conform to the requirements of ASTM C 897.

f. Aggregate for Finish coat: Conform to ASTM C 897, manufactured or natural sand to match approved sample.

g. Water for Mixing and Finishing Plaster: Potable, free of substances, capable of affecting plaster set or of damaging plaster, lath or accessories.

h. Bonding Agents: Conform to ASTM C 932.

8.2.2 Portland cement plaster mixes and compositions:

a. General: Comply with ASTM C 926 for Portland cement plaster base and finish coat mixes as applicable to plaster bases, materials and other requirements indicated. Submit samples of materials used for the approval of Engineer as well as mix design.

b. Base Coat: Proportion materials for respective base coats in parts by volume for cementitious materials and in parts by volume for sum of cementitious materials for aggregates to comply with following requirements for each method of application and plaster

base as required. Adjust mix proportions indicated herein within the limits specified to attain workability as follows:

c. Two-coat Work over Concrete or Unit Masonry: Base coats shall be one part Portland cement, 3/4 to 1-1/2 parts lime, 3 to 4 parts sand.

d. Finish Coat: Proportion materials for finish coats in parts by volume for cementitious materials for aggregates with one part Portland cement, 3/4 to 1-1/2 parts lime and 3 parts sand.

8.3 GYPSUM PLASTER (FOR INTERNAL PLASTERING)

8.3.1 Gypsum Plaster Materials:

a. Base Coat Plaster: Conform to ASTM C 28, ready-mixed gypsum, high strength gypsum neat plaster with minimum average dry compressive strength of 19.3 MPa according to ASTM C 472 for a mix of 45 kg plaster and 0.19 m^3 of sand.

b. Finish Coat Plaster: Ready-mixed gypsum finished plaster, manufacturer's standard mill-mixed gauged interior finish or high-strength gypsum gauging plaster, conforming to ASTM C 28, with a minimum average dry compressive strength of 34.5 MPa according to ASTM C 472 for neat mix.

c. Lime: Conform to ASTM C 206, hydrated lime, Type S, for finishing purposes, unless otherwise indicated.

d. Aggregates for Base Coat: Conform to ASTM C 35, sand aggregate, unless otherwise indicated.

e. Bonding Agent: Conform to ASTM C 631.

8.3.2 Gypsum plaster mixes and compositions:

a. Plaster Base Coat Compositions: Comply with ASTM C 842 and manufacturer's directions for gypsum plaster base coat proportions which corresponds to application and plaster bases as indicated below:

1. Three-coat Work over Metal Lath: Scratch and brown coats of high strength gypsum gauging plaster with job-mixed sand.

2. Two-Coat Work Over Unit Masonry and Concrete: Base coats of gypsum neat plaster with job-mix sand.

b. Finish Coat: Proportion materials for finish coat to comply with ASTM C 842 for type of finish coat and texture required.

8.4 CEMENT SAND SCREED

8.4.1 Cement Sand screed be composed of a mixture of Portland Cement type I, natural sand, crushed stone or a combination of them, as well as water and other additives as indicated on Drawings and as required by the Engineer.

8.4.2 Submit the design mix for Engineer's approval. Cement Sand screed shall have minimum thickness of 75 mm unless otherwise indicated on Drawings. Provide wire fabric reinforcement, hardener, protection layer, insulation and membrane waterproofing as required.

8.4.3 Test screed for a minimum compressive strength of 22 MPa after 28 days.

9. EXECUTION

9.1 INSTALLATION OF LATHING AND FURRING - GENERAL

9.1.1 Install interior lathing and furring materials indicated for plaster to comply with ASTM C 841.

9.1.2 Install lathing and furring materials indicated for Portland cement plaster to comply with ANSI A42.3.

9.1.3 Install supplementary framing, blocking, and bracing at terminations of work for support of fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, and similar work in accordance with details indicated on Drawings or approved shop drawings.

9.1.4 Isolation: Where lathing and metal support system abuts building structure horizontally, and where partition/wall work abuts overhead structure, isolate the work from structural movement sufficiently to prevent transfer of loading into the work from the building structure. Install slip or cushion type joints to absorb deflections but maintain lateral support.

9.1.5 Frame both sides of control and expansion joints independently, and do not bridge joints with furring and lathing or accessories.

9.2 INSTALLATION OF CEILING SUSPENSION SYSTEMS

9.2.1 Coordinate installation of ceiling suspension system with installation of overhead structural systems, ducting and catwalks to ensure that inserts and other structural anchorage provisions have been installed to receive ceiling hangers in a manner that will develop their full strength and at spacing required to support ceiling.

9.2.2 Furnish concrete inserts, and other devices indicated, to other trades for installations well in advance of time needed for coordination with other work.

9.2.3 Attach hangers to structure above ceiling to comply with ML/SFA - Specifications for Metal Lathing and Furring as well as with referenced standards.

9.2.4 Install ceiling suspension system components of sizes and spacing indicated but not in smaller sizes or greater spacing than that required by the referenced lathing and furring installation standards.

9.3 METAL LATHING

Install expanded metal lath for the applications where plaster base coats are required. Provide appropriate type, configuration and weight of metal lath selected from materials required which comply with referenced lathing installation standards.

9.4 INSTALLATION OF PLASTERING ACCESSORIES

9.4.1 General: Comply with referenced lathing and furring installation standards for provision and location of plaster accessories of type indicated. Miter or cope accessories at corners; install with tight joints and in alignment. Attach accessories securely to plaster bases to hold accessories in place and alignment during plastering.

9.4.2 Accessories:

a. Corner Beads: Install at external corners.

b. Casing Beads: Install at terminations of plaster work, except where plaster passes behind and is concealed by other work and where metal screed, bases or metal frames act as casing beads.

c. Control Joints: Install at locations indicated, or if not indicated, at spacings and locations required by referenced standard and recommended by plaster manufacturer and approved by the Engineer.

d. Corner Reinforcement: Install at external corners.

9.5 PLASTER APPLICATION

9.5.1 Prepare monolithic surfaces for bonded base coats and use bonding compound or agent to comply with requirements of referenced plaster application standards for conditioning of monolithic surfaces.

9.5.2 Tolerances: Do not deviate more than 3 mm in 3000 mm from a true plane in finished plaster surfaces, as measured by a 3000 mm straightedge placed at any location on surface.

9.5.3 Grout hollow metal frames, bases and similar work occurring in plastered areas, with base coat plaster material, and prior to lathing where necessary. Except where full grouting is indicated or required for fire-resistance rating, grout 150 mm lengths at each anchorage.

9.5.4 Sequence plaster application with the installation and protection of other work, so that neither will be damaged by the installation of the other.

9.5.5 Plaster finish with metal frames and other built-in metal items or accessories which act as a plaster ground, unless otherwise indicated. Where plaster is not terminated at metal by casing beads, cut base coat-free from metal before plaster sets and groove finish coat the juncture with metal.

9.5.6 Apply thickness and number of coats of plaster as indicated or as required by referenced standards, and as per manufacturer's recommendations.

a. Cement Plaster: Base coat shall be 20 mm thick for concrete and CMU. Finish coat shall be 3 mm.

b. Gypsum Plaster (for internal use): Base coat shall be 12 mm thick. Finish coat shall be 3 mm.

9.5.7 Concealed Plaster: Where plaster application will be concealed by wood paneling, above suspended ceilings and similar locations, finish-coat maybe omitted. Where plaster application will be concealed behind cabinets and similar furnishings and equipment apply finish-coat. Where plaster application will be used as a base for adhesive application of tile and similar finishes, omit finish-coat and coordinate thickness with overall dimension as shown and comply with tolerances specified.

9.6 SAND-CEMENT SCREED

9.6.1 Roughened the concrete slabs to receive screeding before hardening. Clean and wet the hardened base surfaces, preferably overnight prior to laying of screeds.

9.6.2 Batch accurately aggregates and cement by weight at a ratio of cement-aggregate ranging from 1-3 to 1-4.5. Mix screeding material mechanically.

9.6.3 Lay and finish the screed mix carefully to true levels and correct heights for the required thickness. Tolerance in level over a 2 m length shall not exceed plus or minus 3 mm.

9.6.4 Provide adequate means of curing to prevent rapid drying of screed as directed by the Engineer.

9.7 CUTTING AND PATCHING

9.7.1 Cut, patch, point-up and repair plaster as necessary to accommodate other work and to restore cracks, dents and imperfections. Repair or replace work to eliminate blisters, buckles, excessive crazing and check cracking, dry-outs, efflorescence, sweat-outs and similar defects and where bond to the substrate has failed.

9.7.2 Sand smooth-trowelled finishes lightly to remove trowel marks and arises.

9.8 CLEANING AND PROTECTION

9.8.1 Remove temporary protection and enclosure of other work. Promptly remove plaster from door frames, windows, and other surfaces which are not to be plastered. Repair floors, walls and other surfaces which have been stained, marred or otherwise damaged during the plastering work. When plastering work is completed, remove unused materials, containers and equipment and clean remove unused materials, containers and equipment and clean floors of plaster debris.

9.8.2 Provide final protection and maintain conditions which ensure plaster work being without damage or deterioration at the time of substantial completion.

10. MEASUREMENT AND PAYMENT

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

10.1.1 Metal lath over reinforced concrete and masonry joint.

10.1.2 Joints, junctions, corners, beads, drip course edge, roundings, and aluminum U/Y channels in groves. Etc.

10.1.3 More than one layer due to any unevenness in the finished works and base coat plaster in stucco plaster including marble chips/colour pigments.

10.1.4 Cutting & patching of all defective works.

10.1.5 Surface preparation, cleaning and protection as specified.

10.1.6 Marble chips & pigments in stucco plaster.

10.1.7 Roughening of first coat of plaster before application of 2nd coat incase where overall required plaster thickness exceeds 13mm.

10.1.8 Pudlo or approved equivalent water proofing agent.

10.2 Plain Plaster

10.2.1 Measurement

Deductions shall not be made for ends of joints, beam posts, etc., and openings not exceeding 0.5 square meter each and no addition shall be made for reveals, jambs, soffits, sills, etc. of these openings non for finishing the plaster around ends of joints, beams posts, etc.

In case of opening of area exceeding 0.5 square meter each, deduction shall be made for the openings and also no addition shall be made for reveals jambs, soffits, sills, etc., of these openings.

Measurement of acceptably completed works of respective type of plaster will be made on the basis of actual area in square meter of the surface plastered as shown on the Drawings, or as directed by the Engineer.

10.2.2 Payment

Payment will be made for acceptable measured quantity of plaster on the basis of unit rate per square meter quoted in the Bill of Quantities and shall constitute full compensation for all the works related to the item.

*** End of Section 6521 ***

SECTION - 6531

MARBLE

1. SCOPE

The work under this section of specifications, consists of providing all material, labour, plant, equipment, appliances in any floor and at any height and performing all operations required for providing and installing marble natural stone slab for toilet counters, where shown on the drawings, complete in strict accordance with this section of the specification and the applicable Drawings.

2. SUBMITTALS

The Contractor shall submit manufacturer's specifications and other product data for each type of marble stone and fixtures required, including instructions for handling, storage, installation and protection.

Shop Drawings shall be submitted showing sizes, dimensions, sections and profiles of slab, arrangement and provisions for jointing, anchoring, fastening and supports and other necessary fixing details. Indicate locations, layouts and pattern arrangements for each stone type and colour.

Submit three ranges samples 300mm x 300mm in size of each type of stone showing colour, grade, finishing and texture for approval of the Engineer.

3. DELIVERY, STORAGE AND HANDLING

Materials shall be protected from damage during loading, shipment, delivery and storage. Non-staining materials for blocking and packing shall be used. Stack marble at site in accordance with manufacturer's recommendations and as required to prevent staining, scratching, etching or breakage.

4. MATERIALS

4.1 General

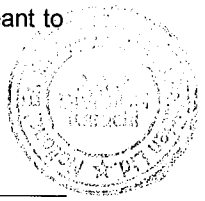
Marble shall be compact, dense, metamorphic rock of lime stone origin obtained from quarries within Pakistan. It shall have a specific gravity of 2.7 and hardness number on Moh's scale shall range from 3 to 4.

Obtain each marble stone type from a single quarry and ensure consistent colour range and texture throughout the work. All pieces shall be of uniform thickness and truly square in shape.

Provide marble slabs/sills and tiles of specified sizes in floors, stair tread & risers and counter tops as shown on drawings.

Provide marble slabs/sills and tiles of type, colour and finish for each area as directed by the Engineer.

Provide stone of specified thickness. Saw cut the back surfaces that are meant to be concealed in finished work.



Provide irregular shaped units, staircase units and skirting base units to the profiles of required shapes & sizes and polished exposed surfaces wherever specified.

4.2 Marble Stone Type

All marble stone types are to be selected and approved by the Engineer for quality, colour and texture.

Marble: Marble of approved type and colour of local origin, first class quality and high class finish acceptable to the Engineer.

4.3 Beds and Backings

Where applicable, standard cementious screed and mortar beds and backings, mixed and proportioned by volume shall be as follows: -

Grey ordinary Portland Cement	: 1 part
Sand	: 2 parts
Water	: Clean, fresh and free from deleterious substances

4.4 Adhesives, Grouts and Sealants

Proprietary adhesives, joint grouts and sealants of approved type as required and recommended by the manufacturer for specific application shall be used. The colour of the joint grout and the sealants shall match with the colour of stone.

5. EXECUTION

5.1 Flooring, Skirting/dado and Stair

Apply cement slurry coat over surfaces of concrete substrate immediately prior to placing setting bed. Limit area of application to avoid premature drying out. Install setting bed of required thickness and set stone units before initial set occurs. Apply a thin layer of cement paste to bottom of each unit. Set tamps and level units immediately. Set units in required pattern with uniform joint widths.

Point joints as soon as possible after initial set. Force grout into joints, strike flush and tool slightly concave.

Remove mortar and grout from surfaces while still moist and as the work progresses.

Do not permit traffic on finished surface during setting and for a minimum of 24 hours after final pointing of joints.

5.2 Marble Toilet Counters

Marble toilet counter tops of the specified size shall be installed in areas shown on Drawings with M.s. angle framing and fixing accessories in accordance with approved shop drawing. Joints shall be cement grouted with matching colour or with matching colour sealant.

5.3 Repair and Cleaning

Remove and replace stone units which are broken, chipped, stained or otherwise damaged. Where directed, remove and replace units which do not match adjoining stonework or are not in line and level as shown on Drawings. Provide new

matching units, install and point joints to eliminate evidence of replacement. Repoint defective and unsatisfactory joints to provide neat, uniform appearance.

Clean stonework not less than 6 days after completion of work, using clean water and bristle brushes. Do not use wire brushes, acid or caustic type cleaning agents or other cleaning compounds which may be detrimental to the stone finish or joint grout.

5.4 Protection

Provide covers, boards, supports and all other necessary materials to protect finished work from collapse, deterioration, discolouration or damage during installation and until contract completion.

5.5 Polishing

The finished surface shall be chemically polished, acceptable to the Engineer.

6. MEASUREMENT AND PAYMENT

6.1 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 Bill of Quantities. The cost thereof shall be deemed to have been included in the quoted unit rate of the respective items of the Bill of Quantities.

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

6.1.1 Finishing, washing, polishing, repair cleaning and protection of marble stone/tiles in position.

6.1.2 Proprietary adhesives, joint grouts and sealants for fixing marble stone where specified on the Drawings or directed by the Engineer.

6.1.3 Class 'C' cement concrete screed bed and 1:2 cement sand mortar for marble stone/tiles in floors, skirting, steps, etc.

6.1.4 Preparation of concrete substrate for laying marble sills/slabs and tiles.

6.1.5 M.S. angle framing and fixing accessories for marble counters.

6.1.6 Chemical polishing on marble surfaces.

6.2 Marble Floor / Skirting / Steps & Risers

6.2.1 Measurement

Measurement of acceptably completed works of marble floor / skirting / steps & risers will be made on the basis of net actual area in square feet of marble floor / skirting / steps & risers provided and installed in position as shown on the Drawings or as directed by the Engineer.

6.2.2 Payment

Payment will be made for acceptable measured quantity of marble floor / skirting / steps & risers on the basis of unit rate per square meter quoted against respective item in the Bills of Quantities and shall constitute full compensation for all the works related to the item.

6.3 Marble Cladding

6.3.1 Measurement

Measurement of acceptably completed works of marble cladding will be made on the basis of net actual area in square feet of marble cladding provided and installed in position as shown on the Drawings or as directed by the Engineer.

6.3.2 Payment

Payment will be made for acceptable measured quantity of marble cladding on the basis of unit rate per square feet quoted against respective item in the Bills of Quantities and shall constitute full compensation for all the works related to the item.

6.4 Marble Vanity Top

6.4.1 Measurement

Measurement of acceptably completed works of marble vanity top including precast slab, masonry and other related civil works, will be made on the basis of net actual area in square feet of marble vanity top provided and installed in position as shown on the Drawings or as directed by the Engineer.

6.4.2 Payment

Payment will be made for acceptable measured quantity of marble vanity top including precast slab, masonry and other related civil works, on the basis of unit rate per square feet quoted against respective item in the Bills of Quantities and shall constitute full compensation for all the works related to the item.

*** End of Section 6531 ***

SECTION - 6532

GRANITE WORKS

1.0 SCOPE

The work under this section of specifications, consists of providing all material, labour, plant, equipment, appliances and performing all operations required for providing and installation of granite natural stone slab and tile finishing as shown on Drawings including interior and exterior floors and wall finishing, counter tops, division panels and the like, complete in strict accordance with this section of the specification and the applicable Drawings.

2.0 SUBMITTALS

The Contractor shall submit manufacturer's specifications and other product data for each type of granite stone required, including instructions for handling, storage, installation and protection.

Shop Drawings shall be submitted showing sizes, dimensions, sections and profiles of slab and tile units, arrangement and provisions for jointing, anchoring, fastening and supports and other necessary fixing details. Indicate locations, layouts and pattern arrangements for each stone type and colour.

Submit three range samples 600 mm x 600 mm 21 ft x 2 ft) in size of each type of stone showing colour, grade, finishing and texture for approval of the Engineer.

3.0 DELIVERY, STORAGE AND HANDLING

Materials shall be protected from damage during loading, shipment delivery and storage. Non-staining materials for blocking and packing shall be used. Stack granite units at site in accordance with manufacturer's recommendations and as required to prevent staining, scratching, etching or breakage.

Units of cladding granite shall be clearly marked to identify the final position in the structure as indicated in the shop drawings.

4.0 MATERIALS

4.1 General

Obtain each stone type from a single quarry and ensure consistent colour range and texture throughout the work.

Provide continuous slabs or tiles for continuous wall areas, intersecting planes, and countertops to provide continuous matching units.

Provide stone of type, colour and finish for each area of use as approved by the Engineer.

Provide stone of thickness shown. Saw-cut back surfaces which will be concealed in finished work.

4.2 Types

All granite stone types are to be selected and approved by the Engineer for quality, colour and texture.

4.3 **Beds and Backings**

Where applicable, standard cementitious mortar beds and backings, mixed and proportioned by volume shall be as follows:

White Portland Cement	1 part
Sand:	2 1/2 to 4 parts
Lime:	1/4 part
Water:	Clean, fresh and free from deleterious substances

4.4 **Adhesives, Grouts and Sealants**

Where specified on the drawing or as directed by the Engineer, proprietary adhesives, joint grouts and sealants; suitable types as required and recommended for specific application; colour match joint grout and sealants to colour of stone shall be used.

4.5 **Dowels & Anchors**

Contractor shall provide necessary loose steel plates, clip angles, seat angles, anchors, dowels, cramps, hangers and other steel/brass shapes for securing granite units to other supporting and adjacent members. Provide at least two anchors for each piece.

4.6 **Setting Shims or Buttons**

Lead buttons of the thickness required for the joint size shown or specified and of the size required to maintain uniform joint width.

5.0 EXECUTION

5.1 **Paving, Flooring and Stair Units**

Apply cement slurry coat over surfaces of concrete substrate immediately prior to placing setting bed. Limit area of application to avoid premature drying out. Install setting bed to thickness required and set stone units before initial set occurs. Apply a thin layer of cement paste to bottom of each unit. Set, tamp and level units immediately. Set units in pattern required, with uniform joint widths.

Point joints as soon as possible after initial set. Force grout into joints, strike flush and tool slightly concave.

Remove mortar and grout from surfaces while still moist and as the work progresses.

Do not permit traffic on finished surface during setting and for a minimum of 24 hours after final pointing of joints.

5.2 **Granite Wall Cladding**

External wall cladding shall be executed in accordance with CP.298 and the approved shop Drawings and as per direction of the Engineer.

The granite stone of the specified size shall be fixed using brass dowels, brackets, anchors and plugs. The dowels, anchors or tie must not be subjected to any loading until complete hardness has taken place. Holes and mortises shall be carefully drilled or cut to avoid fracture of the tile. Patching will not be permitted and any damaged tiles shall be removed and replaced at the cost of the Contractor.

External claddings shall be designed by means of proper structural design calculation. The structural design shall take account of the suitability of both the cladding units and the fixing dowels, anchors and each cladding unit shall be fixed with at least two brass

dowels. Static proof shall be provided by the Contractor for the spacing and number of fixings to be used.

5.3 **Repair and Cleaning**

Remove and replace stone units which are broken, chipped, stained or otherwise damaged. Where directed, remove and replace units which do not match adjoining stonework or is not in line and levels as shown on Drawings. Provide new matching units, install and point joints to eliminate evidence of replacement. Repoint defective and unsatisfactory joints to provide neat, uniform appearance.

Clean stonework not less than 6 days after completion of work, using clean water and bristle brushes. Do not use wire brushes, acid or caustic type cleaning agents or other cleaning compounds which may be detrimental to the stone finish or joint grout.

5.4 **Protection**

Provide covers, boards, supports and all other necessary materials to protect finished work from collapse, deterioration, discolour or damage during installation and until contract completion.

6.0 MEASUREMENT AND PAYMENT

6.1 **General**

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

6.1.1 Finishing, washing, polishing, repair cleaning and protection of granite in position.

6.1.2 Proprietary adhesives, joint grouts and sealants for fixing granite tiles where specified on the Drawings.

6.1.3 Cement concrete setting beds and backings for granite tiles.

6.1.4 Preparation of concrete substrate for laying granite tiles.

6.1.5 Brass dowels, brackets, anchors and plugs in granite wall cladding.

6.2 **Pre-polished Granite on Steps, Risers, Thresholds, Ablution sets & Window Sills**

6.2.1 Measurement

Measurement of acceptably completed works of pre-polished granite on steps & riser will be made on the basis of net actual area in square feet of granite provided and laid in position as shown on the Drawings or as directed by the Engineer.

6.2.2 Payment

Payment will be made for acceptable measured quantity of pre-polished granite on steps & riser on the basis of unit rate per square feet quoted in the Bill of Quantities and shall constitute full compensation for all the works related to the item.

*** End of Section 6532 ***

SECTION - 6560

FALSE CEILING

1. SCOPE

The work under this section of the specifications, consists of furnishing all plant, labour, equipment, appliances and materials in any floor and at any height and in performing all operations in connection with providing and installing different types of false ceiling including suspension system complete, in strict accordance with this section of the specifications and the applicable drawings and subject to the terms and conditions of the Contract.

2. GENERAL

False ceiling shall be installed wherever indicated on the drawings by skilled technicians experienced in this type of work. Installation shall not commence in any room or space before completion of plasterwork on structural roofing / internal walling/external surfaces.

3. MATERIALS

3.1 Tiles

Tiles shall be of approved size, shape and colour as shown on drawing or as approved by the Engineer shall be used.

All four edges shall be revealed to be installed by an approved recessed suspension system, strictly in accordance with the approved shop drawings, manufacturer's recommendations or instructions of the Engineer.

3.2 Aluminum Strips

Aluminum strip ceiling shall be aluminum 4 inches wide strips, plain surfaced, with mineral wool insulation, manufactured by DAMPA (Denmark) brand, Elephant or DFB or Boral or equivalent.

3.3 Gypsum Board Sheet

Water resistant gypsum board sheet shall be of size as that shown on the drawing.

After cutting the sheet in to approved size tiles, all four edges shall be revealed to be installed by an approved recessed suspension system, strictly in accordance with the approved shop drawings, manufacturer's recommendations or instructions of the Engineer.

3.4 Suspension System

The suspension system for all types of false ceiling shall be in accordance with the recommendations of the approved false ceiling manufacturer and approved shop drawings, consisting of painted aluminum universal U-channels / main T/ Cross-T Bars, wall mouldings/ edge trims, hold down/adjustment clips, galvanized hanger strips with adjustment mechanism, etc.

4. SUBMITTALS

4.1 Shop drawings shall be submitted showing reflected ceiling plan, locations of built in products and access facilities, dimensions, layout arrangements, hanger locations, structural connection, details of level changes, direction of pattern and panel joint details. The shop drawings shall be got approved by the Contractor from the Engineer in advance of under taking this item of works.

4.2 No materials shall be procured prior to approval of shop drawings and details.

4.3 The Contractor shall incorporate the required access panels of false ceiling as per approved shop drawings.

5. PRODUCT DELIVERY, STORAGE AND HANDLING

5.1 Material shall be delivered in original, unopened, protective packaging, with manufacturer's labels indicating brand name, pattern, size, thickness and fire rating.

5.2 Material shall be stored in original protective packaging to prevent soiling, physical damage or wetting.

5.3 Cartons shall be stored in the installation area, opened at each end to stabilize moisture content and temperature, for 48 hours prior to installation.

6. JOB SITE CONDITIONS

6.1 Work which will be concealed by false ceilings shall be completed, tested, inspected and accepted before ceiling work is started.

6.2 False ceiling installation shall not begin until the area has been closed in, and temperature and humidity approximate occupancy conditions. Wet work shall be cured and dry before ceiling work is started.

6.3 Surface which will support the ceilings, and those to which the ceiling abut, shall be inspected and accepted for completeness and adequacy to receive the ceilings before the work begins.

7. INSTALLATION AND WORKMANSHIP

False ceiling suspension system and panels shall be installed in accordance with the requirements of BSI-CP.290 and with the manufacturer's recommendations as approved by the Engineer.

7.1 Suspension System

The hangers as specified shall be evenly disposed as per drawings, details and place and position as indicated. The suspension system should be installed by making holes directly in the roof and shall be made good as directed by the Engineer. Their lengths clear of roofing slab shall be as per shop drawing details.

The framing of the specified section and run at spacing as per shop drawings. The jointing of runners to hangers shall be as per approved shop drawing details. The extra framing if required shall be provided for light receptacles as per approved shop drawing details.

Wall hangers shall be positively and rigidly connected to the structure and to cross runners.

7.2 False Ceiling tiles.

Tiles shall be installed in the grid system after completion of installation of the suspension of lighting and air conditioning fixtures.

Forming ceiling panels shall be laid out in pattern including border of uniform width around all sides of each ceiling area. The pattern shall be as per shop drawings approved by the Engineer.

All panels shall be furnished and installed in an approved manner and as per approved types, sizes and surface design.

8. FIXTURES

Light fixtures shall be installed as per approved pattern and supported in accordance with manufacturer's recommendations.

9. FINISHING

After installation, dirty, soiled or discoloured surfaces shall be cleaned and left free from defects and ready to receive any painted finish if required.

The panels which are damaged or improperly installed shall be removed and replaced by the Contractor at his cost.

10. MEASUREMENT AND PAYMENT

10.1 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 Bill of Quantities. The cost thereof shall be deemed to have been included in the quoted unit rate of the respective items of the Bill of Quantities.

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

- Approved suspension system including main channels, main tee/cross tee bars, wall moulding and edge trims, hanger strips and accessories hold down clips.

10.2 False Ceiling

10.2.1 Measurement

Measurement of acceptably completed works of respective types of false ceiling will be made on the basis of net actual area in square feet / square meter of false ceiling provided and installed in position as shown on the Drawings or as directed by the Engineer.

10.2.2 Payment

Payment will be made for acceptable measured quantity of respective type of false ceiling on the basis of unit rate per square feet/square meter quoted in the Bill of Quantities and shall constitute full compensation for all the works related to the item.

*** End of Section 6560 ***

SECTION 6600

FLOOR & WALL FINISHES

1. SCOPE

The work under this section of the Specifications consists of furnishing all plant, labour, equipment, appliances, and materials and in performing all operations in any floor and at any height connection with providing and installation of tiles for interior floor, wall finishes and exterior wall cladding complete in strict accordance with this section of the Specifications and the applicable drawings and subject to the terms and conditions of the Contract.

2. APPLICABLE STANDARDS

2.1 ANSI - American National Standards Institute:

A108.1	Installation of Glazed Wall Tiles
A108.4	Ceramic Tiles Installed with Water-Resistant Organic Adhesives
A118.1	Dry-Set Portland Cement Mortar
A118.2	Conductive Dry-Set Portland Cement Mortar
A118.3	Chemical-Resistant, Water Cleanable Tile-Setting and Grouting Epoxy
A118.6	Ceramic Tile Grouts
E136.1	Organic Adhesive for Installation of Ceramic Tiles
A137.1	Standard Specification for Ceramic Tiles

2.2 ASTM - American Society for Testing and Materials:

ASTM C 150	Specification for Portland Cement
ASTM C 206	Specification for Finishing Hydrated Lime
ASTM C 373	Water Absorption, Bulk Density, Apparent Porosity, and Apparent Specific Gravity of Fired Whiteware
ASTM C 648	Breaking Strength of Ceramic Tile
ASTM C 1027	Abrasion Resistance of Glazed Ceramic Tile

2.3 TCA - Tile Council of America:

TCA 137.1	Standard Specification for Ceramic Tile

TCA Handbook for Ceramic Tile Installation

3. SUBMITTALS

3.1 Complete set of samples of manufacturer's standard products for color selection.

3.2 Certification from manufacturer of tile certifying the following:

- Materials provided are suitable for intended use.
- Materials meet or exceed appropriate ANSI Standard .

3.3 Tile manufacturer's complete installation instructions.

3.4 Shop drawing layout showing the tile arrangements.

4. TRANSPORTATION, HANDLING AND STORAGE

Deliver materials in containers with labels legible and intact and grade- seals unbroken. Store material so as to prevent damage or contamination.

5. QUALITY ASSURANCE

5.1 Source Limitations for Tile: Obtain all tiles of same type and color or finish from one source or producer.

5.2 Source Limitations for Setting and Grouting Materials: Obtain ingredients of a uniform quality for each adhesive, and grout component from a single manufacturer.

5.3 Mockups: Build mockups for the approval of the Engineer to verify qualities of materials and execution. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

5.4 Variation in plane of sub-floor, including concrete fills: Not more than 6 mm in 3 meters from required elevation where Portland cement mortar setting bed is used and not more than 3 mm in 3 meters where dry-set Portland cement, and latex-Portland cement mortar setting beds and chemical resistant bond coats are used.

5.5 Variation in plane of wall surfaces and surface of scratch coat: Not more than 6 mm in 2.40 meters from required plane where Portland cement mortar setting bed is used and not more than 3 mm in 2.40 meters where dry-set or latex-Portland cement mortar or organic adhesive setting materials are used.

6. MATERIAL

6.1 PORCELAIN TILES

6.1.1 Fine porcelain stoneware tiles shall be manufactured by using top quality fine porcelain stoneware, obtained by raw materials wet grinding, followed by partial drying by spraying, silo storage to allow homogenization of properties, and pressing by hydraulic pressure exceeding 500 kg/cm^2, and heat treatment in excess of 1200^{0}C.

6.1.2 Porcelain tiles shall be of sizes, pattern and color as shown on drawings. Physical properties of porcelain tiles shall be as follows:

Properties	Applicable Standard	Value
Dimensions and appearance	EN 98	Compliant
Water absorption	EN 99	≤ 0.1%
	ISO PROJECT 10545/3	
Flexural strength	EN 100	≥ 50 N/mm^2
Scratch resistance	EN 101	≥ 6 MOHS
Deep abrasion resistance	EN 102	140 mm^3
Linear thermal expansion coefficient	EN 103	6 x 10^{-6} deg C^{-1}
Resistance to sudden temperature changes	EN 104	Compliant
Resistance to chemical etching by acids and bases	EN 106	Compliant
Color stability to light	DIN 51094	Compliant
Specific weight	DIN 51057	2.52 g/cm^3
Weight of unit of volume	DIN 5165	2.40/cm^3

6.2 MISCELLANEOUS MATERIALS

6.2.1 Adhesive and Grout:

Tile Adhesive: Shall be white cement-based polymer modified ready-mixed powder adhesive conforming to BS 5980:1980, Type 1, Class AA, or equivalent standards. Use 3-6 mm bed thickness mixed with admixture as per manufacturers written recommendations.

6.2.2 Grouting Material: Shall be cement-based polymer modified ready-mixed powder conforming to BS 5750:Part 2 or equivalent standards. Use grout with admixture as per manufacturers written recommendations. Color of grout shall be as approved by Engineer.

6.2.3 Sealants: Elastomeric type, in conformance with the requirements specified.

6.2.4 Gray/ White Cement

Cement shall be ordinary Portland cement conforming to B.S. 12 or PS232.

6.2.5 Sand: All fine sand shall be obtained from sources approved by the Engineer. The grading shall conform to B.S 882 Grading Zone 1 and 2 of which the gradation limits are as follows:

Percentage (by weight) passing

Sieve	Grading Zone 1	Grading Zone 2
3/8" (9.53mm)	100	100
3/16" (4.76mm)	90-100	90-100
No. 7	60- 95	75-100
No. 14	30- 70	55- 90
No. 25	15- 34	35- 59
No. 52	5- 20	8- 30
No. 100	0- 10	0- 10

6.2.6 Coarse Aggregate :

Coarse aggregate shall be crushed or uncrushed gravel or crushed stone, angular or rounded in shape and shall have granular, crystalline or smooth surface free from friable, flaky and laminated pieces, mica and shale. It shall not contain matters injurious to concrete. All coarse aggregate shall conform to BSS NO.882 and shall be graded as follows:

Sieve	% Passing by weight
25.40mm (1")	100
19mm (3/4")	90-100
9mm (3/8")	20- 55
4.67mm (3/16")	0- 10

The aggregate shall be stored on properly constructed paving or as directed by the Engineer.

There shall be a physical partition between the stockpiles of coarse and fine aggregate. If required aggregates shall be washed and screened to the satisfaction of the Engineer. Sieve analysis of all the aggregates to be used in the works and shall be carried out as and when required by the Engineer. All aggregate shall be subject to the approval of the Engineer.

Any aggregates not found to be of the specified/approved standard shall be rejected by the Engineer and all such rejected material shall be removed from site with-out delay.

Floors, sub-base or base constructed with rejected aggregates shall be dismantled and rebuilt at the expense of the Contractor.

6.2.7 Stone Ballast :

Refer Section 1330 "Stone Soling" for material & construction.

6.2.8 Water

Water used for mixing concrete, curing or any other operation of the works specified herein shall be fresh, clean and free from organic or inorganic matters in solutions or in suspension. Only water of the approved quality shall be used for all constructional purposes.

6.3 EXECUTION

6.3.1 CEMENT CONCRETE FLOORING

The materials for P.C.C flooring shall be same as already specified under clause 6, "Materials".

6.3.2 Preparation

The ground surface shall be cleared and grubbed of top soil and all grass, roots and loose material removed in any. Surface shall be dry, levelled and any fill or backfill under the floors done as per section Earth work Sub-Section 6 of these Specifications.

6.3.3 Sub-Base

The floor sub base shall be either stone ballast or lean concrete or R.C.C Slab as shown in the drawings.

6.3.4 Panels

Before laying the cement concrete flooring, the surface of the sub-base shall be divided into panels of required size as shown on the Drawings. Panels shall be made of plate glass, division strips or as specified. The top of the division strips shall conform to the specified level of the finished floor surface.

6.3.5 Floor

Mixing and placing of first bottom layer of 3000psi. Concrete shall be in accordance with **Section 2300-"Plain and Reinforced concrete".** Concrete may be conveyed in any suitable manner from the place of mixing provided there is no segregation or loss of any ingredients and provided it is placed in its final position before initial setting takes place that is within 30 minutes of addition of water to the mix. The concrete will be laid in a manner so as not to cause the aggregate to separate from the mortar and laid in alternate panels, each panel shall not exceed the area as directed by the Engineer. Dividing strips shall be provided unless otherwise specified on the Drawings and BOQ. The floor concrete panels shall have the thickness as shown on the Drawings. The concrete shall be rammed and thoroughly consolidated and finished rough.

6.3.6 Finishing

Immediately after consolidation, the surface, shall be levelled with a wooden trowel. Excessive trowelling in the early stage shall be avoided. The surface shall be tested with a straight edge to detect undulations, which, if found, shall be eliminated. The finer components in the concrete which come to the surface with the stroking shall be quickly but carefully smoothed with the steel trowel. When the concrete has hardened sufficiently, trowelling shall be done with steel trowels. No dry cement or a mixture of dry cement with sand shall be sprinkled on the surface for hardening the surface.

6.3.7 Dado/Skirting

The plaster on the portion of the wall to be provided with skirting or dado shall be left in a rough state by brooming or by using wire brushes of approved type so as to provide a bond between this base plaster and the dado or skirting. The surface of the wall shall be cleaned of all foreign matter and shall be thoroughly wetted to control the suction. Only so much

mix shall be mixed with water that could be utilized within 30 minutes. This mix of cement and coarse sand in the ratio of 1:2 shall be applied to the wall in a thickness as specified and trowelled hard to a smooth surface, proper in line both vertical and horizontal.

6.3.8 Curing

Curing shall be carried out in accordance with the Specifications given under Section - Plain and Reinforced Concrete.

INSTALLATION OF TILE FLOORING

The base in cement concrete and if required the sub-base in lean concrete shall be prepared as provided in Sub-Section 8.1 "Cement Concrete flooring". The thickness of sub-base if any and base shall be as shown in the Drawings, BOQ or directed by the Engineer. The surface of concrete base shall be rough finished. The curing period of base shall be at least 72 hours before laying the tile work.

6.3.9 General

The sub-base and base shall be prepared by laying cement concrete of specified grade and thickness as shown on the drawings, or as specified in the Bill of Quantities.

The Tiles shall be laid to the required levels and grades over a setting bed of ¾" thick cement sand screed comprising of one part cement to three part of sand of volume unless otherwise shown in the Drawings or specified in the BOQ. As large an area of setting bed shall be spread at one time as can be covered with tiles before the mortar has set. Surplus mortar shall be removed. The thickness of setting bed in any space shall not be less than ½" or as shown on the drawings.

Floor and wall surfaces to receive the tiles shall be thoroughly cleaned of all dirt, dust, oil and other objectionable matters. Tiles shall be laid out from the center line of each space in an outward direction and the pattern should be made symmetrical with a minimum number of cut tiles and shall be laid to straight edges. Tiles shall be cut with a suitable cutting tool and rough edges shall be rubbed smooth.

After each piece is laid, it shall be firmly pressed into place so as to embed it and to even the surface before the mortar takes its initial sating.

Joints between the tiles shall be of uniform width and shall be grouted full with a plastic mix of grey or white cement (as directed by the Engineer) immediately after a suitable area of tiles has been set.

6.4 INSTALLATION OF WALL TILES

6.4.2 Tiles on concrete and CMU walls shall be installed with tile adhesive on cured cement plaster. Tiles shall not be soaked prior to installation.

6.4.3 Tiles shall be pressed firmly into freshly notched 3 to 6 mm thick tile adhesive and shall be tapped and beaten to a true surface.

6.4.4 Joint width shall be determined by spacers on tile or by strings or pegs if tile without spacers are used.

6.4.5 Tiles shall be pressed and beaten into place to obtain full coverage by

adhesive on back.

6.4.6 Tiles shall be adjusted before initial set of adhesive takes place.

6.4.7 Grouting Wall Tiles: Grouting shall be in strict accordance with the manufacturer's recommendations and shall be cured as required to produce a hard grout.

6.5 INSTALLATION OF FLOOR TILES

6.5.1 Install tiles with adhesive 3 - 6 mm thick tile adhesive as per manufacturer's written recommendations over Portland cement screed sloped to drains, not less than 20 mm thick and not more than 30 mm thick.

6.5.2 Press tiles firmly into the adhesive to obtain full contact with adhesive with no voids.

6.5.3 Grouting Floor Tiles: Grouting shall be in strict accordance with the manufacturer's recommendations and shall be cured as required to produce a hard grout.

6.6 CLEANING AND PROTECTION

6.6.1 Upon completion of placement and grouting, all ceramic and quarry tiles surfaces shall be cleaned free of foreign matter.

6.6.2 Glazed tiles surfaces shall be sponged and washed thoroughly diagonally across joints and finally polished with clean, dry clothes.

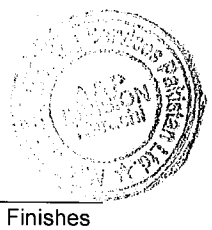
6.6.3 Unglazed tiles may be cleaned with cleaners and/or solvents recommended by tile manufacturer after completion of installation. Protect metal surfaces, cast iron and vitreous plumbing fixtures from effects of cleaning materials. Flush and surface with clean water before and after cleaning.

6.6.4 Finished installation shall be left clean and free of cracked, chipped, broken, un-bonded or otherwise defective tile work.

6.6.5 Apply a protective clear sealer coat(s) for unglazed tiles. Number of coats shall be as recommended by manufacturer. Protect installed tile work with Kraft paper or other heavy covering during the construction period to prevent damage.

6.6.6 Before final inspection, remove protective coverings and rinse neutral cleaner from tile surfaces.

6.6.7 Seal plumbing and electrical penetrations through wall tile with sealants.



8. MEASUREMENT AND PAYMENT

8.1 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 Bill of Quantities. The cost thereof shall be deemed to have been included in the quoted unit rate of the respective item of the Bill of Quantities.

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

8.1.1 Submittals
8.1.2 Transportation, Handling and Storage
8.1.3 Quality Assurance
8.1.4 Adhesive and Grout
8.1.5 Cleaning and protection
8.1.6 Cement sand mortar
8.1.7 Protection and curing

Porcelain tiles (Floor/Dado/skirting)

8.3.1 Measurement

Measurement of acceptably completed works of Porcelain tiles will be made on the basis of actual area in square feet of Porcelain tiles provided and fixed in position as shown on the Drawings and as directed by the Engineer.

8.3.2 Payment

Payment will be made for acceptable measured quantity of Porcelain tiles on the basis of unit rate per square feet quoted in the Bill of Quantities and shall constitute full compensation for all the works related to the item.

*** End of Section 6600 ***

SECTION - 6700
PAINTING

1 SCOPE

The work under 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, Metalworks, wood works, Structural steel, walls, ceilings, pipes ,valves and all such surfaces as shown on the Drawings and/or as directed by the Engineer. The scope of this section of specification is covered with detailed specifications as laid down herein.

2 APPLICABLE STANDARDS

Latest editions of following British Standards are relevant to these specifications wherever applicable.

BSI (British Standards Institution)

245	Specification for mineral solvents (white spirits and related hydrocarbon solvents) for paints and other purposes.
2521	Lead-based priming paint for wood work.
2523	Lead based priming paint for iron and steel.
2569	Sprayed metal coatings.
4800	Paint colours for building purposes.
CP. 231	Painting of building.
CP.3012	Cleaning and preparation of metal surfaces.

3 GENERAL

3.1 Except as otherwise specified, all painting shall be applied in conformity with BS CP 231 "Painting of Building" as applicable to the work.

3.2 The Contractor shall repair at his own expense all damaged or defective areas of shop-painted metal work and structural steelwork. Metal surfaces against which concrete is to be placed will be furnished shop-painted and shall be cleaned prior to being embedded in concrete.

3.3 Except as otherwise specified, all concrete and plastered surfaces are to be painted.

3.4 The Engineer will furnish a schedule of colours for each area and surface. All colours shall be mixed in accordance with the manufacturer's instructions.

3.5 Colours of priming coat (and body coat where specified, shall be lighter than those of finish coat. The Engineer shall have unlimited choice of colours.

3.6 Samples of all colours, and finishes shall be prepared in advance of requirement so as not to delay work and shall be submitted to the Engineer for approval before any work is commenced. Any work done without such approval shall be redone to the Engineer's satisfaction, without additional expense to the Employer. Samples of each type of paint shall be on separate 300 x 300 x 3 mm tempered hard board panels. Manufacturer's colour chart shall be submitted for colour specifications and selection.

4 MATERIALS

4.1 All materials shall be acceptable, proven, first grade products and shall meet or exceed the minimum standards of reputable manufacturers as approved by the Engineer.

4.2 Colours shall be pure, non-fading pigments, mildew-proof sun- proof, finely ground in approved medium. Colours used on- plaster and concrete surfaces shall be lime-proof. All materials shall be subject to the Engineer's approval.

4.3 All synthetic enamel paints and primers for structural steel works, metal work, will be the best available of its type and shall be approved by the Engineer prior to its procurement.

4.4 Unless otherwise specified on Drawings approved quality Durocem/snowcem paint or approved equivalent shall be used for painting the exteriors of the structures or other surfaces and/or as directed by the Engineer.

4.5 The plastic emulsion/weather shield/ vinyl emulsion paint or similar as approved by the Engineer shall be used for interior surfaces.

4.6 Approved quality plasticised Duco Hi Build paint or approved equivalent shall be used for painting the wooden doors or other wood surfaces as shown on the drawings or as directed by the Engineer.

4.7 Fire resistant painting shall be proprietary painting material to be applied in conformity with the recommendations and instructions of the manufacturers.

4.8 Where ever Multi-colour paint coating for interior is specified ZOLA COAT or equivalent as approved by the engineer is to be used. Painting shall be proprietary painting material to be applied in conformity with the recommendations and instructions of the manufacturers.

4.9 Where ever Textured roll on paint for interior is specified, ICI, Dulux or equivalent as approved by the Engineer to be used . Painting shall be proprietary painting material to be applied in conformity with the recommendations and instructions of the manufacturers.

4.10 All material shall be delivered to site in their original unbroken containers or packages and bear the manufacturer's name, label, brand and formula and will be mixed and applied in accordance with manufacturer's recommendations.

4.11 All sprit polish or wax polish shall be first grade of reputable manufacturer as approved by the Engineer.

5 DELIVERY STORAGE AND CONTAINER SIZES

Paints shall be delivered to the site in sealed containers which plainly show the type of paint, colour (formula or specifications number) batch number, quantity, date of manufacture, name of manufacturer and instructions for use. Pigmented paints shall be supplied in containers not larger than 20 liters. All materials shall be stored under cover in a clean storage space which should be accessible at all times to the Engineer. If storage is allowed inside the building, floors shall be kept clean and free from paint spillage.

6 SURFACE PREPARATION

6.1 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 scrapping, chipping, blasting, wire brushing or other effective means as approved by the Engineer.

6.2 In the event the surfaces become otherwise contaminated in the interval between cleaning and painting, recleaning will be done by the Contractor at no additional cost.

6.3 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.

6.4 All the surfaces to be painted with approved quality paint or approved equivalent shall be free from dust, dirt, fungus, lichen, algae etc. Oil paint, varnish and lime wash should always be removed by scraping and washing.

6.5 All surfaces to be painted with Duco paint or approved equivalent shall be free from dust, dirt, oil/grease, etc. Wipe over with a rag soaked in thinner or petrol before painting. The Contractor shall apply sufficient under coat to ensure that no dried film is left on all undercoated areas after flatting. Apply 2-3 coats of Duco Primer surfaces after thinning one part with one part Duco thinner. Dry for 5 to 10 minutes between coats. Leave it to hard dry and petrol wipe before applying Duco Hi-Build.

6.6 No work in this section shall be allowed until all surfaces or conditions have been inspected and approved by the Engineer.

7 APPLICATION

7.1 All paint and coating materials shall be in a thoroughly mixed condition at the time of application. All work shall be done in a workman like 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 metal or of the surrounding air is below 7 degrees centigrade. 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 operation.

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.

Two coats of weather shield paint shall be applied in accordance with the manufacturer's instructions or as directed by the Engineer.

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.

7.2 Where shown on Drawings all exterior finishes shall be painted with Weather Shield paint in approved colours as per manufacturer's specifications. The number of coats shall be as shown on the drawings or as directed by the Engineer.

7.3 All wooden doors shall be painted with approved plasticised Duco Hi-Build paint or approved equivalent as per manufacturer's recommendation and instructions after approval of the Engineer.

7.4 Plastic emulsion paint of the approved make and shade shall be applied to surfaces as shown on Drawings as per manufacturer's instructions. The number of coat shall be as indicated on the Drawings or as directed by the Engineer.

7.5 Where mentioned on Drawings doors and glazed ventilators shall have fire resistant painting of 90 minute rating and shall be applied as per the manufacturer's recommendation and instructions after the Engineer's approval.

7.6 **POLISHING**

Surfaces to be polished shall be rubbed down with suitable sand paper to smooth surface. Filling shall be done with an approved filler and again rubbed so that the surface is smooth free from raised grains, holes, rough spots and gives a silky feeling. It shall then be finished with wax polish or spirit polish of approved manufacturer.

7.6.1 **WAX POLISH:**

The surfaces shall be dusted off and rubbed over with approved mineral oil. After an interval of at least 48 hours wax polish shall be applied in two coats and buffed to the approved finish.

7.6.2 **SPIRIT POLISH:**

Dana Lakh shall be melted in spirit overnight and clean sediment free spirit polish prepared. With a soft cloth or pad, the polish shall be applied to the surface coat after coat until the surface is shiny, smooth, satin finish to the approval of the Engineer

7.7 **WHITE OR COLOUR WASHING**

7.7.1 Fresh white lime slaked at site of work should be mixed with suficient water to make a thin cream. The approximate quantity of water required in making the cream is 5 litre of water to 1 kg of lime. It shall then be screened through a coarse cloth and gum (glue) in the proportion of 1`00 grams of gum to 16 litres (thre chattacks of gum to 6 gallon) of wash shall be added. The surface should be dry and thoroughly cleaned from dust and dirt. The wash shall be applied with 'moonj' or jute brush, vertically and horizontally allternatively, and fine wash kept stirred in the container while using. Two or three coats shall be applied as specified and each coat shall be perfectly dry befoe the succeeding coat is applied over it. After finishing, the surface shall be of uniform colour. The white wash should not splash on the floor and other surfaces. In old surface the surface should be cleaned and repaired with cement mortar where necessary and allowed to dry before white wash is applied. For final coat blue pigment powder should be mixed to the required quantity with the lime water to give a bright white surface.

7.7.2 Colour wash shall be prepared with fresh slaked white lime mixed with water to make thin cream adding the coloured pigment to the required quantity to give the required tint. Gum (glue) in the proportion of 100 gm of gum to 16 litre of wash shall be added. The colour wash may be applied one or two coats as specified. The method of application should be same as for white washing. For new work the priming coat shall be of white wash.

8 FINISHES

The finished coating film shall show uniform coverage throughout and shall be reasonably free from brush marks, runs, sags, or noticeable colour variations. Edges where coating ends, change colour or change thickness shall be clean and straight.

The completed coating shall be compared with sample areas. The completed coating shall be at least as smooth (free from orange peel effect, overspray, embedded or partially embedded particles, craters, pinholes, holes, etc.) as the approved sample areas.

The thickness of the coating shall be checked by the Engineer at random locations by cutting out sections on concrete and plaster surfaces. The cut out sections shall be patched by the Contractor, using the same material and thickness used originally. Porosities shall be marked and patched with the basic primer material, or with a mixture of the basic primer material and finely divided filler, or with a proprietary patching compound compatible with the coating. Any moisture on the surface of the coating shall be allowed to dry thoroughly before patching. In addition, all porosities and imperfections which become evident after applying subsequent coats shall be repaired. This repairing shall be done with the basic coating material or with a proprietary patching compound compatible with the specified coating, except for the top coat, where only basic coating material shall be used. The completed coating shall be free of porosity visible to the naked eye.

9 JOB CONDITIONS

9.1 Observe manufacturer's recommended minimum and maximum temperature but do not apply paint or finish to any surface unless ambient temperature is 10 degree C or above and less than 43 degree C. No painting shall be done above 90% relative humidity.

9.2 Place drop cloths to adequately protect all finished work.

9.3 Remove and replace all items of finish hardware, device plates, accessories, lighting fixtures or other removable items.

9.4 In no case shall any finish hardware or other finished item that is already fitted into place be painted, unless otherwise specified.

10 QUALITY ASSURANCE

All paint for any one surface shall be top quality, of one manufacturer and approved by the Engineer. Deep tone accent colours shall be used and the unavailability of final coat colours may be the basis for rejecting materials for any one surface.

11 SCHEDULE OF MEASUREMENT OF PAINT AREA :

11.1 Irrespective of prime coats and number of paint coats applied to exposed painting surface area of column, walls, projections; ceilings and other surfaces (Except gates, doors windows and ventilators the cost therof shall be deemed to have been included in quoted unit rate of the respective items of Bill of Quantities) shall be measured as per actual paint surface area for single time only and paid in accordance with quoted rate of Bill of Quantities

12 MEASUREMENT AND PAYMENT

12.1 General

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

- Preparatory works, including preparatory materials, scraping, scratching, sand blasting, cleaning, priming, protection of finished works etc.

12.2 PAINTING

12.2.1 Measurement

Measurement of acceptably completed respective type of painting works will be made on the basis of net actual areas in square feet of the surface painted as shown on the Drawings or as directed by the Engineer.

12.2.2 Payment

Payment will be made for acceptable measured quantity of respective type of painting on the basis of unit rate per square feet quoted in the Bill of Quantities and shall constitute full compensation for all the works related to the item.

*** End of Section 6700 ***

PLUMBING WORKS

ESTABLISHMENT OF SINDH FORENSIC SCIENCE LABORATORY, KARACHI

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SPECIFICATIONS FOR PLUMBING WORKS

GENERAL

This section involves Specifications of materials, supply, delivery on site, installation, testing and commissioning of the hot and cold water for plumbing and sanitary drainage piping services proposed for the project.

OBJECTIVES

The specifications have been prepared for guidance of the contractor. The contractor shall guarantee the capacity and performance of the equipment will be as specified and the quality of the installation and workmanship will be in accordance with the specifications. The contractor shall be solely responsible for the supply and installation of a complete system and shall guarantee the performance to meet the design intent.

I. PLUMBING WORKS FOR WATER SUPPLY SYSTEM SHALL INCLUDE BUT NOT LIMITED TO THE FOLLOWING:

a) Hot and Cold water system

b) Water Storage tanks, pipe work, fittings and accessories

c) All external services of water supply system

d) Installation of all fittings and fixtures i-e water closets, showers, wash basins and sinks

e) Acoustic treatment and vibration control

f) Painting and labeling of pipe work and equipment

g) Provision of all hold down bolts, spigots and struts required to be built in during construction

h) Testing and commissioning

II. PLUMBING WORKS FOR SEWERAGE AND STORM WATER DRAINAGE SYSTEMS SHALL INCLUDE THE FOLLOWING:

a) Internal and underground sanitary drainage system

b) All external services such as sewerage network

c) Installation of all sanitary wares and fittings including flush tanks, water closets,

d) urinal and bath tubs

e) Acoustic treatment and vibration control

f) Painting and labeling of pipe work and equipment

g) Provision of all hold down bolts, spigots and struts required to be built in during construction

h) Testing and commissioning

1 PLUMBING WORKS FOR WATER SUPPLY SYSTEM

1.1. SYSTEM DESCRIPTION

A fully functional system including external loop for building connections, overhead water tanks piping, fittings, valves and other accessories shall be provided.

System shall be provided for the whole block, complete with pumps (integrated with IBMS), tanks, pipe works, controls, conduits, wiring etc. in full compliance with all relevant specifications and requirements.

This shall consist of but not limited to the following:

(a) Cold water supply system

i. Connection from water main loop running near the building, this shall deem to include all necessary valves and fittings. The water tanks shall be complete with the following items;

- High and low level alarms
- Water level indicator
- Vent pipe, overflow, drain off, access manhole, all required valve, etc.

ii. Complete hot and cold water pipe work with taps and relevant sanitary fixtures and fittings at toilets/ kitchens etc. as indicated in the drawings.

iii. Water supply piping from overhead tank to all floors including all accessories as a part of gravity feed system.

1.2. COLD AND HOT WATER PIPES & FITTINGS

- Polyethylene pipes for supply to underground and overhead tanks complying ISO 4427-2(E):2007& DIN 8074/8075.
- Providing, fixing, jointing and testing Polypropylene Random (PPR) pipes of approved make pressure pipe for cold and hot water as per DIN 8077-8078,PN-20 for pipes and DIN 16962,PN-25 for fittings (polyfusion welded joints) inside building including fittings and specials (sockets, tees, elbows, bends, crosses, reducers, adaptor, plugs and union etc.) supported on walls or suspended from roof slab or run in chases including pipe hangers, supports, cutting and making good the chases and holes, complete in all respects.

1.3. INSTALLATION OF SANITARY APPLIANCES

1.3.1 Bath Tub

The bath tub shall be bound to the earthen system of the building. A separate floor waste shall be installed below the bath tub. Access opening shall be provided to reach the underside of bath for maintenance.

1.3.2 Shower Mixer

Where shower mixer is of concealed type, pipe union shall be provided to allow for connection to shower hose.

1.3.3 Plumbing Fittings and Accessories

The contractor shall supply and fix all plumbing fittings such as water faucets, shower fittings, mixing valves, etc, in accordance with manufacturer's instructions and connect to piping system. The contractor shall supply all fixing materials such as screws, rawal plugs, union, collars, compression fittings, etc. as required.

1.3.4 Water Service Connection

The Licensed Plumber shall apply and make all necessary arrangements/inspections with the Local Authorities for the water connection.

1.3.5 Piping Materials

All piping materials shall be of type/brands stated in the list of approved fittings and pipes for water service installation.

1.3.6 Piping Joints

Pipe joints for the various pipes shall be as follows.

PPR-C Piping	Heat Fusion Welding as per manufacturer's recommendations.

1.3.7 Testing of Mains

All cold and hot water supply pipe work shall be subjected to a hydrostatic pressure test of 12 bar or 1-1/2 items the maximum working pressure, whichever is higher. The test period shall be two (2) hours during which no leakage is allowed.

1.3.8 Sterilization of Main

After the pipe work has been tested and approved, it shall be sterilized with a solution of chloride of lime before it is coupled.

1.3.9 Valves

All valves shall be suitable for the working pressure involved but not less than one (1) MPa.

i. Isolation Valves (Gate Valve)

Up to 50mm: Bronze gate conforming to BS 5154 series 'B', non-rising stem, solid wedge disc, inside screw, union bonnet; female threaded (BS 21) connection; fitted with enameled metal and hand wheel valves for working pressure above 16 bars shall be conforming to BS 5154 PN 32 series B.

65mm and above : Cast iron body conforming to BS 5150, bolted bonnet; solid wedge disc and bronze trim; inside screw, non-rising stem, flange connection (PN 16), fitted with cast iron and hand wheel valves for working pressure above 16 bars to PN 25 shall be of Class 300 cast steel wedge gate valve with flanges.

ii. Check Valve

Check valve shall comply with the requirements of BSS 5153: 1974 or equivalent. The valve shall be of swing type and shall be of quick acting single door type.

(Swing check valve conforming to BS 5154 series 'B' bronze with removable hinge pin and screwed cap, suitable for operation in either horizontal or vertical position. Threaded (BS-21) connection for 50mm and smaller. Flanged (PN 16) connection for valves above 50mm. for valves above 16 bar working pressure. It shall be of class 300 cast carbon steel swing check valve with PN 25 flanges)

iii. Ball (Float) Valves

Equilibrium type conforming to BS 1212:Part 1. foam plastic ball float with stainless steel rod and double lock nuts or copper ball float complete with brass rod. The valve shall be made of cast iron or bronze body and suitable for minimum working pressure of PN 16. Screwed joints shall be provided for up to 65mm diameter and flanged joints for 80mm diameter and above. Locking device to be provided, so that the valve can only be opened when the water level drop to a pre-determined level.

iv. Pressure Relief Valves

Each pressure relief valve shall be of the fully enclosed type and fitted with hand easing gear.

Each pressure relief valve in a pressure reducing station shall give a flow capacity equal to that of the pressure reducing valve.

Pressure relief valves in locations other than reducing station shall have a flow capacity equal to that of the pressure reducing valve.

Pressure relief valves in locations other than reducing stations shall have flow capacities equal to that of the associated equipment.

v. Strainers

Strainers shall be installed on all system and equipment susceptible to damage from dirt, grit or foreign matter including, but not limited to pumps, control valves and where required.

Strainer shall be Y –pattern bucket type, not less than full line size. Unit shall be constructed of cast iron or copper alloy body with perforated stainless steel screen. The total perforation area shall not be less than twice the cross sectional area of the pump suction pipe. Strainer with working pressure above 16 bars shall be of cast steel type.

Size up to 50mm, screwed connection shall be used or flanged joints (PN 16) shall be used. For 65mm and above, flanged joints shall be used up to PN 25. For valves with working pressure above 16 bars, drain cocks shall be provided.

a) Size 15 – 50mm

Y –type strainers with screwed cover, 18/8 stainless steel screen, 26 swg with 0.8mm perforation. Ends screwed BS 21 taper thread.

Service Rating: 10°C to 100°C

10.5 bar 186°C at steam.

b) Size 65 – 150mm

Y –type single basket strainer. 20 mesh stainless steel screen, cover. Size 200mm and above

Bucker type strainers, 40 mesh stainless steel screen, bolted cover.

1.3.10 Schedule of Valves

The contractor shall supply and install all valves to all fixtures as specified below

a) WC Pan

25mm ball valve with suitable 25mm union piece for connection to flush valve or 12mm union piece for connection to cistern.

b) Basin/sink

Ball valve of size to suit distribution pipe for multi-basin arrangement and 12mm ball valve for single-basin arrangement.

c) Kitchen

Ball valve of size to suit each branch pipe.

1.3.11 Tap

a) All taps for the garden, plants and in each plant rooms shall be of the brass type.

b) Using otherwise mentioned all taps for sinks in kitchen, utilities rooms shall be of chrome plated type.

1.3.12 Pressure Gauges

The maximum scale value of the gauge shall be about 150% of the anticipated maximum operating pressure. It shall be graduated both in imperial units (psi) and metric units (Kpa).

Provisions shall be provided to enable each pressure gauge to be easily removed without interruption to the installation.

1.3.13 Connector (Pipe Line Vibration Eliminator)

Flexible connectors shall be provided to prevent vibration from all rotating equipment. Flexible connectors shall be located as close to the rotating equipment as practical.

1.3.14 Water Level Controllers

Water level controllers shall be provided and fitted in all water tanks for monitoring the water levels in the water tanks and give the appropriate control/warning signals for the system. Water level controllers shall be of the floatless type using water-proof sensing electrodes with controller containing the switching circuits and control relays, suitable for conductive liquids like water and dilute acidic fluid. It shall be used to automatically operate sequential pump sets and give low and high level alarms. However, provisions shall also be provided for manual override to enable manual operation of pump sets.

Sensing electrodes and the controller shall be suitable for operation temperature of up to 55°C.

2 PIPE WORK AND FITTINGS

The word 'pipe work' or 'piping' shall mean all pipes, drains, tubes, pipe fittings, valves including hangers, brackets, anchors, expansion devices, sleeves, and all accessories connected thereto for the complete piping installation.

Pipelines accessories such as gauges, meters, control devices, etc, shall have the same working pressure rating as the associated pipe work.

All pipes and fittings supplied shall conform to relevant codes as specified in these specifications.

2.1 PIPE SUPPORTS

Pipe hangers shall be provided at the following maximum spacing and/or as per manufacture's recommendations.

Pipe Dia	Hanger Rod Dia	PPR-C Max Spacing	uPVC Pipe (Type-B) Max Spacing
mm	Mm	m	m
20	6	0.70	0.8
25	6	0.80	0.85
32	10	0.90	0.90
40	10	1.05	1.07
50	10	1.15	1.25
63	12	1.30	1.40

Horizontal pipe work shall be supported by adjustable flat iron of clevis type hangers hung by hot rolled steel rods of the following diameters and spacing, and as per recommendations of pipe manufactures.

NORMAL PIPE (mm)	**DISTANGE BETWEEN SUPPORTS** (m)	**DIAMETER OF ROD** (mm)
25	1.8	10
32	2.4	10
40	2.7	10
50	2.7	10
63	3.0	12
110	3.0	16
160	3.6	18

2.2 PIPE SLEEVES

Pipe sleeves shall be provided and installed by the Contractor for casting in where pipes penetrate the concrete structure.

The minimum clearance between the pipe and pipe sleeve shall not be less than 25mm.

Sleeves through fire rated partitions or walls or floors shall be of galvanized wrought iron pipe. The annular space of pipe sleeves shall be tightly packed with approved fire-rated material.

Where sleeves occur in finished spaces, solid close fitted chrome plated steel plates secured by screws shall be provided.

2.3 PIPE WORK INSTALLATION

All pipe work shall be installed to meet structural, architectural, and functional conditions and shall not interfere with the work of other trades.

All pipe work shall be installed and supported so that it is free from excessive stresses due to weight from its contents plus its own dead weight, dynamic forces due to liquid movement, and expansion and contraction due to change in temperature.

Pipe work connected to the pumps shall be separately supported so as not to impose any load on the pump casings.

3 SANITARY AND WASTE WATER DRAINAGE SYSTEMS

The sanitary and waste water drainage systems shall be as follows.

3.1 SOIL AND WASTE PIPES

- Unplasticised polyvinyl chloride (uPVC) pipes conforming to ISO 3633 & EN-1329.

FITTINGS
There are two types of fittings available as per ISO 3633:

- uPVC fittings with Solvent Cement (SC) socket joint conforming to ISO 3633 & EN-1329.
- uPVC fittings with rubber ring socket joint conforming to ISO 3633 & EN-1329.

3.2 RUBBER RINGS

The rubber rings may either be Synthetic or natural conforming to PS 1915& ISO 4633 (E).UPVC pipes shall be used for domestic installation inside the buildings for soil and waste discharge, ventilation and drainage of rain water.

The material shall consist substantially of poly-vinyl chloride (PVC) to which may be added only those additives that are needed to facilitate the manufacture of pipes and fittings having good mechanical strength and opacity.

The pipes and fittings shall be tested mechanically and physically in accordance with the relevant Standards as and when directed by the Engineer, before and during installation.

3.3 SCHEDULE OF MATERIALS AND EQUIPMENT

The following schedule consists of the relevant materials and equipment necessary for the completion of all sanitary and plumbing works.

3.3.1 Soil and Waste Pipes

UnplasticisedPolyvinyle Chloride (uPVC) pipe will be used for soil and waste pipes.

3.3.2 Storm Water Drainage Pipes

UnplasticisedPolyvinyle Chloride (uPVC) pipe will be used for rain water drainage system.

National Engineering Services Pakistan (Pvt.) Ltd. A&E DIVISION Karachi

3.3.3 Floor Traps, Gully Traps, Concrete Sump, Inspection Chamber Covers

Every waste sanitary appliance shall be provided with a waste filling trap for connection to the waste pipe. The waste pipe shall connect to the floor trap above the water seal of the trap.

Where a group of 3 or more wash basins are connected in series, loop venting is required. However, the loop venting shall be terminated separately to the atmosphere. The minimum diameter of loop venting pipe shall be 25mm.

Criteria for Minimum Internal Diameter of Waste Pipe for each type of Sanitary Appliance

Type of Appliance	Minimum Internal Diameter of Waste Pipe
	mm
Wash Basin	32
Sink (Single or double bowl)	40
Laboratory sink	40
Long bath/Shower Tray	40
Foot Bath	40
Wash Tub	50
Wash Trough/Custom-Made Sink	50
Drinking Fountain	50

Minimum number of waste sanitary appliance allowed on each diameter of common waste pipe for waste sanitary appliances connected in series

Type of waste sanitary appliances connected in series	Maximum number of waste sanitary appliances allowed on common waste pipes
Wash basin	3
Sink (Single or double bowl)	2
Laboratory Sink	2
Drinking Fountain	12
Wash Trough/Custom-Made Sink	2
Wash Tub	2

i. Floor Traps

Floor trap shall be of uPVC or of other anti-corrosive material, compatible with the material of pipe. They shall have minimum water seal of 40 mm and shall be provided with removable metal strainers. The traps shall be of self-clearing type. The open area of the strainer shall be greater than the cross section area of the drain line to which it connects. Floor traps shall be well set in position so that there is no leakage at the joint between trap and the floor.

ii. Cleanouts

Cleanout shall be of the same nominal size as that of the pipe on which it is installed. Cast Iron Cleanout shall consist of tapped heavy duty cast iron ferrule caulked into cast iron fitting and heavy duty brass tapered even plug. UPVC cleanout shall consist of either two 45° bends or one long radius bend both with an removable end cap and other necessary fittings/material for complete installation in floor Cleanouts shall be turned up through floors by long sweep fittings, wherever the space so permits. Top finish of cleanout shall be flush with the floor by means of finished metal plate secured in position and screwed firmly to the plug. Cleanout shall be so installed that there is a clearance of at least 300 mm for pipes less than 75 mm diameter and at least 457 mm for pipes of 75 mm and larger diameter, for the purpose of roding.

iii. Roof Drains

Roof drains shall be of bitumen coated cast iron/ brass or uPVC or of other anti-corrosive material, compatible with the material of pipe. They shall have strainers extending at least 15 mm above the roof surface immediately adjacent to them, when installed on flat part. Bottom of strainer shall be flush with the roof surface, when installed on vertical part. Strainer shall have an available inlet area, above roof level, of not less than 1-1/2 times the area of the down-pipe to which the drain is connected.

The connection between roof and roof drain shall be made watertight by the use of proper flashing material.

Minimum size of the rain water pipe will be 3 inch for roof area upto 548 Sft. For larger roof area, number of roof drainage pipes and sizes may be more.

iv. Gully Trap

Gully trap shall be of upvc with specified size outlet. The inlet shall be provided with upvc grating. The open area of the grating shall be at least 1-1/2 times the area of the outlet. The trap shall be of P-Type with a minimum water seal of 50 mm.

Electric Water Heaters

Water heater shall be of automatic storage type electrically operated or solar type, including all necessary fittings for complete installation & operation. The heater shall be of best quality, as approved by the Engineer.

Storage capacity of water heater shall be capable to meet the peak demand. Minimum heating capacity of the water heater shall be 12 liter/minute.

Heater shall be provided with following accessories.

- Thermostatic control
- Temperature & pressure relief valve High limit Control.

3.3.4 Pipe Joints

i. Jointing materials

For unplasticized PVC pipes, all joints shall be solvent weld/push fit joints made in accordance with manufacturer's recommendations and to the approval of the Engineer. Joints shall be made with proper pipe fittings and heating of pipes for jointing will not be permitted.

Joints between unplasticized PVC pipes shall be made with an approved jointing ring.

ii. Weld joints on upvc pipe works

Unplasticized PVC pipe work shall be solvent or push fit ring jointed as recommended by the manufacturers or as detailed elsewhere in this Specification.

Where solvent welding is used, particular attention must be paid to prepare an abrasive paper and spirit cleaner must be used. When applying solvent, heat shall be avoided in order to prevent the cement drying before the chemical bond between the two surfaces is completed. Mating surfaces shall be turned for even spread of the solvent. Excessive cement shall be wiped off quickly.

3.4 UNDERGROUND DRAINING SYSTEM

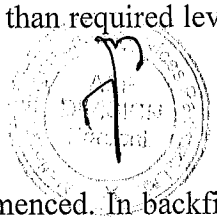
The work includes design, supply and installation of whole of the entire underground sanitary drainage system including inspection chamber, concrete sumps, gully traps, grease interceptors, drain lines, all frames and covers. Excavation, concreting, backfilling, reinstatement of existing ground surfaces, and connections to the last manhole including all internal components of inspection chambers and sumps are included.

3.5 INSTALLATION

3.5.1 Excavation

All excavation shall be carried out as necessary for the construction of the works. Excavation for pipe trenches shall not be less than 600mm wider than the diameter of the pipes and the ground near beds shall be carefully graded.

All excavation shall be kept free from water at all times by pumping or temporary drainage. In the event of the excavations being made deeper than required level, it shall be filled to the proper level with lean concrete.



3.5.2 Backfilling

All concrete shall be thoroughly set before refilling is commenced. In backfilling of the excavation, only selected hard dry material free from lumps exceeding

75mm in size and from stones shall be used in the initial refilling and shall be carefully placed next to the permanent work and well packed and well rammed in layers of 150mm. The remainder of the excavations shall be filled in with the excavated material, in layers of not more than 300mm deep. Each layer shall be thoroughly rammed before the next layer is placed. Surplus soil shall be piled on top of the filling to the extent of possible subsidence. All refilled trenches shall be maintained to the satisfaction of the Engineer.

3.5.3 Pipeline Setting Out

Excavation for trenches shall be to straight lines and gradients required for the pipes and beds as specified. The trench bottom shall be of sufficient width to allow adequate working space for pipe laying and jointing but beyond these requirements, the width must be kept to a minimum.

3.5.4 Concreting Works

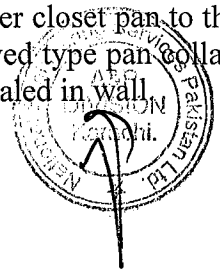
All Concreting works shall comply with specification of concrete given for Structural works.

All drain lines passing under buildings and driveways are to be surrounded with concrete which shall be carried up from the bed in a square section with a minimum of 150mm thickness over the barrel of the pipes. Traps and gullies shall be properly bedded on and shall be surrounded with concrete.

3.5.5 Installation of Sanitary Appliances

a) Water Closet

Joints between unplasticized PVC pipes and fixtures shall be made with approved rubber seal ring joints. The water closets shall be firmly bedded in cement mortar. Every pedestal water closet pan shall be secured to the floor/wall using stainless steel or non-ferrous screws. The joining of the outlet of the water closet pan to the branch drain-line or discharge pipe shall be made by an approved type pan collar. The flushing cistern for Water closets shall be coupled or concealed in wall.



b) Flushing Cisterns

Flushing cisterns for Indian/Asian water closet shall be firmly fixed to the wall or concealed in wall by means of either bolts and nuts or brackets. The flush pipe connecting a flushing cistern to a water closet shall be fixed as straight as possible and shall not be less than 32mm in diameter if the bottom of the cistern is fixed 1.5m or more above the top of the water closet. The flush pipe shall not be less than 38mm in diameter if the bottom of the cistern is fixed less than 1.5m above

the top of the water closet. Flush pipes from the cistern to a squat pan shall be securely fixed to the wall. The Contractor shall apply a 12mm chromium plated stopcock for each flushing cistern.

c) Waste Sanitary Appliances

Every waste sanitary appliance which is suspended shall be fixed to the wall by means of brackets which are built or screwed into the wall. Every floor mounted waste sanitary appliance shall be provided with pedestal, foot and leg. Any sink and wash basin may be mounted on a cabinet or mounted on wall. All fixing screws shall be corrosion resistant. All joints between any waste sanitary appliance and the abutting wall shall be water-tight.

d) Plumbing Fittings and Accessories

The contractor shall supply and fix all plumbing fittings such as water faucets, shower fittings, mixing valves, etc, in accordance with manufacturer's instructions and connect to piping system. The contractor shall supply all fixing materials such as screws, rawl plugs, union, collars, compression fittings, etc. as required.

3.6 MATERIALS AND MANUFACTURERS

3.6.1 WATER SUPPLY SYSTEM

i. COLD AND HOT WATER PIPES & FITTINGS

Material

- Polyethylene (P.E) pipes for supply to underground and overhead tanks.
- Polypropylene Random Copolymer (PPRC) for water supply to toilets/kitchens.

Manufacturers

- Dadex
- Tetra Plast
- Beta Pipes
- MAF Pipes

ii. VALVES

Valves up to 50mm diameter shall have bronze bodies and trim with screwed connections. Valves greater than 50mm diameter and above shall have cast iron or cast steel bodies, bronze trim with flanged connections.

Manufacturer:

- Kitz Valves
- SCON Valves
- Niko Valves
- KSB Pumps Company Limited

iii. PUMPS AND VALVES

- Bronze bodies and trim, screwed connection up to 50mm dia.
- Cast iron or cast steel bodies, bronze trim, flanged connections for greater than 50mm dia.
- Non-slam type check valves at discharge side of water supply pumps.
- Centrifugal pump sets for water supply from underground to overhead tank.

iv. Manufacturer of Pumps:

- KSB Pumps Company Limited
- Grundfos (HMA) Pumps

3.6.2 SEWERAGE SYSTEM

i. SOIL AND WASTE PIPES & FITTINGS

Material

- UnplasticizedPolyvinyle chloride (uPVC) soil and waste pipes.

Manufacturers

- Dadex
- Tetra Plast
- Beta Pipes
- MAF Pipes

ii. FLOOR TRAPS, CLEANOUTS, ROOF DRAINS GULLY TRAPS AND ELECTRIC WATER HEATER/GEYSERS

a. Floor Traps

Material

Floor trap shall be of uPVC or of other anti-corrosive material, compatible with the material of pipe.

b. Cleanouts

Material

Cleanout shall be of the same nominal size as that of the pipe on which it is installed. uPVC cleanout shall consist of either two 45° bends or one long radius bend both with a removable end cap and other necessary fittings/material

c. Roof Drains

Material

Roof drains shall be of bitumen coated cast iron/ brass or uPVC or of other anti-corrosive material, compatible with the material of pipe.

d. Gully Trap

Material

Gully trap shall be of upvc with specified size outlet. The inlet shall be provided with stainless steel grating.

Manufacturers

- Dadex
- Tetra Plast
- Beta Pipes
- MAF Pipes

e. Electric Water Heater/Geysers:

Material

Inner tank shall be extra heavy gauge anti-rust G.I. sheet metal to hold maximum inside water pressure. As insulation, imported genuine glass wool shall be used to maintain the desired temperature that controls the liting up of the burner. The outer body shall be made of requisite gauge M.S. sheet shaped into reinforced circumference. Flow and delivery pipes shall be of high quality G.I. pipes fabricated with heavy gauge anti-rust baffle plate. Special anti-rust-baked primer-heavy coated stoved enamel paint with high gloss automotive shine shall be used on sheet metal.

Manufacturers

- Asia Geysers
- Canon Geysers
- Embassador

Supply, Installation, Testing and Commissioning of Firefighting Works for Sindh Forensic Science Laboratory Karachi

TECHNICAL SPECIFICATIONS

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SPECIAL PROVISIONS

SECTION- 5150

SPECIAL PROVISIONS

1.1 GENERAL

This specification is intended to set out general outline and the minimum requirements and standards of installation for the various units of equipment and works it covers.

This Specification shall be read in conjunction with the Bidding Drawings (as per Schedule of Drawings) and are intended to be mutually explanatory and complementary to one another. All works and specification called for by one, i.e. Specification or Drawings even if not by the other shall be fully executed and complied.

Whenever international standards are specified, the Contractor may use the better local standard subject to Engineer's approval. In the event that different standards are specified, the most applicable standard shall apply.

The contractor shall carry out detailed design and localize to suit requirements of the local Competent Authority. The contractor shall engage approved professional engineer to endorse the design and make submission to Competent Authorities for approval.

All necessary works to comply with requirements of the local Competent Authority are deemed to be included in the tender sum.

The Contractor shall be deemed to have inspected and examined the site and its surroundings and acquainted himself as to the nature of the existing works, buildings and the site, the extent and nature of works and materials or equipment required for the necessary completion of the Contract works, the means of communication and access to the site and in general obtain for himself all Bid. No claim whatsoever made by the Contractor on the grounds of want of knowledge of any of the aforesaid will be entertained.

1.2 Scope of Work

The works to be performed consists of design, supply, delivery, installation, painting, testing, commissioning, Maintenance and Warranty of the following entire fire protection system and equipment comprising:

a) Sprinkler System

b) Internal fire hose reel system

c) External Fire Hydrant/Pillar Hydrant system

d) The entire Electrical power supply and control system to the whole fire protection system equipment including Distribution Boards, Sub-

National Engineering Services Pakistan (Pvt) Ltd. Division Karachi.

distribution Boards, isolators, power .points, control panels, wiring, conduits, turnings and other necessary accessories. The Contractor's approved electrical professional engineer shall endorse on certificate of supervision, electrical single-lines (shop drawings and as-built drawings), testing and commissioning of the electrical related works.

e) The construction of flat 4" to 6" thick Grade 30 concrete plinths to all floor-mounted equipment (pumps, electrical supply distribution boards and control panels, etc) and concrete stumps for all piping, etc running on roof/floor.

f) Hoisting of equipment, coring/forming of openings, pipe sleeve, sealing of all openings including existing openings already provided, and fire stops, etc necessary for the successful completion of the Contract.

g) All other works necessary for the successful completion of the Contract for the full functioning of the Fire Protection systems.

h) Monthly maintenance and servicing including labor and parts replacement for the twelve (12) months defects liability period.

i) Making good all works disturbed to match existing and cleaning up on completion including patching of openings, painting, etc. to the satisfaction of the Engineer.

1.3 Minimum Qualification Requirement Of Main Contractor/Firefighting Sub Contractor

i. Registered with Pakistan Engineering Council in relevant category.

ii. Minimum experience as Contractor in the execution of at least five (05) projects of similar nature and complexity within last ten years; this experience should include supply, installation, testing and commissioning and operation & maintenance of firefighting system.

iii. Minimum experience as Contractor in execution of at least three (03) multi storey's/ hospitals/ apartments building Firefighting system of same type and capacity.

1.4 Statutory Regulations and Bye-Laws

The works and all plants, equipment materials forming part of this contract shall comply in all respect with any relevant Local Statution Regulation, Bye-Laws and other Regulation currently in force.

The contractor shall obtain and complete all notices required by the above Authorities as necessary and shall obtain all consents necessary for the various works to be executed and shall' pay all fees in connections herewith.

All codes, acts, standards and regulations shall be the latest published edition unless otherwise stated. In addition, current Rules and Requirements of the following bodies as applicable shall be complied with:

a) Building Code of Pakistan-Fire Safety Provisions 2016

b) Installation of Sprinkler Systems (NFPA 13)

c) Installation of stationary pumps for fire protection (NFPA 20)

d) Fire Hydrant installations Part 1: System design, installation and commissioning (AS 2419.1)

e) Inspection, testing and maintenance of standpipe, Private Hydrant and hose systems (NFPA14)

f) Installation of Private Fire Service Mains and Their Appurtenances (NFPA 24)

g) Fixed firefighting systems - Hose systems Part 1 : Hose reels with semi-grid hose (BS EN 671-1)

h) Code of practice for fire extinguishing installations and equipment on premises Part 1: Hydrant systems, hose reels and foam inlets Part 2: Specification for sprinkler system (BS 5306)

i) Standard for Clean Agent Fire Extinguishing Systems (NFPA 2001 :2000)

j) Electrical Installation as per local authority requirements.

k) All other Authorities having jurisdiction over the installation of equipment and carrying out this contract works in the locality.

The work shall also be carried out strictly in accordance with the current editions of all applicable British Standards or other National Standard acceptable to the Engineer. All electrical installations and materials supplied shall comply with IEEE and Local Codes and to be approved by the Local Electricity Department or Authority.

Where discrepancy arises, the most stringent Standard shall take precedence on all matters relating to the works.

The Contractor shall bear the cost for all necessary arrangement to obtain approval for fittings, valves expansion joints, equipment and materials from the relevant authority, if required.

1.5 Noise Level, Sound and Vibration Control

All installed plants are to be reasonably quiet in operation. Preference will be given to equipment operating at low noise level.

Vibration isolators shall be installed where necessary so as to eliminate the transmission of vibration.

During initial testing operation of the installation, the Contractor is to correct for any undue noise and to make any adjustment and modifications necessary for this purpose.

Unless otherwise specified, the noise/sound level in the various areas due to operation of equipment shall not exceed the recommended standard by local Authority or ASHRAE whichever is the lowest.

Special care is to be exercised in the manufacture of equipment and installation of pipe work and outlets to keep air borne noise down to a practical minimum.

1.6 Permits and Fees

The Contractor shall procure all permits and pay all fees and charges incurred in connection with this Contract.

1.7 Shop Drawings

The Contractor shall prepare and submit to the Engineer for approval all plant and equipment layout drawings showing full details within fourteen (14) days upon award of the Contract. Detailed calculations shall be submitted where applicable. All equipment and materials proposed shall be submitted for approval.

Shop drawings shall cover complete details for the following but not limited to.

a) Operating load of all items of plant, equipment and accessories.

b) Dimensions of all plant,-equipment and accessories.

c) Equipment room layout, showing all clearances for operating and servicing, etc.

d) Control equipment and system, wiring and control diagrams and power requirements.

e) Vibration Isolation Equipment.

f) Hangers and supports

g) Foundations

h) Chases, drains with channels, openings in walls, floors, roof slab and beams.

i) Piping and electrical cable runs.

j) All other items as is reasonably required by the Engineer.

Three (03) copies of each drawing shall be submitted for approval. Drawings with inadequate details and not conforming to the requirements as stated above will not be considered.

Upon approval of the drawings, the Contractor shall deliver three (3) copies of each approved drawing to the Engineer for the purpose of Contract administration.

The drawings shall be submitted in ample time for review and approval by the Engineer and no work shall be carried out until such drawings are approved, The Contractor shall allow a period of not less than three (3) weeks for the Engineer to study the drawings for approval.

It is the obligation of the Contractor to ensure that his drawings conform to the requirements of the Specification and that they are approved by the Engineer early.

Review of shop and working drawings is not to be considered as a guarantee of measurements or building conditions. Where drawings are reviewed and approved by the Engineer, such approval does not in any way relieve the Contractor neither from his responsibility nor from the necessity of furnishing material or performing work required by the Drawings and Specification which shall in the event of a dispute, take precedence over shop drawings.

1.8 As-Installed Drawings and Manuals

Prior to the completion of the works, and not later than the date of Practical Completion, the Contractor shall submit to the satisfaction of. the Engineer six (6) hard cover bound sets of Comprehensive Operation and Maintenance Manuals and Data Sheets published by the equipment manufacturers, six (6) hard cover bound sets of "As-Installed" drawings and two (2) sets of "As-Installed" drawings (in AutoCAD -latest release) in CD-Rom subject to Engineer's approval.

These instruction manuals shall be typed in good quality paper and neatly bound into a manual having rigid covers. A draft shall be approved before final submission.

The operation manual and As-Built drawings shall be bound with hard covers.

All "As-Installed" electrical single line drawings and control diagram shall be endorsed and signed by the Contractor's Approved Mechanical Engineer.

The manuals shall contain and be set out as follows:

a) Description of System servicing, etc.

This section shall simply but clearly describe the operation of the system

and the equipment.

b) Summary of Equipment List

This section shall include all major equipment complete with makes, models, serial number with technical catalogues (at least one set to be original and others in legible print).

c) Spare Parts, Special Tools and Equipment List

Include manufacturer's list of all recommended spare parts for replacement and special tools and equipment for maintenance used.

d) Operational Procedure

This section shall fully described start and stop sequence of operation; programmed for alternate planning of plant to even out wear and testing procedures for all section of the plant including emergency procedures and breakdown trouble shooting.

e) Manufacturer's Handbook

Include Manufacturer's technical literature on all components of the installation, particularly as applying to operation and maintenance. The technical literature shall include all major equipment, control instruments and equipment used and other related materials

f) Maintenance and Trouble Shooting Instruction

i) Equipment operation instruction
ii) Hang-up instructions
iii) Equipment suppliers

This section shall comprise a full list of names, addresses and telephone numbers (including after office hours numbers) of all Sub-Contractors and Suppliers of equipment (local and overseas) incorporated in the installation.

iv) Maintenance & Breakdown Service

This section shall comprise a list of the names and telephone numbers of Company's Maintenance 'and Servicing Section personnel for normal maintenance and breakdown request.

In the event of the Contractor failing to fulfill the aforesaid requirements, the Engineer shall reserve the right to obtain-all of the required operating and maintenance manuals by other means shall deduct all cost incurred thereof from monies due to the Contractor. In addition the Engineer shall forfeit the rights of the Contractor in relation to further payment and the issue of the Certificate Taking Over will also be withheld until he has so complied accordingly.

1.9 Spare Parts

All necessary spare parts required for two (02) years beyond defects liability period shall be included in the main bid.

1.10 Shop Inspection, Damages and Material Order

1.10.1 Shop Inspection and Damages

1.10.1.1 Inspection at Factory Premises

All major equipment to be supplied under this Contract which has been manufactured or shop-assembled in or outside Pakistan shall be subject to inspection (if the Employer so desires) by Employer or its authorized representative at its point of original manufacture or final shop assembly before its dispatch to SITE. The Contractor shall make necessary arrangements and provide all the facilities required for such inspection. The cost of travel, boarding and lodging of Employer, his authorized representative or the Engineer shall be the responsibility of the Contractor.

The following equipment shall be inspected and tested at the manufacturer's works:

a) Fire Fighting Pumps

For local items inspection, Contractor will pay Rs. 2000/Day (Daily Allowance) in addition to cost of traveling, boarding or lodging for one Employers representative and one Engineer's representative for the subject inspection.

1.10.1.2 Special Requirements for Fire Fighting Pumps

The pre shipment inspection of fire Fighting Pumps is required. The detail requirements are as below:

a) The Contractor shall import the equipment, preferably on proforma invoice issued by the local distributor. Trans-shipment will not be allowed. The Contractor may import the equipment without involvement of local distributor provided he fulfills following conditions:

A certificate from the manufacturer, on original stationery be furnished along with equipment submittal for approval, certifying that the manufacturer will be responsible to provide after-sale service through his authorized local representative. The certificate should carry the name and location of the project as well as the name and address of the authorized local distributor.

b) The Contractor shall arrange at his own cost factory visit(s) for pre-shipment inspection separately for Fire Fighting Pumps. One Engineer's

representative and one Employer's representative accompany with Contractor's representative will visit manufacturer's premises. Business Class Air-fare to and from inspector's home town, boarding and lodging, and transport for two persons shall be Contractor's responsibility. The Contractor shall arrange visa for the inspectors and all formalities and costs in this respect shall also be the Contractor's responsibilities.

In addition, the Contractor shall provide (for two persons) daily allowance in US$ for out of pocket expenses at 200 US $ / day/person. The number of days shall be actual days spent in travel calculated from the dates of travel from and to the home town of the concerned inspector, but not less than five (5) days. The US$ in cash shall be provided before start of travel from hometown.

c) Technical submittal furnished in accordance with Contract provisions shall include:

Manufacturer's computer selection sheet, in original on Manufacturer's stationery stating, besides other information project name and location, make, country of origin and source of supply.

Manufacturer's Warrantee Statement on Manufacturer's stationery in original shall be submitted.

Manufacturer's confirmation on his stationery in original, acknowledging the condition that no trans-shipment would be allowed, Warrantee Statement will be part of shipping documents, and shipment will be subject to pre-shipment inspection and witnessing of performance test by two (2) representatives of the Owner at Manufacturer's factory. The Acceptance Certificate by Owner's Representatives will be part of shipping documents.

After approval of Technical Submittal for all equipment, following documentation shall be furnished.

- Attested copy of Letter of Credit (price portion may be blanked off).

- Manufacturer's confirmation on his original stationery, that the order has been entered for production. Project name, location and expected shipment date be stated.

d) In case of absence of pre-shipment inspection for any reason, Engineer may advise 3rd party inspection/testing or will deduct suitable amount of pre-shipment inspection or direct the Contractor to change the make/country of origin of the equipment if so required.

e) The Contractor is required to fill the rates of pre shipment inspection of Fire fighting pumps in item no. 31 of BOQ as per requirement of clause SP 1.9.1.2.

1.10.1.3 Inspection at Karachi Port

All major imported equipment (Fire fighting Pumps) will be inspected at Karachi port. The Contractor shall make necessary arrangements and provide all the facilities required for such inspection. The cost of travel, boarding and lodging of Employer, his authorized representative or the Engineer shall be the responsibility of the Contractor. In case of unavailability of such inspection, Engineer reserves the right to deduct suitable amount from Contractor's payment and subsequent inspection at dry port will be additional responsibility of the Contractor up to Engineer's satisfaction.

1.10.2 Material Orders

Triplicate copies of material or equipment orders required in this Contract shall be furnished to the Engineer. All orders shall state the specification designation under which the material is to be furnished and shall bear reference to the drawing number, if any, pertinent thereto. Orders shall also state that material is subject to inspection and testing and shall show the required date of delivery of the material to destination.

1.10.2.1 Acceptance of Materials

The acceptance of any material or equipment prior to shipment shall in no way relieve the Contractor of any of his responsibilities for meeting all of the requirements of the specifications and shall not prevent subsequent rejection if such material or equipment is later found to be defective.

1.10.2.2 Damages, During Transportation, Storage and Installation

The Contractor shall be responsible for any damage of the Equipment/ material during transportation to site, storage and until satisfactory handling over the works. The Contractor shall replace any damaged equipment/ materials at his own cost.

1.11 Addition/Omission Works

The Engineer reserves the right to add/omit any part, item, or scope of work to the Contract. Any variation will be according to the Schedule of Rates.

1.12 Building Works and Making Good of Damages

All sealing up of holes, erection of brick walls, surface finishing etc. necessary for the carrying out the installation, including making good to match surrounding finishes, shall be deemed to be included in the Lump Sum Tender Price.

All damages caused during the installation work shall be, making good by the Contractor to match the existing and surrounding finishes. All costs in connection with such work shall deem to be included in the Lump Sum Tender Price.

1.13 Training Course

The Contractor shall conduct minimum one (01) full complete comprehensive operating and maintenance training program on the operation and maintenance of the systems installed. The training programs shall include but not limited to overall systems, the familiarization of the equipment, trouble-shooting techniques for fault rectification and servicing of the systems/equipment installed. The training shall consist of all notes and materials, etc. including hands-on training as a major portion of the whole training program.

1.14 Certification Endorsement by Contractor

The Contractor shall submit hydraulic calculations and relevant documents for the fire pump, wet riser, hose reel, fire hydrants and clean agent fire suppression systems to the Engineer for approval. All calculations and submission-materials shall be endorsed by the Contractor's approve Mechanical Professional Engineer. After submissions, hose reel pumps selection, pump curve, friction loss calculations and pump control panel shall be endorsement by the Contractor's approved Mechanical Professional Engineer.

The Contractor shall submit structural calculations and relevant documents for all water tanks installed under this Contract to the Engineer for approval. All calculations and submission materials shall be endorsed by the Contractor's approved Structural Professional Engineer.

All shop drawing and as-installed drawings on electrical single-line diagrams shall be endorsed by the Contractor's approved- Electrical Professional Engineer.

On completion of all performance testing as required in the Specification, the Contractor is required to submit all test reports to the Engineer for approval prior to acceptance of installation. The Contractor shall also be required to certify in writing to the Engineer that Installation is in full compliance with the requirements of the Specification and the Codes to which are designed by an approved Professional Engineer/Licensed Electrical Worker.

All drawings, calculations, test certificates', Certificate of Supervision, data and analysis submitted in this Contract shall be endorsed by the Contractor's approved Professional Engineer tests and inspections required by the relevant authorities for his installation works for obtaining occupation permit of the building shall be carried out by the Contractor.

This Contract shall be deemed to include for all testing requirement.

The Certification of Taking Over will not be issued unless the clauses as stated above a complied with to the satisfaction of the Engineer.

1.15 Contractor Assistance during DLP Period

The Contractor shall operate, service and maintain complete firefighting System for a period of three hundred and sixty five (365) days after date of issuance of Certificate of Completion. The system shall be operated as specified and shall include supply of operating staff, consumables, all necessary adjustments, greasing, oiling and cleaning and the furnishing of necessary tools, instruments supplies and parts to keep the system in perfect operation, except such parts made necessary by misuse or neglect not caused by the Contractor. All costs incidental to the above specified Servicing and Maintenance shall be deemed to be included in other items of the Schedule of prices and no separate payment shall be made to the Contractor for fulfillment of his obligations under this clause with respect to Servicing and Maintenance. The Contractor may withdraw maintenance tools and instruments at the completion of Defects Liability Period.

The cost of operating the plant during Defects Liability Period shall be paid by the Employer to the Contractor under BOQ item named "Firefighting System Operation during Defects Liability Period As specified"

TECHNICAL PROVISIONS

SECTION 5150

TECHNICAL PROVISIONS

SECTION I - GENERAL REQUIREMENTS

1.1 MATERIAL

All materials shall be of the highest grade, free from defects and imperfections, of recent manufacture and unused, and of the classification and grades designated, conforming to the requirements of the latest issue of the appropriate specifications cited herein. All materials, supplies, and articles forming part of major equipment and not fabricated by the manufacturer of the equipment shall be the products of the recognized reputable manufacturers.

1.2 WORKMANSHIP

Workmanship and general finish shall be of the highest grade, in accordance with the requirements specified herein, and the best modern standard practice.

1.3 EQUIPMENT

a) For ratings and characteristics of manufactured equipment, Equipment Schedule as appended to Technical Provisions shall be followed.

b) All equipment shall be manufactured by companies, which have had at least ten years previous experience in the design and manufacture of equipment of comparable type, capacity and operating conditions. Unless otherwise approved by the Engineer.

c) Where the requirement of this Clause make any equipment proprietary or non-obtainable, the Engineer reserves the right to waive any portion or portions of it as required to obtain the intent of the technical specifications (s).

d) When a manufacturer's product is specified by name, or equivalent, it shall be in the sole judgment of the Engineer as to acceptability of any product, which is offered as equal to that specified.

e) Where two or more units of the same class of equipment are furnished, product of the same manufacturers shall be used: component parts of entire system need not be product of same manufacturer.

1.4 CHASSES AND OPENINGS

The Contractor shall provide shop drawings, templates or details for chases and openings to be left in concrete walls, concrete partitions, and floor or roof slabs to accommodate work under Firefighting scope of works.

1.5 PROTECTION

The Contractor shall keep pipe, duct and other openings closed to prevent entry of foreign matter. All fixtures, equipment and apparatus shall be covered and protected against dirt, water, chemical or mechanical damage, before and during the construction period. All fixtures, apparatus, or equipment damaged including damaged shop coats of paint shall be restored to original conditions prior to Commissioning and also again prior to Final Acceptance. All bright finished shafts bearing housings and similar items shall be protected until in service: no rust will be permitted.

1.6 CUTTING, PATCHING AND REPAIRING

Required for proper installation and completion of Firefighting works, including masonry work, concrete work, carpentry work, painting and re-painting shall be performed by skilled craftsmen in respective trades, at expense of the Contractor. Construction shall be cut only after obtaining written permission from the Engineer.

1.7 LINES, LEVELS AND SPACES

The Contractor shall check dimensions at the building site and establish lines and levels for work specified in Specifications. The Contractor shall check with work of other trades to ensure proper clearance of piping, ductwork, conduit and other items. Any deviations observed between drawings and actual construction shall be brought to the notice of the Engineer. The erection supervisor shall regularly inspect, during progress of civil works, the areas allocated for installation of Firefighting equipment and any conflict observed shall immediately be reported to the Engineer.

1.8 MACHINERY GUARDS

All moving parts of machinery are to be protected by strong guards to adequately protect all personnel working on or in the vicinity of equipment.

Wherever possible, moving parts should be protected by guards supplied by the equipment manufacturer. All guards must be strongly attached to equipment and should be designed for easy removal for access, servicing, adjustment and maintenance.

1.9 TOOLS

The Contractor shall supply in a toolbox, full sets of tools suitable for maintenance of all components of the plant furnished by him including the electrical equipment, for use by the Employer after completion of Maintenance Period. List of Tools shall be subject to approval by the Engineer.

1.10 OIL AND GREASES

The oils and greases shall be supplied in sealed containers. These shall be of suitable quality sufficient for the initial charge plus hundred percent (100%) extra. The quantity, grade of oil and greases and their manufacturer shall be approved by the Engineer the extra oils and greases shall be reserved for use by the Employer after completion of Defects Liability Period.

1.11 SPARE PARTS

The spare parts for Firefighting System shall be duplicates of the original parts with same country of origin furnished and interchangeable therewith.

1.12 ACOUSTIC TREATMENT

The noise criteria for different areas stated in Special Provisions is to be obtained.

Sound measurements will be made at approximately five (5) feet above floor level in the occupied area served and not more than five (5) feet from the grills, diffusers or other air devices being tested. Instruments for sound measurement shall be provided by the Contractor.

Provision is to be made to minimize noise and vibration. However, different manufacturers equipment have varying sound and vibration characteristics and it is, therefore, the responsibility of the Contractor to ensure that the requirements in these specifications are fully met by the equipment he is offering. If the Contractor has any requirements for additional vibration or sound isolation, these must be incorporated into the price quoted.

All equipment installed should not be audible inside the occupied areas and the Contractor must ensure that all equipment he is offering is quiet and have satisfactory sound levels. Where silencers are required, these must be incorporated into the price quoted.

1.13 ACCESS PANELS

The Contractor shall mark locations of, and give sizes of, access panels required in false ceiling and wall paneling for adjustment and maintenance of Firefighting Equipment, such as Dampers, Fire Dampers, valves, ceiling-hung equipment, etc. This information shall be provided to the Engineer before commencement of false ceiling work by the concerned persons.

1.14 SEALING OF OPENINGS

The contractor shall seal all openings in external walls and roof where Firefighting pipes penetrate in external membrane. The sealing shall be air tight to prevent penetration of outside air and water into building. The method and materials for sealing shall be subject to Engineer's approval.

SECTION – II – FIRE PROTECTION EQUIPMENT

1.0 SCOPE OF WORK

The work to be done under this section of the Specifications includes furnishing all plant, labor, equipment, appliances and materials and in performing all operations required in connection with the supply, installation, testing & commissioning of black steel pipes and fittings for firefighting system, portable fire extinguishers, fire hose cabinets, sprinklers as shown on the Drawings, as specified herein and/or as directed by the Engineer.

2.0 PIPE AND FITTINGS

2.1 Material

Seamless black steel plain end pipe shall conform to ASTM A106 & fittings shall conform to BS 534, for detail specification refer Section IV and for testing & commissioning of firefighting system refer section II.

3.0 PORTABLE FIRE EXTINGUISHERS

3.1 Materials and Equipment

Portable fire extinguishers shall be of European origin or approved equal and shall contain specified quantities and types of extinguishing agents. Extinguishers shall be classified according to type of extinguishing agents and the Class of fire types for which it is intended to be used. The extinguisher container/vessel shall be of anticorrosive material or otherwise lined internally with corrosion-resistant material. The outside surfaces of the container/vessel shall be painted with at least two coats of anti- corrosive paint. The extinguisher container shall be designed as pressure vessel and shall conform all the applicable standards of ASME pressure vessel codes. The container shall be fitted with spring-loaded pressure safety valve. The valve shall be set to blow off at 90% of container test pressure. It shall be fitted with gauge showing empty and full status.

3.2 Codes and Standards

Portable fire extinguishers shall conform to NFPA (National Fire Protection Association) of USA or FOC (Fire Offices Committee) of UK and BS 5423.

3.3 Types of Extinguishers

3.3.1 Carbon Dioxide Extinguisher

Carbon dioxide extinguisher shall-contain specified quantities of carbon dioxide gas under pressure. The extinguisher shall have knob or lever operated valve, a short length of hose and discharge hose at the end of the hose. A siphon/dip tube

shall extend from the valve to the bottom of the container. The valve shall have safety pin to prevent accidental release of the extinguishing agent.

When operated the discharge time for 6 kg carbon dioxide extinguisher shall not be less than 14 seconds and maximum range of throw shall be 5-8 meter.

3.3.2 Dry Chemical Powder Extinguisher

Dry chemical extinguisher shall contain specified quantities of dry powder chemical. The type of dry powder shall be suitable for the intended use. The extinguisher shall have knob or lever operated valve, a short length of hose and a nozzle at the end of the hose. A siphon/dip tube shall extend from the valve to the bottom of the container. The valve shall have safety pin to prevent accidental release of the extinguishing agent. The discharge pressure shall be obtained from pressurized carbon dioxide cartage attached to the body of the extinguisher. The operation of the knob or lever shall pierce the cartage to obtain the expellant pressures. When operated the discharge time of 6 kg dry powder extinguisher shall not be less than 14 second and max range of throw shall be not less than 5-8 meter.

Automatic Dry Chemical Powder Extinguishers shall have coverage area not less than 100 Sq. ft.

3.3.3 Wet Chemical Extinguisher

Wet chemical extinguisher shall contain specified quantity of wet chemical. The type of wet chemical shall be suitable for the intended use in kitchen. The extinguisher shall have knob or lever operated valve, a short length of hose and a nozzle at the end of the hose. A siphon/dip tube shall extend from the valve to the bottom of the container. The valve shall have safety pin to prevent accidental release of the extinguishing agent. The operation of the knob or lever shall pierce the cartage to obtain the expellant pressures.

When operated the discharge time of 6 ltr. wet chemical extinguisher shall not be less than 17 second and max range of throw shall be not less than 5-6 meter.

3.4 Installation

Portable fire extinguishers shall be installed at three feet height above finished floor.

Where only extinguishers are installed they shall be fixed to wall/column with painted steel clamps or stored in steel or concrete in extinguisher cabinets as shown on the applicable drawings or as directed by the Engineer. Where clamped to the wall/column the clamp shall be such that extinguisher can be conveniently fixed and removed without loss of time.

Where stored in cabinets, the cabinets shall be of steel or concrete with glazed steel door painted with at least two coats of anti-corrosive signal red enamel paint over a prime coat of red oxide paint. The locking arrangement will be such that the door can be opened from inside by breaking the glass and from outside with key.

3.5 Markings

Portable Fire extinguishers shall be painted with color code according to NFPA Standard specifications. On the body of the extinguishers shall be marked/imprinted the following information.

a) Instructions on how to use the extinguisher
b) Name of the extinguishing agent
c) Weight/volume of the extinguishing agent
d) Gross weight of the extinguisher
e) Filling pressure of the extinguishing agent
f) Classes of fires for which the extinguishing agents may be effectively used
g) Name of the manufacturer and the year of manufacture

4.0 Siamese Connection

It shall be with two B-couplings according to NFPA or another equivalent, approved standard, (65 mm diameter) with ball valves, caps, and union, installed in on galvanized sheet steel plate.

5.0 Automatic Sprinkler System

5.1 General

The sprinkler system is designed to Light Hazard.

The Contractor shall submit sprinkler system hydraulic calculations for the entire sprinkler system for the approval of the Engineer. The format of hydraulic calculation worksheets shall be approved by the Engineer and soft copies of the hydraulic calculation worksheets shall be submitted to the Engineer. All sprinklers/water spray hydraulic calculations shall be endorsed by the Contractor's approved Mechanical Professional Engineer.

The locations of sprinkler/ spray nozzles as shown on the drawings are indicative only. The Contractor shall co-ordinate with ceiling layout and services for final sprinkler head/ spray nozzles position. No additional cost claims will be entertained for final heads position adjustment within 3m radius form the positions as shown on the drawings.

5.2 Sprinkler System

The sprinkler system shall be installed such that when any one or more of the sprinklers are in operation or when the drain/test valve of the main control valve is turned on, the pump shall start automatically. This will cause the water motor alarm and the bell to ring and indicators in the main control panel lit. The fire alarm shall also sound when actuated by the flow switches installed in the system.

5.3 Sprinkler Head

Sprinklers/water spray nozzles shall be UL and FM approved. The sprinkler heads

shall be installed as shown on the drawings. The Contractor shall install sprinkler heads including sprinkler pipes teeing off from main pipes to sprinklers. Sprinklers shall be of conventional pattern designed to produce a spherical type of discharge with a proportion of water being thrown upwards to the ceiling. Sprinklers shall be designed with universal type deflector enabling the sprinkler to be erected in either the upright or pendent position. All sprinkler heads and components used shall conform to the requirement of the latest edition of the code of practice.

Sprinklers and spray nozzles shall be of Electroless Nickle plating (PTFE). Where sprinklers are likely to be accidently damaged or as shown on the drawings, the Contractor shall supply and install the protective guards or cages of approved types.

The sizes of sprinkler/ spray nozzle orifice for various hazard class and the temperature ratings for various areas shall meet the requirement of relevant code of practice.

The spacing and location of sprinklers and spray nozzles shall meet as per sprinkler layout shown on the drawings. If any deviation found to the drawing with code of practice, Contractor shall seek approval from Engineer before preceding the work.

Unless otherwise stated, sprinkler temperature rating shall be 68°C/ 79°C and shall be color coded accordingly. Sprinkler pressure head shall not be less than 15 psi and K factor shall be as specified in Schedule of prices.

5.4 Spare Sprinkler

A stock of spare sprinklers shall be provided and stored in a cabinet installed at a suitable location. A storage capacity of not less than as designated by NFPA 13 shall be provided to store the stock of sprinklers.

The number of spare sprinklers is to be in accordance with the NFPA 13. Special sprinkler wrench shall be provided in the cabinet to be used for the removal and installation of sprinklers.

6.0 Fire Hose Cabinets

The recess type/ wall mounted Cabinet shall be of 18-gauge steel of size as shown in drawing. The door shall be hinged steel glass door with locking arrangement. It shall have steel hose rack with hose which can swing 180^0 on hinges. The cabinet shall have hose valve, 100 feet (30 meter) long synthetic, double jacket lined hose for test pressure of 20 bars minimum, with diameter one triple-purpose brass nozzle as approved by fire department.

Fire Hose Cabinet shall be installed flushed with outside finishes as approved. The fire hose shall be connected to fire water system, 2" diameter with reducer and 2" x 1-1/2" hydrant valve connected to hose with instantaneous coupling and with multipurpose nozzle" as shown on drawing. The minimum pressure at the valve in cabinet shall not be less than 4.5 bars. In case the pressure at the valve

exceeds 4.5 bars, the pressure shall be reduced to 4.5 bars using pressure reducing device.

7.0 External Fire Hydrants/Pillar Hydrants With Hydrant Cabinets

Above grade wet barrel fire hydrant shall be cast iron or steel and shall conform to BS EN 671. It shall have 2 Nos. dia 2-1/2" (65mm) outlets suitable for connection of instantaneous coupling hose. It shall be suitable for working pressure of 1.5 times the system working pressure.

The outlets shall be provided with protective standard caps of galvanized steel and attached to the standpipe by chains. The hydrants shall be coated internally and externally with black bituminous coating.

Each hydrant shall be provided with two 100 feet (30 meter) of 2-1/2" (65mm) diameter rubber lined hose instantaneous coupling and nozzles, all housed within a steel cabinet beside the hydrant.

Valve pits shall be of adequate size and readily/easily accessible for inspection, operation, testing, maintenance and removal of equipment contained therein. They shall be constructed and arranged so as to property protect the installed equipment from any ground movement and accumulation of water. The valve pits shall be precast concrete with reinforcement. Crushed stone or gravel shall be used for the floor of the pit.

The pit covers shall be able to withstand the heaviest vehicle, which are using the roadside to be specified.

8.0 MEASUREMENT AND PAYMENT

Portable Fire Extinguishers, Siamese Connection, External Fire Hydrants/Pillar Hydrants, Fire Hose Cabinets.

8.1 Measurement

Measurement of acceptably completed works of fire Portable Fire Extinguishers, Siamese Connection, External Fire Hydrants/Pillar Hydrants
will be made on the basis of actual number provided and installed in position as shown on the drawing or as directed by the Engineer.

8.2 Payment

Payment will be made for acceptable measured quantity of fire hose cabinet, orifice plate, pressure reducing valve and Siamese connection on the basis of unit rate per number quoted in the Bill of Quantities and shall constitute full compensation for all the works related to the item.

SECTION- III - PUMPING MACHINERY

1.0 SCOPE

The work to be done under this section of the specifications includes furnishing all plant, labor, equipment, appliances, materials, sundries and in performing all operations required in connection with the installation of pumping machinery including all accessories as specified herein or shown on the Drawings or as directed by the Engineer.

2.0 MATERIALS AND PRODUCTS

Materials and machinery shall conform to the latest referenced specifications and other provisions specified herein and shall be new and unused. In case where manufacturers are specified, materials and equipment will be of the same manufacturers. In all other cases the Contractor shall submit the names and addresses of the Manufacturers and trade names of the materials and equipment that he intends to buy. Other information such as diagram, drawing and descriptive data will be supplied if so desired by the Engineer. Approval of materials and all the machinery under this provision shall not be construed as authorizing any deviations from the specifications. The approval of machinery of manufacturer other than that specified will be purely on the discretion of the Engineer. The Engineer will fully ascertain the facts and satisfy himself as to the performance of the machinery offered by the Contractor.

3.0 SPECIAL REQUIREMENTS OF PUMPS

The Contractor shall supply and install firefighting pumps as shown and detailed on the drawings and as per NFPA 20. The pumps shall be FM approved and UL listed. The pump coupled with motor shall be factory tested.

Each pump shall be capable of circulating the required nominal rate against the head of the system. The pump head indicated on the drawing is indicative only. The Contractor shall carry out detailed calculations relating to the pressure drop of the equipment selected by them and of the system piping so that each pump is capable of providing the necessary output at the designated head. The Contractor shall supply to consultant a licensed software for crosschecking of hydraulic calculations. Pump performance curves with the predicted operating points shown shall be submitted together with the Tender offer. It shall be the sole responsibility of the Contractor to ensure that the pump head selected is adequate for the efficient functioning of the system and to meet the design intents.

The pumps shall have stable throttling curves and be suitable for unrestricted parallel operation.

One duty pump and jockey pump shall be electrically driven and one standby pump shall be Diesel driven.

The pumps and their drives shall not overload or trip when operating against zero pressure.

The design, construction and materials shall be such that damage as a result of cavitation is completely eliminated.

Pumps shall have bearings and be suitable for continuous as well as intermittent operation without external sealing or cooling water. The pumps shall be such that they shall come into operation at once after a prolonged shutdown period without having to take special measures. Pumps shall be capable of delivering specified quantity of water at the specified pressure.

Pumps shall be tested at site before their final acceptance.

Pumps shall be installed at positions shown on the Drawings and/or as directed by Engineer.

Pumps and their drives shall be in perfect alignment when installed in position.

4.0 FIRE PUMPS

4.1 VERTICAL TURBINE PUMP, MOTOR & DIESEL ENGINE FOR FIRE WATER PUMPS

Pumps shall be Vertical Turbine type, all bronze except where other material is scheduled. The capacity of each pump shall be as specified. The shaft shall be supported by bearing and shaft sleeve at such interval that the shaft shall not twist, bend or vibrate excessively. The shaft bearing shall be water lubricated. Pressure tank of steel of required capacity shall be placed with jockey pump for fire system.

Bronze statically and dynamically balanced, closed, overhung, single suction, and keyed to shaft, and secured by a locking cap screw, replaceable bronze casing wearing ring, stainless steel shaft with bronze sleeve. Include flinger on motor shaft between motor and seals to prevent liquid that leaks past pump seals from entering the motor bearings. Mechanical seals shall be of Carbon steel Rotating ring, stainless steel spring, ceramic seating and flexible bellows and gasket.

Pump suction and discharge shall be of steel drilled to B.S 450 or B.S 10 and shall be rated for the pressure of 1.5 times the firewater pumps. Such measures shall be taken in pump designing so that no negative pressure is created at suction end.

The motor shall be fully sub-tropicalized and comply with IP 55 rating and insulation Class F. The motor shall be of such capacity that at rated voltage, the full load ampere rating will not be exceeded under any conditions of pump load.

The motor shall be totally enclosed forced cooling (TEFC) type and shall be tested in compliance with NEMA (National Electrical Manufacturer's Association) standard. The motor shall be suitable for connection to a 400V (as per Electrical design), 3-phase, 50 Hz A.C. and rated for continuous operation at ambient temperature not less than 50 deg C.

The engine shall be of 4-stroke mechanical injection air-cooled type with automatic speed regulator and flywheel housing.

The engine shall be provided with double battery kit (12 VDC) and charger, complete with exhaust pipe (insulated) and arranged to discharge outside.

The engine shall be manually switched off. Fuel supply shall be adequate for minimum two (02) hour operation.

4.2 CONTROL PANEL

1.1.1 Approvals

The Fire Pump Controller shall meet the requirements of the latest edition of NFPA 20 as well as meeting CE mark requirements. It shall be FM approved and UL listed.

1.1.2 Construction

All internal components shall be front mounted and wired for ease of inspection and maintenance. All relays shall be of the plug-in type, complete with visual indication to show that the relays are energized. The controller shall include an LCD display to indicate battery voltage and amperes as well as system pressure, in PSI or Bars.

The controller shall have twin battery chargers meeting NFPA 20 requirements. The battery chargers shall have reverse polarity protection/indication and be capable of recharging a completely discharged battery within 24 hours. The chargers shall auto detect the input voltage of either 120VAC or 220VAC and shall be able to be programmed for either 12VDC or 24VDC output.

The controller shall come standard with a breaker disconnect on the AC line and for both battery connections.

A solid state pressure transducer shall be installed in the enclosure bottom to ensure all plumbing connections are made external to the controller. The controller piping and pressure system shall be rated for operation in system pressures up to 600 PSI (42.25 kg/cm2) within +/- 1.5% accuracy.

1.1.3 Enclosure

The controller shall be housed in a NEMA Type 2 (IEC IP11), powder baked finish, free- standing enclosure.

1.1.4 Microprocessor Control

The control panel shall consist of the following control parameters:

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1. Start and stop psi points
2. High and low pressure alarm set points
3. Stop mode: manual or auto
4. Run period timer: 0-60 min
5. Ac power failure: enable or disable
6. Sequential start timer: 0-300 sec.
7. Weekly test timer
8. Pressure deviation: 1-99 psi
9. Language: English

The following visual and audible alarms shall be provided:

1. Fail to start high engine temp.
2. Low oil pressure engine run
3. Engine over speed low fuel
4. Battery #1 failure charger #1 failure
5. Battery #2 failure charger #2 failure
6. Remote start deluge valve
7. Low pressure interlock on
8. Speed switch fault low suction
9. ECM selector in alt position
10. Fuel injector malfunction
11. Starter #1 failure
12. Starter #2 failure
13. Transducer failure
14. Data cable disconnect
15. DC fail

The controller shall have a 4 line by 40 character LCD display mounted on a panel opening in the front door. The LCD display shall indicate the system pressure, Battery #1/#2 voltage and amperage, operation mode, shutdown mode, custom messages, alarms, timers, date, and time. Etc.

The controller shall be supplied green status LED's and RED alarm LEDs to indicate status and alarms mentioned above.

The microprocessor logic board shall be equipped with:

a. A J1939 Engine Communication port.
b. A USB port for transference of message history, controller status, diagnostics, and statistics and the ability to update firmware.
c. An Ethernet port for direct connection to a computer for data transfer.
d. An RS485/RS422 Modbus communication terminals.
e. RS232 Serial Port

The controller shall come complete with an embedded web page which allows viewing of the controllers' current status, data values, programmed set points, and downloadable history.

a. A Fail-to-Start alarm shall occur if the engine does not start after the crank cycle.

b. A sequential start timer, weekly test timer and AC Failure Start timer shall be provided as standard.
c. The controller shall be supplied with interlock and shutdown circuits as standard. A flashing green LED shall indicate an interlock on condition.
d. Where shutdown of the pump(s) due to low suction pressure is required, it shall be accomplished without the addition of a separate panel or enclosure. The LCD display shall indicate low suction shutdown. Resetting of the condition shall be automatic or manual as selected by the user.
e. Means shall be provided to test the operation of all LED's to ensure their functionality.

4.2 Operation and Control

- Electric Driven pump shall be duty and Diesel Driven Pump shall be standby
- The pumps shall be protected from dry running by low water level cut out switch.
- UPS shall be provided for batteries backup of controller.

4.3 Control Panel Features

- The pump shall be controlled by a combined manual and automatic across the line type fire pump control panel.
- UPS shall be provided for battery backup of controller.
- The control panel shall have an externally operated circuit breaker, a pilot light to indicate when power is on, switches or push button for manual or automatic operation, a pressure switch control for automatic operation and a remote alarm signal when pump is operating.
- The panel shall have provision for connection to BMS. The controller shall be integrated with BMS on open protocols, preferably BACnet over IP, through local areas network (LAN). For this purpose, LAN port (RJ-45) shall be available in the controller.
- Controllers to have auto program for start/stop for future periodic maintenance.
- A pressure switch and single phase failure relay with local visual indication and auxiliary contact for remote indication of 240 volt AC power failure shall be provided which will, upon drop in system pressure or loss of single phase AC power, cause the controller to open or close all circuits necessary to automatically start the engine by performing the following functions:-

a) Turn on fuel supply.
b) Automatically alternating between the dual batteries on each cycle.
c) Disconnect cranking motor upon engine start.
d) Once the engine is started, it shall remain in operation until shut down automatically.
e) If the engine should fail to start after several cranking attempts, the controller shall disconnect all starting circuits and energize an audible and visual alarm to indicate "over crank" in the panel as well as in the engine control panel.

5.0 INSTALLATION

The fire water pumps shall be installed on concrete foundation at the specified

location.

6.0 PUMP ACCESSORIES

Pumps shall be provided inclusive of the following accessories:

i) Strainer on pump suction pipe.

ii) Pump flexible connections and reducer/enlarger is necessary if the pump discharge size is different from discharge piping and the items are not given separately in the BOQ.

iii) Pressure relief valve in pump discharge

iv) Anti vibration mating

7.0 MOTOR PROTECTION

Motors of 3kw or less power shall be started direct on line. Larger motors shall be started by star-delta starter.

Motor shall be protected against under voltage over voltage, overload, over-heating and phase failure.

Motor shall be rated for normal operation against a voltage fluctuation of + 10% and frequency fluctuation of + 2Hz.

8.0 PRESSURE GAUGE

Pressure gauge shall be of copper alloy, bourdon tube type with 4" diameter dial face. The dial shall be engraved in black on white background from zero to 16 bars or 1.5 times the working pressure whichever is larger. Gauge shall be installed to socket welded to the pipeline with an isolating plug/ball valve. If the pipeline installation is such that the above requirement cannot be met, pressure gauge of remote reading type shall be installed.

9.0 BRASS STRAINER

Brass strainers shall be of bucket type with flanged end. They shall be installed at the end of pump suction pipe. The wall thickness of the strainer shall not be less 1/8 inch (3 mm). The diameter of the holes or the width' of the slots shall not be greater than 1/4 inch (6 mm). The open area of the strainer shall not be less than 1.5 times the cross-sectional area of the suction pipe on which it is installed.

10.0 PRESSURE SWITCH

Pressure switch shall be electric actuating device, which will close/open the circuit at preset lower/higher pressures. The device shall be housed in die-cast aluminum casing with enamel finish. The switch shall be adjustable between pressures of 6-11 Bars. The pressure switch shall be rated for a working pressure of 16 Bar. The switch shall be wired to control panel.

11.0 WATER LEVEL INDICATOR

The water level indicator for high and low water level cut off shall operate on 230 Volt AC, 50 Hz and supplied complete with float, float chains, counter-weights, chain clamps, steel mounting brackets, chain guide roller and any other equipment and material necessary for installation and satisfactory operation.

The bidder may quote for non-mechanical type of water level indicator to give equivalent performance. Technical literature and data of the indicator to be furnished along with the bid documents.

12. 0 MAINTENANCE MANUALS AND TOOLS

12.1 A book or books containing the complete information in connection with the assembly, operation, lubrication, adjustment and repair of the pumping equipment, electric motor, together with detailed parts list with drawing or photographs shall be furnished in duplicate.

12.2 For the pump room, special tools necessary for maintenance and repair of the pumps and electric motors including tools kits, grease' guns etc. with accessories shall be furnished.

12.3 The manufacturer's recommended list of spare parts to be stocked by the CLIENT shall be submitted by the Contractor to the Engineer for approval. Such spare parts will also be furnished by the Contractor.

12.4 All the maintenance manuals, tools, spare parts etc., shall be supplied by the Contractor at no cost of the CLIENT and all cost shall be deemed to be included by the Contractor in his bid against item of pumping set.

13.0 MEASUREMENT AND PAYMENT

13.1 Pumping Machinery
13.1.1 Measurement

Measurement for payment of pumping machinery pressure gauge, strainer, pressure switch and water level indicator shall be the actual number acceptably provided and installed in position; the Contractor's bid against these item shall include cost of providing and installing the pumping machinery including the pumps, electric motors, all accessories, manuals, tools, spare parts, etc., as shown on the drawings, as specified herein or as directed by the Engineer.

Payment will be made for acceptable measured quantity of pumping machinery pressure gauge, brass strainer, pressure switch and water level indicator on the basis of unit rate per number quoted in the Bill of Quantities. The bid amount shall be full payment for the work specified as specified herein or as directed by the Engineer.

SECTION – IV – VALVES AND APPURTENANCES

1.0 SCOPE

The work to be done under this section of the specifications includes furnishing all plant, labor, equipment, appliances, materials, sundries and performing all operations required in connection with supply, installation, testing and commissioning of valves and appurtenances as specified herein, as shown on the drawings and as directed by the Engineer.

2.0 GENERAL

Material of valves and appurtenances shall be suitable for installation on water pipelines.

Service ratings of the valves and appurtenances shall be as specified herein, on the drawings or in the contract document but shall not be less than ***16 bars***.

All valves of size 50mm and larger shall have cast iron body and renewable bronze seal rings, bronze spindles and self-packing feature so that they can be packed while open and under pressure.

Valve ends shall be of appropriate class, material and type of the pipe/fittings to which they are to be joined.

Valves and appurtenances shall be installed in positions as shown on the drawings or as directed by the Engineer.

Before installation the interior of valves and appurtenances shall be cleaned of all foreign materials and greased. Damaged paints shall be retouched.

Before installation and after commissioning valves and appurtenances shall be Subjected to test pressure which shall be not less than 1-1/2 times the working pressure or the service pressure of the valves and appurtenances, whichever is higher and that no leakage shall be permitted during the test.

Valves and appurtenances shall be adequately supported and labeled.

Manufacturer's literature and operation manual for valves and appurtenances shall be provided.

3.0 CAST IRON GATE VALVES

Cast iron gate valves shall have flanged ends and wheel handle and shall conform to B.S.5163 "Specifications for Double Flanged Cast Iron Wedge Gate Valves for Waterworks purposes". Flanges shall be drilled to B.S. 4504 Part 1. Valves shall be rated not less than 1.5 times the system working pressure. Valves shall close in clockwise direction.

The valve parts shall be of the following materials.

- Valve body shall be of cast iron
- Flanges shall be of cast iron
- Shaft shall be of stainless steel
- Disc shall be of cast iron with bronze trim
- Seat shall be of cast iron with bronze trim
- Disc and shaft seal shall be of rubber (O-ring type)
- Wheel handle shall be of cast iron

Valve parts in contact with water shall be of corrosion resistant material, free from toxic substances and shall not foster microbiological growth or impart taste, odor, turbidity or color to the water.

Inside surfaces of valves shall be enameled and outside surfaces shall be epoxy coated.

4.0 CAST IRON CHECK VALVES

Cast iron check valves shall be of non-slam, swing type with flanged ends shall conform to B.S. 5153, "Specifications for Cast Iron Check Valves for general Purposes". Flanges shall be drilled to B.S. 4504 Part 1. Valves shall be rated not less than 1.5 times the system working pressure. The direction of flow shall be permanently marked on the body of the valve.

- Valve body shall be of cast iron
- Flanges shall be of cast iron
- Shaft and spring shall be of stainless steel
- Disc and seat shall be of cast iron with bronze trim
- Disc and shaft seal shall be of rubber (O-ring type)
- Wheel handle shall be of cast iron

Valve parts in contact with water shall be of corrosion resistant material, free from toxic substances and shall not foster microbiological growth or impart taste, odor, turbidity or color to the water.

Inside surfaces of valves shall be enameled and outside surfaces shall be epoxy coated.

5.0 BRONZE GATE VALVES

Bronze gate valves, ball valve shall conform to B.S.5104 "Specifications for Copper Alloy. Globe, Globe Stop, Check and Gate Valve of General Purposes". Valves shall be rated not less than 1.5 times the system working pressure. Valve ends shall be screwed or flanged as shown on the drawings. Threads shall be to B.S. 21 and flanges shall be drilled to B.S. 4504 Part 1. Valve shall close in clockwise direction. Open and shut indicators shall be marked on the wheel handle.

6.0 BRONZE CHECK VALVES

Bronze check valves shall conform to B.S. 5154, "Specifications for Copper Alloy. Globe, Globe Stop, Check and Gate Valves for General Purposes". Valves shall

be rated not less than 1.5 times the system working pressure. Valve ends shall be screwed or flanged as shown on the drawings. Threads shall be to B.S. 21 and flanges shall be drilled to B.S. 4504 Part 1. The direction of flow shall be permanently marked on the valve body.

7.0 ZONE CONTROL VALVES

Cast from ductile iron conforming to ASTM A-536, flanges per ANSI B 16.5, Supply Connection and System Discharge Connection. Zone Control Valve shall be designed to separate the area in case of maintenance and to get the indication of fire zone on a combination of Butterfly valve, Flow Switch, Pressure Gauge and Test & Drain Valves.

The zone control valve assembly shall consist of the following:

- Butterfly Valve
- Water flow Alarm switch
- Water flow Detector
- Test & Drain Valve
- Motor Gong
- Pressure Gauge

Zone control valve shall be connected to the main Fire control panel and fire alarm control panel through Building Management System (BMS). The control panel shall have auto, manual and off selector switch.

Valve shall be installed in vertical position in fire protection riser. Trim shall be installed as per manufacturer's recommendations including drain and test valves. Pipe drains to hub or floor drains. Test and adjust operation of valves, alarms and pressure maintenance devices.

8.0 ALARM CHECK VALVES

Alarm check valves shall be equipped to give clear positive audible alarm at any water flow through the sprinkler system equal to or greater than that from a single automatic sprinkler. It shall be suitable for vertical/horizontal installations as per system requirement or as directed by the Engineer and for the variable pressure of water supply.

Alarm check valves shall be of flanged type designed to withstand up to working pressure of 250 psi. It shall have cast iron body and clapper hinge, bronze clapper assembly, pilot valve assembly and other moving parts.

The alarm check valve assembly shall consist of the following:

- Alarm checks Valve, with trimmings for variable pressure, open drain, Vertical installation.
- Ø 2 inches main drain valve.
- System pressure gage.
- Supply pressure gage.

- Bypass check valve.
- Alarm control and test valve.
- Retainer chamber.
- Water motor alarm gong.
- Pressure operated alarm switch to actuate a bell

Alarm check valve shall be connected to the main control panel. The control panel shall have auto, manual and off selector switch. If the selector switch is in either off or manual position, an alarm signal should be sent to the main Fire Control and fire alarm panel.

Valve shall be installed in vertical position in fire protection riser. Trim shall be installed as per manufacturer's recommendations including drain and test valves. Pipe drains to hub or floor drains. Test and adjust operation of valves, alarms and pressure maintenance devices.

9.0 DELUGE VALVE

An electric deluge system is a fixed fire protection system in which the pipe system is empty until the deluge valve operates to distribute pressurized water from open nozzles or sprinklers/hose reels.

Deluge valve shall be of flanged type designed to withstand up to working pressure of 250 psi. It shall have cast iron body and clapper hinge, bronze clapper assembly, pilot valve assembly and other moving parts.

The deluge valve assembly shall consist of the following:

- Deluge Valve, with trimmings for variable pressure, open drain, Vertical installation.
- Main drain valve.
- Diaphragm Chamber pressure gage.
- Water Supply pressure gage.
- Diaphragm Chamber connections.
- Automatic drain valve.
- System drain valve.
- Alarm Test valve.
- Manual Control station.

Deluge valve shall be connected to the main control panel. The control panel shall have auto, manual and off selector switch. If the selector switch is in either off or manual position, an alarm signal should be sent to the main Fire Control and fire alarm panel.

Valve shall be installed in vertical position in fire protection riser. Trim shall be installed as per manufacturer's recommendations including drain and test valves. Pipe drains to hub or floor drains. Test and adjust operation of valves, alarms and pressure maintenance devices.

10.0 ISOLATING VALVES

Isolating valves shall be supplied and fitted generally as shown on the drawing. These valves shall be of full-way, solid edge disc pattern with non-rising spindles of special brass or cast bronze fitted with detachable aluminum alloy die casting hand wheels.

All valves shall be "right-handed" i.e. they shall be so constructed that in order to shut the valve, spindle must turn clockwise. The hand wheels shall be clearly marked showing the direction of the wheel to be turned to close the valve.

11.0 SURGE RELIEF VALVES

Surge relief valves shall be spring operated globe type for continuous services conforming to ISO Standard or Equivalent. Valves body shall be of cast iron with stainless steel rim. Spring shall be of stainless or high tensile steel. Flanges shall be drilled to B.S. 4504 Part 1. Valves shall be rated not less than 1.5 times the system working pressure. Valves shall relieve pressure when the surge pressure in the system exceeds the pre-set value. The pressure will be adjustable between 6 to 9 bars.

12.0 AIR RELEASE VALVE

Air release valves shall be suitable for the liquid for which it is used. Valves body and cover shall be of malleable iron. Float and valve seat shall be of stainless steel. Valve ends shall be screwed or flanged as shown on the drawings. Threads shall be to B.S. 21 and flanges shall be drilled to B.S. 4504 Part 1.

Air release valve shall be provided at all high points to ensure adequate venting of the piping system.

13.0 INSPECTORS TEST CONNECTION

Each sprinkler shall be provided with an inspector Test Connection. The Inspectors Test Connection shall consist of one inch piping & gate valve, discharged to the outside through a ½ inch orifice on a concrete splash block. Area of splash block shall be 2.5 sft. Escutcheon plates shall be provided to cover the pipe sleeve openings.

14.0 INSTALLATION OF VALVES

Valves shall be installed either in chambers or above grade on line as shown on the drawings and as directed by the Engineer. Before installation, the interior surfaces of valves shall be cleaned of all foreign matters, inspected to ensure that all components are sound and in working condition and tested to 1-1/2 times the working pressure or the service pressure whichever is greater. After installation, valves shall be securely anchored; tested, retouched where paints have been damaged and labeled.

15.0 PRESSURE GAUGES

Pressure gauges shall be of copper alloy, bourdon tube type with four inches dial diameter. The dial shall be engraved in black or white background from 0 to 6 bars

or 1-1/2 times the working pressure whichever is larger. Pressure gauges shall be installed on to the pipeline with an isolating ball valve.

16.0 FOOT VALVE WITH BRASS STRAINER

Brass strainer with foot valve shall be of bucket type with flanged end. The valve shall be installed at the end of the pump suction pipe or suction line. The wall thickness of the strainer shall not be less than 1/8 inch (3mm). The diameter of the holes or width of the slot shall not be greater than ¼" (6 mm). The open area of the strainer shall not be less than 1.5 times the cross section area of the suction pipe on which it is installed.

17.0 WATER FLOW METER

Water meter shall be of turbine/vane type. The body shall be of fine grained cast iron with baked enamel coating. Ends shall be flanged. Valve body and flange shall be rated not less than 1.5 times the system working pressure. The normal flow rate shall range from 50 cu.m/hr. to 300 cu.m/hr.

18.0 PRESSURE REDUCING VALVE

Screwed pressure reducing valve, body and screws of brass, spring, bonnet an regulation handle of high quality synthetic material, valve insert of corrosion resisting synthetic material (completely interchangeable), mesh strainer corrosion resisting synthetic material with fine mesh of stainless steel, mesh width 0.16 mm dia, strainer chamber of standard construction of shock-proof transparent synthetic material, ¼" connection for pressure gauge on both sides of valve body, 2 pressure gauges, casing of synthetic material, dia 63 mm, ¼" connection bar, calibrated scale 0-16 bars. One double socket wrench for loosening spring and strainer chambers, including all necessary sealing, and fixing material.

19.0 MEASUREMENT AND PAYMENT

19.1 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 Bill of Quantities. The cost therefore shall be deemed to have been included in the quoted unit rate of the respective items of the Bill of Quantities.

- Jointing arrangement of pipe on both ends of valves, water meter including gaskets, nuts, bolts etc.
- Valves and appurtenances and anchors, sundries for the system
- Keys for operation of valves
- Steel embedded parts and label plates
- Manufacturer's literature and operation manual valves and appurtenances
- Painting of valves, water meter and appurtenances

19.2 Measurement

Measurement of acceptably completed works of all type valves, pressure gauges, water meter and brass strainer will be made on the basis of actual number of valves, pressure gauges, water meter and brass strainer provided and installed in position as shown on the drawing and as directed by the Engineer.

19.3 Payment

Payment for the acceptably measured number of valves pressure gauges, water meter and brass strainer will be made on the basis of unit rate per number for each valve, pressure gauges, water meter and brass strainer quoted in the Bills of Quantities and shall constitute full compensation for ail the works related to the item.

SECTION – V - STEEL PIPES & PIPE FITTINGS

1.0 SCOPE

The works under this section of the specifications include furnishing all plant, labor, equipment, appliances and materials, sundries and in performing all operations required in connection with the supply, installation, testing, flushing and commissioning of black steel pipes and pipe fittings as specified herein, in bill of quantities, as shown on the drawings, and/or as directed by the Engineer.

2.0 APPLICABLE CODES AND STANDARDS

All works and materials under this section shall conform to the latest edition of the following applicable codes and standards. When the requirements of these specifications or the drawings exceed the code requirements, the Contractor shall be bound by the specifications and/or drawings for that requirement.

B.S. 4504:	Flanges and Bolting for Pipes, Valves and Fittings." (Part 1)
B.S. 534:	"Steel Pipes, Fittings and Specials for Water, Gas and Sewage."
B.S. 1387:	"Galvanized/Black steel pipes and fitting."
B.S. 1965:	"Butt Welding Pipe Fittings for Pressure purposes, Part 1 Carbon Steel."
B.S. 3601:	"Steel Pipes and Tubes for pressure purposes, Carbon steel: Ordinary Duties."
B.S. 3063:	"Dimensions of Gaskets for Pipe flanges"
B.S. 4147:	"Hot Applied bitumen, based coatings for ferrous products."
B.S. 4161:	"Coal tar based hot applied coating materials for protecting Iron & Steel products"
B.S. 4515:	"Field welding of carbon steel pipe lines"
B.S. 21	"For threaded pipes and fittings."
ISO 898:	"Mechanical Properties of Fasteners, Bolts, Screws and Studs."
C.P.2010:	"Pipelines Part 2: Design and Construction of Steel Pipelines in Land."

Other authoritative codes and standards which ensure equal or higher quality than those references may also be acceptable subject to satisfaction and approval of the Engineer.

Any conflict between the requirements of this specification and those on the figures herein or in the codes, standards and specifications referred to herein shall be brought to the attention of the Engineer for resolution whose decision will be final and binding.

3.0 GENERAL REQUIREMENTS

3.1 Pipes and fittings shall be new and unused.

3.2 Where manufacturers of pipes and fittings are specified, they shall be of the same manufacturers unless otherwise approved by the Engineer.

3.3 Where more than one similar item of pipes and fittings are specified, they shall be of the same manufacturer.

3.4 The Contractor shall submit to the Engineer for approval of the following information regarding the specified/proposed items of pipes and fittings.

i. Name and address of the manufacturers
ii. Country of origin, make and model
iii. Dimensions and wall thicknesses of pipes and fittings
iv. Material and thicknesses of coating and lining
v. Factory test certificate from the manufacturers (MTC)
vi. Warranty if so provided by the manufacturers
vii. Method of jointing, testing and commissioning

3.5 Approval by the Engineer shall not be construed as authorizing any deviation(s) from the specifications unless they are specifically brought to notice of the Engineer.

3.6 Approval by the Engineer shall not relieve the Contractor from any of his contractual responsibility regarding satisfactory performance and other requirements of pipes and fittings.

4.0 SPECIAL REQUIREMENTS

4.1 Pipes and fittings shall be suitable for the intended use.

4.2 Every pipe shall be tested at the manufacturer's works to specified hydraulic test pressure. The test pressure shall be maintained for sufficiently long time for proof and inspection.

4.3 Each pipe and fitting shall be permanently marked or engraved giving the following information:

(i) Make and Nominal diameter
(ii) Class, Duty or Service (Pressure) Rating
(iii) Standards according to which the pipes and fittings have been manufactured.

4.4 Unless otherwise specified diameters of pipes and fittings shall be nominal. Actual inside and outside diameters and tolerances in diameters of pipes and fittings shall be according to the specified standards.

4.5 Pipes and fittings shall be seamless or welded as specified herein or in bill of quantities, as shown on the drawings and/or as directed by the Engineer. If the Contractor so desires, seamless pipes and fittings may be substituted for welded pipes and fittings at no risk or cost to the owner. Where neither seamless nor welded pipes and fittings are specified, pipes and fittings shall be seamless unless otherwise approved by the Engineer.

4.6 Unless otherwise specified, service ratings of pipes and fittings shall not be less than the maximum pressure to which they will be subjected to.

4.7 Unless otherwise specified, wall thicknesses of the pipes shall be according to the class, schedule or duty of the pipes. The wall thicknesses shall be measured at locations excluding the jointing ends. The tolerances in wall thicknesses shall be according to the specified standards. Wall thicknesses of fittings shall not be less than those of corresponding pipes to which they are joined together.

4.8 Pipes and fittings ends shall be matching and compatible with each other and with the ends of valves and appurtenances to which they are joined.

4.9 Unless otherwise approved by the Engineer, pipes and fittings, jointing materials such as rubber rings, gaskets, nuts & bolts and jointing compound etc. shall be of the same manufacturers as those of the pipes and fittings.

5.0 MATERIAL

5.1 Pipe

Black steel pipes shall conform to API Standard 5L. The material of the pipes shall be having minimum yield strength of 42,000 psi and minimum ultimate tensile strength of 60000 psi for fire protection pipe.

5.2 Fittings

Dimensions of black steel fittings shall conform B.S. 534/1965.

5.3 Joints

Black steel pipes and fittings shall be joined by welding except for joining of valves and appurtenances and at locations as shown on the drawings and/or as directed by the Engineer. Welded joint shall conform to B.S. 4515. Black steel pipe flanges shall conform to specified or appropriate Table of B.S. 10. Nuts and bolts for flanges shall be of hexagon shape and shall conform to ISO 898. Gaskets shall be of flat shape and shall conform to B.S. 3063.

6.0 INSTALLATION

6.1 Transportation, Handling and Storage

The Contractor shall be responsible for proper transportation, handling (loading and unloading) and storage of pipes and fittings as per the manufacturer's recommendations and direction of the Engineer.

Crane, rope or nylon slings, lifting beams with flattened hook scissor-dog shall be used for loading and unloading of pipes fittings. Hooks and dogs shaft be well padded to prevent the pipe being damaged and shall be fitted-with locking device. Steadying ropes essential.

Pipes and fittings damaged during transportation, handling or storage of lowering shall be rejected and replaced at the Contractor's expense storage of gaskets and jointing compound shall be under shade to prevent damage by sunlight and

extreme heat.

6.2 Inspection

Pipes and fittings shall be visually inspected for any evidence damage or hair cracks. The turned ends of pipes and fittings shall be inspected for any local irregularities, which could affect the water tightness of the joint. Damaged pipes and fittings shall be rejected and replaced at the Contractor's expense.

6.3 Laying and Jointing

a) Above Ground (Unburied)

Before installation, the interior of pipes and fittings shall be thoroughly cleaned of all rust, dirt and foreign materials. Pipe and fittings shall be installed to lines and grades as shown on the drawings and/or as directed by the Engineer.

Pipe joints shall be welded unless otherwise specified and/or directed by the Engineer except for jointing valves and appurtenances and where welding is not possible. Welding shall be done by qualified and licensed welders using electric arc welding process. The welding shall develop full strength of the adjoining steel. Defective joints and joints not developing full strength shall be rejected at the risk and cost of the Contractor.

Pipes and fittings shall be properly supported by galvanized steel clamps, brackets and hangers, etc. Supports shall permit unrestrained expansion and contraction. Clamps, brackets and hangers etc. shall be designed to take the weight of pipe, weight of water, seismic and wind loads.

Thrust anchors shall be provided at all changes in the pipe diameters and directions and at all branches and dead ends.

Thrust anchors shall be designed to resist maximum thrust forces resulting from the worst possible combination of working/static/test pressures, transient/water hammer pressure, and thermal expansion/contraction, seismic and wind loads.

The Contractor shall submit to the Engineer for approval shop drawings of the pipes supports and thrust anchors. The supports and anchors shall be used only after approval by the Engineer.

Approval by the Engineer shall however, not relieve the Contactor from any of his contractual responsibility regarding safety requirements of the supports and anchors.

Pipes passing through floors, ceilings, roof, walls and columns in non-water retaining structures above ground or water table shall be encased in black steel pipe sleeve. The annular space between the pipes and the pipe sleeves shall not be less than one inch. The annular space shall be filled with approved packing material and sealed at both ends with approved fire

rated sealant.

Pipes passing through water retaining structures above or below ground and non-water retaining structures below water table shall be provided with leak proof puddle flange. The flange diameter shall be larger than the outside diameter of the pipe by at least 4" for pipe diameters 6" and smaller and by at least 6" for pipe diameters larger than 6".

After installation, pipes, fittings, pipe supports and thrust anchors shall be painted with two coats of red oxide or zinc chromate primer and two coat of synthetic enamel paint of approved quality.

b) Below Ground (Buried)

Before installation, the interior of pipes and fittings shall be thoroughly cleaned of all rust, dirt and foreign materials.

Laying of pipes and fittings shall be carried out according to the British Standard practice CP201 0: Part 4.

Pipes and fittings shall be laid to alignments and grades as shown on the drawings and/or as directed by the Engineer.

Pipes and fittings shall be lowered into the trench in a manner approved by the Engineer. All care shall be taken to avoid abrasion of the pipes and fittings.

The pipes shall be laid on specified bedding material. Before laying bedding material shall be approved by the Engineer. Recesses shall be excavated in the bottom and sides of the trench to accommodate joints, fittings and specials. After laying of pipe and fittings, the recesses shall be filled with specified bedding material and thoroughly compacted manually.

Pipes and fittings alignments, that have the grades or joint disturbed or dislocated after laying shall be removed and re-laid to the entire satisfaction of the Engineer.

Backfilling shall be carried out with the specified materials and in the specified sequence. Backfill shall be laid in layers and compacted to 95% of AASHTO modified density.

The thickness of each compacted layer shall not exceed 6". Hand tools shall be used for compaction of backfill/bedding material around the pipe and fittings. Mechanical methods may be used for compaction of backfill 12" over/above crown the pipeline.

When laying is not in progress, the open ends of the pipeline shall be closed with a temporary plug as approved by Engineer.

Small changes in direction may be made by deflecting the last laid pipe after the joint has been made. If the alignment requires deflection in

excess of the manufacturer's recommended limits bends shall be used.

Concrete thrust blocks shall be provided at all changes in the pipe diameters and directions and at all branches and dead ends.

After installation, pipe and fittings shall be applied with two coats of bituminous paint and wrapped with soaked bitumen hessian cloth. Alternatively pipe and fittings shall be double wrapped with bituminized tape.

7.0 TESTING

After laying each section of pipeline as convenient to the contractor or as necessary in the Engineer's opinion, shall be tested for hydrostatic pressure. Field hydrostatic test pressure shall not be less than 1-1/2 times the maximum pressure to which the system will be subjected to.

Before testing, pipe section shall be cleaned and their ends shall be closed with blank flanges, plugs or caps. The closed ends shall be anchored against thrust forces. Valve air vent outlet shall be installed at the upper end of the pipe section and valve water inlet fitting shall be installed at the lower end of the section. Pressure gauge certified from any approved laboratory shall be installed at both lower and upper ends of the pipe section. An isolating ball valve shall be fitted between the pipe section and the gauges.

Sufficient backfill material shall be placed over the centre section of each pipe (leaving the joints exposed) to allow inspection of the pipe joints under the test pressure. All permanent anchors shall be in positions and shall have developed adequate strength before the testing begins. The pipe section under test shall be filled with water from the inlet fitting, taking care that all air is displaced through the vent outlet.

After filling, the pipeline shall be left under small pressure for 24 hours as directed by the Engineer in order to wet the pipe and the pipe joints. After the wetting period, additional water shall be introduced into the pipe section until the test pressure is achieved when the pipe section shall be closed.

The test pressure shall be maintained for at least two hours or for a period as directed by the Engineer. Pressure gauges shall be read at maximum intervals of 15 minutes during the test period.

If the pressure measurements are not made at the lowest point of the section, an allowance shall be made for the static head between the lowest point and the point of measurement to ensure that the specified works test pressure is not exceeded at the lowest point.

If a drop in pressure occurs, additional quantity of water shall be introduced into the pipe section in order to re-establish the test pressure. The additional quantity of water introduced into the pipe section shall be accurately measured.

During the test period all joints shall be inspected. If any abnormal movement, distortion, squirm or leakage is detected, the test pressure shall be relieved immediately and the defects shall be rectified in consultation and with the approval of the Engineer.

After rectification of the defects, the pipe section shall be re-tested.

The test will be considered to have passed, if the quantity of water required to be added the test pressure does not exceed 100 liters per day, per meter of diameter and per kilometer of pipeline for each 30 meters head of test pressure.

8.0 FLUSHING

After installation and testing pipelines shall be flushed with water until all dust, dirt, scales and extraneous matters are removed from the inside of the pipeline. During flushing all valves and appurtenances shall be closed and open several times.

9.0 COMMISSIONING

After successful completion of testing and flushing duly approved by the Engineer, pipelines shall be commissioned. All valves and appurtenances shall be set at proper openings and all parameters shall be set at specified or manufacturers' recommended values.

10.0 PIPEWORK SUPPORTS

All pipe work supports shall be of mild steel rolled sections and shall be painted with two coats of approved rich metallic zinc primer. Straps, rods and hangers shall be of mild steel when used for galvanized steel pipes.

Straps shall be provided on all pipe supports. Straps shall have a pair of nut and washers on each leg with the supporting steel flange clamped tight between the pair of nuts to form a rigid guide allowing the pipe to slide axially.

Horizontal pipe work along 'walls shall be supported on channel frames securely fixed to the column. All pipes shall be arranged to slide on the pipe supports and straps shall be provided to form a rigid guide.

Vertical pipe work shall be supported at the base or at anchor point to withstand the total weight of the riser. Brackets from risers shall not be used as a means of support for the riser.

Pipe work supports shall be so designed and installed as to allow free movement due to expansion and contraction. Supports shall be anchor to steel or reinforced concrete column, wall, beam or slab.

Each support shall be able to carry independently its all the operational loads of pipe work and water.

All pipes shall be individually supported. Pipes shall not hang from other pipes. Points at which pipes pass through walls, floors, connections to plan equipment

and heat emitters, etc. do not constitute points of supports for the pipes.

Provide suitable and substantial hangers and supports for all piping. As a minimum for metallic pressure piping, support schedule shall be as follows:

Pipe Size	Maximum hanger spacing (feet)	Rod Sizes (inches)
1 inch and smaller	6	3/8
1-1/4 inch to 2 inch	8	3/8
2-1/2 inch to 4 inch	10	3/8
5 inch and larger	12	1/2

11.0 MEASUREMENT AND PAYMENT

11.1 General

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

11.1.1 Cutting, welding, jointing and laying including jointing materials such as rubber rings, gaskets, nuts and bolts, jointing compounds, welding electrodes etc.

11.1.2 Protective painting, coating, lining and wrapping

11.1.3 Testing, flushing and commissioning

11.1.4 Pipe work supports such as clamps, brackets, hangers etc.

11.1.5 Cutting and breaking of concrete and then making it good.

11.2 Measurement and Payment

Refer Section 1

SECTION – VI- HDPE PIPES & PIPE FITTINGS

1.0 SCOPE

The works under this section of the specifications include furnishing all plant, labor, equipment, appliances and materials, sundries and in performing all operations required in connection with the supply, installation, testing, flushing and commissioning of black steel pipes and pipe fittings as specified herein, in bill of quantities, as shown on the drawings, and/or as directed by the Engineer.

2.0 APPLICABLE CODES AND STANDARDS

All works and materials under this section shall conform to the latest edition of the following applicable codes and standards. When the requirements of these specifications or the drawings exceed the code requirements, the Contractor shall be bound by the specifications and/or drawings for that requirement.

All materials and workman ship described herein shall be in accordance with the latest editions and addenda of the NFPA, ANSI, ASTM codes.

Any work or materials found to be defective or which do not meet the requirements of this specifications, shall be replaced by the Vendor at his own expense.

All materials shall be new, unused and free of defects and imperfections.

All piping shall be supplied from the factory to prevent while under storage and installation. Provide factory applied plastic end caps on each length of pipe and tube. Maintain end caps through shipping, storage and handling as required to pre vent pipe end damage and eliminate dirt and moisture from inside of pipe and tube.

Where possible, store pipe and tube inside and protected from weather. Where necessary to store outside, elevate above grade and enclose with durable, or by packaging with durable, water proof wrapping.

Protect flanges and fittings from moisture and dirt by inside storage and enclosure or by packaging with durable, water proof wrapping.

Vendor shall guarantee and provide a written statement as proof that the product shall perform as specified on the Data Sheets.

All products shall be guaranteed for satisfactory performance and shall be warranted against faulty design, defective or improper materials.

The Material and Workmanship Guarantees shall be extended for a period of eighteen months from the date of commissioning.

3.0 FACTORY INSPECTION AND TESTING

The contractor shall be required at his own cost to have all tests on piping carried out at manufacturer's facility. The Contractor shall provide the manufacturer's mill test certificate for all piping.

4.0 POLY ETHYLENE PIPE AND FITTINGS

The manufacturer shall have manufacturing facilities and a quality assurance program capable of producing and assuring the quality of the pipe and fittings. Materials used for the manufacturing of polyethylene pipe and fittings shall be PE 4710 high density polyethylene meeting cell classification per ASTM D 335 0.

Flange adapters shall have sufficient through-bore length to be clamped in a butt fusion joining machine without the use of a stub-end holder. The sealing surface of the flange adapter shall be machined with a series of small v-shaped grooves to pro mote gasket less sealing or restrain the gasket against blowout. Flange adapters shall be fitting with FM approved back- up rings. Flange bolts and nuts shall be grade 30 or higher.

4.1 Joining

4.1.1. Heat fusion joints between p lain end pipes and fitting s shall be made by butt fusion using only procedures that are recommended by the pipe and fitting manufacturer.

4.1.2. Butt fusion of unlike wall thickness shall be performed between pipe ends or pipe ends and fitting outlets having same outside diameters. Butt fusion joints between one SDR is per mitted, however the system pressure rating retains the lowest component rated pressure class. Transition s between different classes shall be made with approved flange connections.

4.1.3. Poly ethylene pipe and fittings may be joined together or to other materials by means of FM Approved flange adapters and back -up rings or FM Approved adapters. Where FM Approved pipe or fittings are connected to the socket of mechanical joint pipe, fittings or appurtenances, an F M approved adapter shall be used. Plain end pipe with or without an ID stiffener shall not be installed into the hub of a mechanical joint component. Mechanical couplings and external joint restraints shall not be used to connect FM Approved polyethylene pipe or fittings.

4.1.4. Mechanical joint and flange connections shall be installed in accordance with the manufacture's recommended procedure. Adapters and flanges s hall be centered and aligned to the mating components before assembling and tightening bolts. In no case shall gland or flange blots be used to draw the connection into alignment. Bolt threads s hall be lubricated and flat washer s

should be used under the nuts. Bolts shall be evenly tightened according to the tightening pattern and torque step recommendations of the manufacturer. At least 1 hour after initial assembly flange connections shall be re- tightened following the tightening pattern and torque step recommendations of the manufacturer. The final tightening torque shall be as recommended by the manufacturer.

5.0 Installation

Installation shall be in accordance with ASTM D2774, manufacturer's recommendation s as per local authority approval.

Trench excavations shall conform to the plans and drawings. Where necessary, trench walls shall be shored or reinforced and all precautions shall be taken to ensure a safe working environment.

Pipes shall be I aid on grade and on a stable foundation. Unstable trench bottom soil shall be removed and a 6" foundation or bedding of compacted material shall be installed to pipe bottom grade as per manufactures recommendation s. Excess ground water shall be removed from the trench before laying the foundation or bedding for the pipe. A trench cut in rock or stony soil shall be excavated 6" below pipe bottom grade and brought back to grade with compacted bed ding as recommended by the manufacturer. All ledge rock, boulders and large stones shall be removed.

Backfilling embedment material soil type and particle size shall be in accordance with ASTM D 2 774 and as recommended by the Manufacture.

6.0 MEASUREMENT AND PAYMENT

6.1 General

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

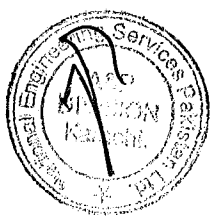
Cutting, welding, jointing and laying including jointing materials such as rubber rings, gaskets, nuts and bolts, jointing compounds, welding electrodes etc.

Protective painting, coating, lining and wrapping

Testing, flushing and commissioning

Pipe work supports such as clamps, brackets, hangers etc.

Cutting and breaking of concrete and then making it good.



SECTION – VII- FM 200 SYSTEM

1.0 General

Provision of fire detection and firefighting system complete in all respects as per applicable NFPA standards including but not limited to Automatic gas Flooding System (Clean Agent). The total firefighting water demand shall be considered while designing of water storage tank.

1.1 Automatic Gas Flooding System

1.1.1 General

The design and installation shall fully comply with NFPA 2001. The Contractor shall submit complete design and layout for automatic gas flooding system as per layout of the rooms.

The clean agent is discharged after a time delay upon detection of fire to warn any occupant to evacuate the room. Thus, this system can be installed in manned areas or semi-manned areas, that is, areas that are occasionally or periodically occupied.

A complete clean agent suppression system provided shall consist of charged FM-200 gas storage cylinder(s), manifold(s), flexible hose(s), pressure gauge(s), pneumatic actuator(s), solenoid actuator, piping, nozzle(s) and all other equipment required for a complete operational system including gas control panel, self-contained breathing apparatus, detector(s), flashing light(s), key switch(s), alarm bell(s) etc.

Unless otherwise specified, automatic gas flooding systems shall be of the total flooding type with a high pressure open-ended piping installation on the distribution side. The automatic gas release mechanism shall be operated by means of fire detection units at the protected compartment or manually by a pull handle or push button.

HFC-227ae as specified shall be used as extinguishing agent.

1.1.2 Design Requirements

The FM-200 suppression system installation shall be made in strict accordance with the, drawings, specifications and applicable NFPA and FM/UL standards.

The design and installation of the FM-200 system shall be based on manual/automatic release total flooding principle of approved/listed systems.

The system shall provide an FM-200 agent minimum design concentration of 6.25% by volume for protected spaces, at the minimum anticipated temperature within the protected area.

System design shall not exceed 9% for normally occupied spaces, adjusted for maximum space temperature anticipated, with provisions for room evacuation prior to agent release.

The Contractor's approved Professional Engineer shall ensure that the design of the system be such that a uniform design concentration is achieved throughout the protected area as stated by calculation using an approved listed software program for engineered system.

The quantity of the clean gas shall be carefully pre-determined to ensure fastest extinction of any fire in the protected areas as well as to ensure an adequate margin of safety to cater for leakage and environmental conditions. The Contractor shall submit the complete catalogue, technical information, samples and complete with full technical hydraulic calculations for Engineers approval before installation. All layout drawings, design calculations shall be endorsed by the Contractor's approved Mechanical Professional Engineer. '

The following design data shall be submitted at tender stage as the minimum requirement:

Number and size of cylinder(s)

Total agent and designed concentration (kg/%)

Pipe schedule

Automatic control system

The design, supply and installation shall be made in strict accordance with the approved working drawings, specifications and applicable standards. The room shall be divided into 3 zones, namely, above false ceiling space, room space and under floor space.

The capacity and quantity of clean agent, cylinders, nozzles piping etc. is tentative. Prior to installation, Contractor shall submit complete set of calculations on manufacturer's software for Automatic flooding system and all other equipment/material with accessories for all rooms as per site condition for approval of Engineer.

1.1.3 Extinguishing Agent

The extinguishing agent shall be HFC227ea with physical properties conforming to NFPA2001 or ISO 14520 standard.

1.1.4 HFC 227ea

HFC227ea Fire Suppression agent is a chemical agent and was the first environmentally acceptable replacement for Halon 1301. HFC227ea has zero ozone depleting potential, a low global warming potential and a short atmospheric lifetime. It is particularly useful where an environmentally acceptable agent is essential, where cleanup of other media presents a problem, where weight versus suppression potential is a factor, where an electrically non-conductive medium is needed, and people compatibility an overriding factor.

HFC227ea is a colorless, liquefied compressed gas. It is stored as a liquid and dispensed into the hazard as a colorless, eclectically non-conductive vapor that is clear and does not obscure vision. It leaves no residue and has acceptable toxicity for use in occupied spaces at design concentration.

HFC227ea does not displace oxygen and therefore is safer for use in occupied spaces without fear of oxygen deprivation. HFC227 total flooding systems shall be, unless otherwise specified, designed to achieve a minimum concentration of 7 % at 5°C and a maximum of 9 % by volume at 38°C.

Discharge of gas shall be substantially completed within ten seconds and following discharge the concentration of extinguishing agent shall develop throughout the protected compartment to achieve final extinguishment of fire within 60 seconds.

The system pressure shall not be higher than 42 bar.

1.2 Hazard to Environment

The agent to be used shall not be made obsolete in the near future and with atmospheric life time not more than 42 years'. The agent shall be non-global warming and non-ozone depleting.

1.3 Hazard to Personnel

The areas to be protected are occupied by personnel(s) and there is a possibility that the personnel might be trapped inside the protected areas. The agent to be proposed shall not pose any hazard to personnel(s) or force them to breathe faster artificially by introducing carbon dioxide gas in the extinguishing agent. A medical report shall be submitted to certify that the agent is safe for use in human occupied areas at tender stage. The agent shall also be a homogeneous gas and not cause

1.4 Gas Storage Cylinders

The cylinders shall be supported securely in frames bolted to the wall. The mounting of the cylinders shall be such that all external parts can be readily inspected.

Each cylinder shall be fitted with an automatic pressure release device which shall function when the pressure of the liquid within the cylinder exceeds a predetermined value, which shall be less than the test pressure defined in BS 5045 or equivalent.

Carbon dioxide cylinders shall be of seamless steel construction to BS 5045: Parts 1 or equivalent.

Each cylinder shall complete with gas valve/actuator, pressure gauge, flexible hose, check valve and all other necessary accessories.

A reliable means of indication, other than weighing the cylinder, shall be provided for measuring the amount of liquid in the cylinder at any time. This shall be done by a

method which does not require the cylinder to be detached from the remainder of the plant.

The liquid shall be discharged from the cylinder through a siphon tube. The pressure of the liquid stored in the cylinder shall be such that freezing cannot take place at the lowest possible ambient temperature.

Means shall be provided to prevent gas discharging into empty containers and to prevent loss if the gas is released when any of the cylinders is disconnected.

Safety latches shall be provided in each bank of gas cylinders to prevent accidental discharge of gas during maintenance. Safety latches shall incorporate a set of contacts to initiate a warning at the control panel that the system has been locked off.

Gas cylinders shall be painted signal red as specified in BS 381C. The type of extinguishing agent, tare weight, gross weight, liquid level at 25°C for CO2 (21°C for HFC227) shall be clearly painted on each cylinder with white paint.

In case of minor leak of a cylinder, which mostly occurs at the top of the cylinder in areas such as valve threads, pressure safety device, valve stem and valve outlet, the following information may apply to the remediation of these minor leak:

- For flammable or inert gases, move the cylinder to an isolated and well ventilated area away from combustible material.

- For corrosive and toxic gas, move the cylinder to an isolated well-ventilated area and use suitable means to direct the gas into an appropriate chemical neutralizer.

- If it is necessary to move a leaking cylinder trough populated area, place a plastic bag, rubber shroud or similar device over the top and tape it (duct tape preferred) to the cylinder to confine the leaking gas.

In case of major leak, such as a large gas release or if an accident takes place, the best is to alert emergencies authority, evacuate the area, securing entrances and providing assistance to the others on the way out.

Alarms system exists for pressure loss of extinguisher gas cylinder. There operate when a leakage in any gas cylinder is detected. An alarm sounds when a leak is detected and may close the valve of the gas cylinder.

1.5 Evacuation of Extinguishing Gas

Rooms that have gas-extinguishing systems will be connected to a purge ventilation system, with an extract fan in the plant room. Following a release of extinguishing agent, the extract fan will be operated manually to purge the room of gas. Ventilation systems serving these areas will also be fitted with motorized dampers, which automatically close

(and shut down the associated system) on an alarm within the area, prior to gas being released. A local control panel will be provided, mounted outside of the protected room, adjacent to the gas system control panel.

1.6 Cylinder Bracket

Each cylinder assembly shall be furnished with wooden spacer(s) and a bracket made of hot-dipped galvanized steel. The bracket shall hold the cylinders in a saddle with a front wooden piece that secures the cylinders well. The brackets shall be modular in design to allow added bracketing or stacking of cylinders depending on installation requirements.

1.7 Selector Valves

For system utilizing selector valves, it shall be opened pneumatically before gas discharged from any cylinder, manual activation of each selector shall be possible.

1.8 Valve Actuator

Solenoid valve shall be of brass construction and stackable design with swivel connections to allow removal of actuators for maintenance or testing. Operation of actuators shall not require replacement of components. No electro explosive device shall be used to actuate the valve assembly. Electric actuator shall be the magnetic latch, continuous duty type for 24VDC operation:

All actuators shall be able to be manually reset and capable of being functionally tested at the quarterly service intervals without the need to replace consumable parts. Actuation devices to be used shall be listed by an internationally recognized approval bod for use with the FM-200 gas fire suppression system.

1.9 Discharge Hose

When manifold(s) is employed, all cylinder assemblies shall include flexible discharge hoses, which connects cylinder discharge valve to manifold inlet.

All hose shall be approved for use.

1.10 Discharge Nozzles

Engineered discharged nozzles shall be provided within the manufacturer's guidelines to distribute the FM-200 agent throughout the protected spaces.

The nozzle body shall have discharge outlets designed to provide a multi-directional and even-distribution discharge pattern.

Orifice(s) opening diameter shall be determined by an approved computer software programmer in order to deliver the required amount of agent within the designed discharge time.

Nozzles shall be permanently marked with the manufacturer's part number and also the orifice diameter accordingly. Nozzle spacing shall be in accordance with the UL listing and/or FM approval.

1.11 System Descriptions And Operation

1.11.1 General

The system shall be a total flooding - FM-200 gas fire suppression system designed to provide a uniform concentration gas throughout the protected area.

The amount of FM-200 gas supplied shall be the amount required to provide a uniform concentration as required - by-the 'manufacturer's recommendation and NFPA 2001. The design concentration shall be by volume at 21°C. The discharge time shall be within 10 seconds in - accordance with NFPA 2001 standards.

The FM-200 gas fire suppression system shall be left in automatic mode at all times if the design concentration is below the NOAEL (Non-Observable Adverse Effect Level) concentration.

System shall be able to perform independently via interlocking with the automatic detection system as well as manual actuation under emergency situation.

As a special requirement, a group of extra gas cylinders and same amount of as will be provided. In case of agent discharge to the primary cylinder bank, back up cylinder group shall take over the duty. Contractor shall provide necessary protection and accessories for spare cylinder group to be in operational at any time and all the costs shall be borne by contractor.

The automatic detection system shall comprise cross-zone detection to activate before activation of the FM-200 gas fire suppression system. A single detector activation shall cause an alarm signal to be generated; a second detector activation shall generate a pre-discharge signal and start the pre-discharge condition.

Upon activation of the FM-200 gas fire suppression system, operation of the computer air- conditioning units, which are installed by others, shall be shut off. The Contractor shall provide and connect all the necessary controls, relay, cable, conduit, etc. to effect this interlocking operation.

Discharge of the FM-200 gas may be prevented by pressing the 'Abort' switch' pushbutton at the control panel. However, alarm status must remain.

If the 'Abort switch' pushbutton is being pressed before the LED timer reaches '0', timer shall re-start countdown immediately upon release of the pushbutton.

The clean agent extinguishing system installed to be data center/rooms as specified shall be completed but not limited with the followings:

a. Detectors
b. Alarm 8ell, 6" Diameter
c. Strobe and Horn
d. Evacuate Area Immediately" warning sign and Flashing Strobe Light
e. Gas Discharged" Flashing warning sign and Strobe Light
f. Caution Sign
g. Manual Release Sign
h. Abort Switch "Deadman Type"
i. Clean Agent Control Panel
j. Clean Agent Gas
k. Container c/w standard accessories
l. A4 Size Zone Chart
m. A4 Size Instruction Sign
n. Discharge Nozzle
o. Electrical Wiring
p. Pipe work
q. Self-contained breathing apparatus

Alarm actuation devices and breathing apparatus shall be installed -one at each door to the data center where necessary or required additional equipment shall be provided at all egress and ingress point to the room.

FM-200 system will have capability to integrate with Building's main Fire Alarm Control panel (FACP).

1.12 Inspection Testing & Commissioning

1.12.1 General

All defects and deficiencies in performance, reliability, safety and efficiency shall be rectified and tested to the entire satisfaction of the Engineer before acceptance.

Before hand over of the system to the Employer, all gaseous containers shall be fully charged.

1.12.2 Inspection

The completed installation shall be inspected by authorized agent and trained personnel.

The inspection shall include a full operational test of all components as per the equipment manufacturer's recommendations during warranty period.

All mechanical and electrical components shall be tested according to the manufacturers recommended procedure to verify system integrity.

Inspection shall include a complete checkout of. The detection I control system and certification of cylinder pressure.

The quantity of agent shall reflect the actual design quantity of the FM-200 gas.

1.12.3 Test Mode

The system shall be tested according to the design mode of operation in the presence of an engineer that is certified by the Principal Supplier of theFM-200 gas fire suppression system.

1.13 Steel Pipes & Pipe Fittings

1.13.1 Applicable Codes And Standards

All works and materials under this section shall conform to the latest edition of the following applicable codes and standards. When the requirements of these specifications or the drawings exceed the code requirements, the Contractor shall be bound by the specifications and/or drawings for that requirement.

B.S. 4504:	Flanges and Bolting for Pipes, Valves and Fittings." (Part 1)
B.S. 534:	"Steel Pipes, Fittings and Specials for Water, Gas and Sewage."
B.S. 1387:	"Galvanized/Black steel pipes and fitting."
B.S. 1965:	"Butt Welding Pipe Fittings for Pressure purposes, Part 1 Carbon Steel."
B.S. 3601:	"Steel Pipes and Tubes for pressure purposes, Carbon steel: Ordinary Duties."
B.S. 3063:	"Dimensions of Gaskets for Pipe flanges"
B.S. 4147:	"Hot Applied bitumen, based coatings for ferrous products."
B.S. 4161:	"Coal tar based hot applied coating materials for protecting Iron & Steel products"
B.S. 4515:	"Field welding of carbon steel pipe lines"
B.S. 21	"For threaded pipes and fittings."
ISO 898:	"Mechanical Properties of Fasteners, Bolts, Screws and Studs."
C.P.2010:	"Pipelines Part 2: Design and Construction of Steel Pipelines in Land."

Other authoritative codes and standards which ensure equal or higher quality than those references may also be acceptable subject to satisfaction and approval of the Engineer.

Any conflict between the requirements of this specification and those on the figures herein or in the codes, standards and specifications referred to herein shall be brought to the attention of the Engineer for resolution whose decision will be final and binding.

1.13.2 General Requirements

a) Pipes and fittings shall be new and unused.

b) Where manufacturers of pipes and fittings are specified, they shall be of the same manufacturers unless otherwise approved by the Engineer.

c) Where more than one similar item of pipes and fittings are specified, they shall be of the same manufacturer.

d) The Contractor shall submit to the Engineer for approval of the following information regarding the specified/proposed items of pipes and fittings.

i. Name and address of the manufacturers

ii. Country of origin, make and model

iii. Dimensions and wall thicknesses of pipes and fittings

iv. Material and thicknesses of coating and lining

v. Factory test certificate from the manufacturers (MTC)

vi. Warranty if so provided by the manufacturers

vii. Method of jointing, testing and commissioning

e) Approval by the Engineer shall not be construed as authorizing any deviation(s) from the specifications unless they are specifically brought to notice of the Engineer.

f) Approval by the Engineer shall not relieve the Contractor from any of his contractual responsibility regarding satisfactory performance and other requirements of pipes and fittings.

1.13.3 Special Requirements

a) Pipes and fittings shall be suitable for the intended use.

b) Every pipe shall be tested at the manufacturer's works to specified hydraulic test pressure. The test pressure shall be maintained for sufficiently long time for proof and inspection.

c) Each pipe and fitting shall be permanently marked or engraved giving the following information:

(i) Make and Nominal diameter

(ii) Class, Duty or Service (Pressure) Rating

(iii) Standards according to which the pipes and fittings have been manufactured.

d) Unless otherwise specified diameters of pipes and fittings shall be nominal. Actual inside and outside diameters and tolerances in diameters of pipes and fittings shall be according to the specified standards.

e) Pipes and fittings shall be seamless or welded as specified herein or in bill of quantities, as shown on the drawings and/or as directed by the Engineer. If the Contractor so desires, seamless pipes and fittings may be substituted for welded pipes and fittings at no risk or cost to the owner. Where neither seamless nor welded pipes and fittings are specified, pipes and fittings shall be seamless unless otherwise approved by the Engineer.

f) Unless otherwise specified, service ratings of pipes and fittings shall not be less than the maximum pressure to which they will be subjected to.

g) Unless otherwise specified, wall thicknesses of the pipes shall be according to the class, schedule or duty of the pipes. The wall thicknesses shall be measured at locations excluding the jointing ends. The tolerances in wall thicknesses shall be according to the specified standards. Wall thicknesses of fittings shall not be less than those of corresponding pipes to which they are joined together.

h) Pipes and fittings ends shall be matching and compatible with each other and with the ends of valves and appurtenances to which they are joined.

i) Unless otherwise approved by the Engineer, pipes and fittings, jointing materials such as rubber rings, gaskets, nuts & bolts and jointing compound etc. shall be of the same manufacturers as those of the pipes and fittings.

1.13.4 Material

a) Pipe

Black steel pipes shall conform to API Standard 5L. The material of the pipes shall be having minimum yield strength of 42,000 psi and minimum ultimate tensile strength of 60000 psi for fire protection pipe.

b) Fittings

Dimensions of black steel fittings shall conform B.S. 534/1965.

c) Joints

Black steel pipes and fittings shall be joined by welding except for joining of valves and appurtenances and at locations as shown on the drawings and/or as directed by the Engineer. Welded joint shall conform to B.S. 4515. Black steel pipe flanges shall conform

to specified or appropriate Table of B.S. 10. Nuts and bolts for flanges shall be of hexagon shape and shall conform to ISO 898. Gaskets shall be of flat shape and shall conform to B.S. 3063.

1.13.5 Installation

a) Transportation, Handling and Storage

The Contractor shall be responsible for proper transportation, handling (loading and unloading) and storage of pipes and fittings as per the manufacturer's recommendations and direction of the Engineer.

Crane, rope or nylon slings, lifting beams with flattened hook scissor-dog shall be used for loading and unloading of pipes fittings. Hooks and dogs shaft be well padded to prevent the pipe being damaged and shall be fitted-with locking device. Steadying ropes essential.

Pipes and fittings damaged during transportation, handling or storage of lowering shall be rejected and replaced at the Contractor's expense storage of gaskets and jointing compound shall be under shade to prevent damage by sunlight and extreme heat.

b) Inspection

Pipes and fittings shall be visually inspected for any evidence damage or hair cracks. The turned ends of pipes and fittings shall be inspected for any local irregularities, which could affect the water tightness of the joint. Damaged pipes and fittings shall be rejected and replaced at the Contractor's expense.

c) Laying and Jointing

Before installation, the interior of pipes and fittings shall be thoroughly cleaned of all rust, dirt and foreign materials. Pipe and fittings shall be installed to lines and grades as shown on the drawings and/or as directed by the Engineer.

Pipe joints shall be welded unless otherwise specified and/or directed by the Engineer except for jointing valves and appurtenances and where welding is not possible. Welding shall be done by qualified and licensed welders using electric arc welding process. The welding shall develop full strength of the adjoining steel. Defective joints and joints not developing full strength shall be rejected at the risk and cost of the Contractor.

Pipes and fittings shall be properly supported by galvanized steel clamps, brackets and hangers, etc. Supports shall permit unrestrained expansion and contraction. Clamps, brackets and hangers etc. shall be designed to take the weight of pipe, weight of water, seismic and wind loads.

Thrust anchors shall be provided at all changes in the pipe diameters and directions and at all branches and dead ends.

Thrust anchors shall be designed to resist maximum thrust forces resulting from the worst

possible combination of working/static/test pressures, transient/water hammer pressure, and thermal expansion/contraction, seismic and wind loads.

The Contractor shall submit to the Engineer for approval shop drawings of the pipes supports and thrust anchors. The supports and anchors shall be used only after approval by the Engineer.

Approval by the Engineer shall however, not relieve the Contactor from any of his contractual responsibility regarding safety requirements of the supports and anchors.

Pipes passing through floors, ceilings, roof, walls and columns in non-water retaining structures above ground or water table shall be encased in black steel pipe sleeve. The annular space between the pipes and the pipe sleeves shall not be less than one inch. The annular space shall be filled with approved packing material and sealed at both ends with approved fire rated sealant.

Pipes passing through water retaining structures above or below ground and non-water retaining structures below water table shall be provided with leak proof puddle flange. The flange diameter shall be larger than the outside diameter of the pipe by at least 4" for pipe diameters 6" and smaller and by at least 6" for pipe diameters larger than 6".

After installation, pipes, fittings, pipe supports and thrust anchors shall be painted with two coats of red oxide or zinc chromate primer and two coat of synthetic enamel paint of approved quality.

1.13.6 FLUSHING

After installation and testing pipelines shall be flushed with water until all dust, dirt, scales and extraneous matters are removed from the inside of the pipeline. During flushing all valves and appurtenances shall be closed and open several times.

1.13.7 COMMISSIONING

After successful completion of testing and flushing duly approved by the Engineer, pipelines shall be commissioned. All valves and appurtenances shall be set at proper openings and all parameters shall be set at specified or manufacturers' recommended values.

1.13.8 PIPEWORK SUPPORTS

All pipe work supports shall be of mild steel rolled sections and shall be painted with two coats of approved rich metallic zinc primer. Straps, rods and hangers shall be of mild steel when used for galvanized steel pipes.

Straps shall be provided on all pipe supports. Straps shall have a pair of nut and washers on each leg with the supporting steel flange clamped tight between the pair of nuts to form a rigid guide allowing the pipe to slide axially.

Horizontal pipe work along 'walls shall be supported on channel frames securely fixed to

the column. All pipes shall be arranged to slide on the pipe supports and straps shall be provided to form a rigid guide.

Vertical pipe work shall be supported at the base or at anchor point to withstand the total weight of the riser. Brackets from risers shall not be used as a means of support for the riser.

Pipe work supports shall be so designed and installed as to allow free movement due to expansion and contraction. Supports shall be anchor to steel or reinforced concrete column, wall, beam or slab.

Each support shall be able to carry independently its all the operational loads of pipe work and water.

All pipes shall be individually supported. Pipes shall not hang from other pipes. Points at which pipes pass through walls, floors, connections to plan equipment and heat emitters, etc. do not constitute points of supports for the pipes.

SECTION –VIII - BALANCING, TESTING AND COMMISSIONING

1.0 SCOPE OF WORK

The work under this section of specifications includes furnishing all plant, labor, equipment, appliances and materials and performing all operations required in connection with testing and commissioning of all water line, firefighting equipment and system etc. in parts and as a whole as specified herein or as shown in the Contract Documents or as directed by the Engineer.

2.0 GENERAL

The Contractor shall submit methodology and provide a complete set of testing equipment for the proper and complete testing of the system.

The instruments, equipment and labor required for conducting these tests and demonstration shall be provided by the Contractor.

The Contractor shall supply all material and labor and provide all notices and pay all fees in connection with all necessary tests to be carried out to the approval of the relevant authorities and the Engineer.

The installation shall be under the charge of the Contractor during the commissioning period, at which time the Contractor shall advise the corporation in all matters regarding the commissioning, operation, maintenance, servicing and trouble shooting of the system.

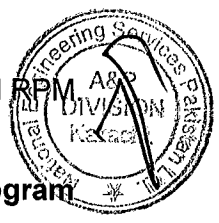
The testing shall include a complete visual inspection of the whole fire fighting system and verification or performance as stipulated in the material specification and of correct functioning of the electrical and control systems.

All supply documents, operating instructions, acceptance documentation and maintenance regulations shall be checked to ensure that they correspond with equipment described and also all certificates such as that of the inspection authorities, test certificates and data about quality, temperature and pressure shall be submitted.

3.0 FIRE FIGHTING SYSTEMS

3.1 Pumps

All pumps shall be checked for flow rates, pressures and RPM.



3.2.1 External Fire Hydrant/Pillar Hydrant System Test Program

Visual inspections shall be made of the entire network for the standpipe system with regard to laying, fixing, and suspension of pipes, particularly the arrangements of the fixed points and the separation of the individual connections in the various parts of the system.

The satisfactory function of all valves, air relief valves, check valves, pressure gauges, shall be checked.

The test program shall also cover:

- Checking number, form and inscription of the labeling.
- Performance of pressure test for the entire network.

3.2.2 Hydrostatic And Leakage Test

The hydrant line shall be tested in sections as the laying proceeds. Each section to be tested shall not exceed 200m.

All joints shall be left exposed for inspection during testing.

Pipes with cement lining shall be allowed to stand full of water for at least 24 hours before proceeding with the test.

Any leakage shall be measured by the quantity of water pumped into the main in that time. The leakage shall not exceed 0.2 per millimeter of pipe diameter per kilometer of pipe line at each 100 meter test pressure head for every 2 hours test duration. Any visible individual leak shall be repaired.

3.3 Pipe Work

All water pipe work shall be hydro-statically tested to 16 bars or 1.5 times the working pressure whichever is greater and this test pressure shall be maintained for 24 hours. During this test, all welded joints shall be hammered.

3.4 Flow Switches

All flow switches shall be tested after installation. All switches shall be correctly set to the satisfaction of Engineer.

3.5 Test Records

At the completion of the installation, the Contractor shall submit four (04) copies of the records of test.

3.6 Reliability Tests

When the preparatory tests have been concluded successfully and the Contractor has notified the Engineer that the installation is ready to work, each section of the installation will be required to operate either continuously or intermittently as may be required without failure of any kind for period of one calendar month.

Should any failure occur due to, or arising from, faulty fittings, materials or workmanship, the reliability test period of one calendar month shall be recommended after the Contractor has remedied the cause of failure to the satisfaction of the Engineer.

4.0 MEASUREMENT AND PAYMENT

No payment shall be made for the works involved within the scope of this section of specification 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 other item of the Bills of Quantities.

LIST OF APPROVED MANUFACTURERS FOR ITEMS/ MATERIALS/EQUIPMENT OF FIRE FIGHTING WORKS

The Bidder should note that only Equipment/materials from the following approved manufacturers shall be allowed to be used on this Project provided their products meet the specified requirements.

SR. NO.	EQUIPMENT/ MATERIAL	APPROVED MANUFACTURER/ SUPPLIER	COUNTRY (origin, manufacturing, assembly, testing & supply)
1.	Fire Fighting Pumps (FM Approved /UL Listed)	ITT PATTERSON READY BAFFALO PEARLESS GRUNDFOS NAFFCO SFEECO AURORA KSB EBITT OR APPROVED EQUAL	USA/UAE/EUROPE
2.	Pump Motors (UL Listed /NEMA)	ABB SIEMENS WEG OR APPROVED EQUAL	UK/USA/EUROPE
3.	Diesel Engine (UL Listed /NEMA)	CLARKE BLACK STALLION OR APPROVED EQUAL	USA/EUROPE/UAE
4.	Gas Suppression System	KIDDIE FIKE VIKING SFFECO LIFECO OR APPROVED EQUAL	USA/EUROPE/UAE
5.	Hose Reel & Cabinets	NAFFCO SFEECO LIFECO OR APPROVED EQUAL	UAE/UK
6.	External Hydrants	NAFFCO SFEECO LIFECO OR APPROVED EQUAL	UAE/UK

7.	Sprinklers	TYCO VIKING SHIELD LIFECO OR APPROVED EQUAL	JAPAN/USA/UK/ EUROPE
8.	Valves, Alarm Check Valve Assembly, Zone Control Valve Assembly, Pressure Reducing Valve, Pressure Relief valve, Drain Cocks, Air vents etc.	TYCO VIKING SHIELD LIFECO REDAY FLOW OR APPROVED EQUAL	JAPAN/USA/UK/ EUROPE
9.	MS Seamless Pipe	HUFFAZ ECONOSTO OR APPROVED EQUAL	PAKISTAN/China
10.	HDPE pipe	DADEX OR APPROVED EQUAL	PAKISTAN
11.	Hangers / Supports	FISCHER HILTI OR APPROVED EQUAL	UK/EUROPE
12.	Portable Fire Extinguishers	NAFFCO SFFECO OR APPROVED EQUAL	UAE

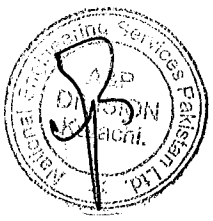
NOTE 1: ALL EQUIPMENT/MATERIAL MUST BE SUPPLIED FROM AUTHORIZED/SOLE DISTRIBUTORS. MANUFACTURERS AUTHORIZATION CERTIFICATE IN ORIGINAL MUST BE PROVIDED.

NOTE 2: MINIMUM QUALIFICATION CRITERIA REQUIREMENT OF FIREFIGHTING EQUIPMENT MANUFACTURER

For all proposed equipment manufacturer shall meet the minimum following criteria:

- Minimum ten (10) years of international experience for same offered equipment.
- Minimum three (03) years national experience with local authorization representative and after sale service available in Pakistan.
- Compliance with international standards/codes as per Clause S-08 of specifications of firefighting works applicable to relevant equipment.
- High ambient compatibility equipment.
- Most energy efficient equipment/model available in market and offered for the project.

ELECTRICAL WORKS



SECTION - 8001

GENERAL SPECIFICATIONS FOR ELECTRICAL SYSTEMS

1.0 SCOPE OF WORK

The scope of this contract covers all operation and activities required for proper and complete construction of internal/building electrification, external electrification & sub-station works and communication systems.

The works related to the Electrical & Communication systems that are included in the scope of this Contract are shown on the Drawings, stated in the Bill of Quantities and explained in these specifications. All the equipment & allied accessories and their installation shall also comply with General Specifications described here-under, with other relevant provisions of Document and WAPDA/other utilities' latest Specifications/Standards. Electrical & Communication systems shall broadly include but not limited to the following:

- Design, manufacturing, supply, installation, testing and commissioning of Lighting fixtures/Luminaries

- Design, fabrication, manufacturing, supply, installation, testing and commissioning of the 11kV 450 MVA 50 Hz Medium Voltage Switchgear

- Supply, installation, testing and commissioning of the MV 15kV three core Cross Linked Polyethylene Power cables in underground pipes or cable trenches.

- Design, fabrication, manufacturing, supply, installation, testing and commissioning of the Low Voltage 400 Volt three phase and 250 Volt single phase switchgears.

- Supply, installation, testing and commissioning of the Low Voltage Single core/multicore PVC/PVC & PVC/SWA/PVC Copper conductor cables in Cable trenches, underground pipes, on cable trays.

- Design, fabrication, manufacturing, supply, installation, testing and commissioning of the 11Kv 50Hz Diesel Generator sets

- Design, fabrication, manufacturing, supply, installation, testing and commissioning of the Type 11/0.400 kV 50 Hz Indoor/ Outdoor Dry Type / oil type Transformers

- Supply, installation, testing and commissioning of the Earthing of Electrical system.

- Supply, installation, testing and commissioning of the Maintenance Bypass Switch.

- Design, Supply, installation, testing and commissioning of the Control Panel, Smoke Detectors, Heat Detectors, Manual Call Point and Audio Alarm etc for complete Fire Detection & Alarm system.

- Each DG set and Energy Monitoring system shall have the provision to integrate with the Integrated Building Management System (IBMS) for local and remote monitoring.

The scope shall include the continuing of the contractor to remain responsible for removal of defects detected in the works and for achieving satisfactory operation/functioning/service of the works during defect liability period.

The contract shall include furnishing of all construction equipment, tools, labour, supervisory staff, plants, transport, power, testing apparatus/arrangements and all construction materials as shall be required for satisfactory completion of works strictly in accordance with the technical specifications and bill of quantities forming part of these documents and as per levels and dimensions as shown on the drawings supplied with these documents and in drawings which may be supplied by the Employer from time to time under approved variation orders.

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 included in the scope of this Contract. The Contractor shall solely be responsible for ensuring proper functional requirements of various equipments. He 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 Engineer to achieve proper co-ordination with various other equipment's offered in the bid and also with those installed by others.

2.0 RULES & REGULATIONS

The entire Electrical & Communication systems installation/work shall be carried out by licensed Contractor, authorized to undertake such work under the provisions of the Electricity Act 1910 and The Electricity Rules 1937 as adopted and modified upto date by the Government of Pakistan.

All works shall be carried out in accordance with the latest edition of the Regulations of the Electrical Equipment of Buildings issued by the Institute of Electrical Engineers-London, 16thed. NEC 1999, the Contract Documents, the Electricity Rules 1937 and bye-laws that are in force from time to time.

Any discrepancy between these specifications and the standards/ regulations shall be brought to the notice of Engineer for his instructions and decision of the Engineer 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 utility company WAPDA shall be complied with.

3.0 AMBIENT 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.

Minimum indoor ambient temperature:	Zero Degree Celsius
Maximum indoor ambient temperature:	+ 40 Degree Celsius
Minimum outdoor ambient temperature:	Zero Degree Celsius
Maximum outdoor ambient temperature:	+ 50 Degree Celsius
Maximum Relative Humidity:	90 Percent
Minimum Relative Humidity:	10 Percent

The atmospheric conditions are tropical and arid.

4.0 MARKINGS

The Contractor shall provide "Danger Boards" and "Shock Charts", wherever required, to comply with the requirements of local Electricity Rules and according to normal practice.

5.0 SYSTEM DATA

Unless otherwise specified elsewhere, all equipment and material shall be designed to operate satisfactorily with the following minimum requirements with the specified tolerance without any derating.

a.	Voltage rating of equipments	MV	15000V	Three phase	±10%
b.	Voltage rating of equipments	LV	500V	Three phase	± 10%
			250V	Single phase	± 10%
c.	DC voltages		24V DC		± 10%
			12V DC		
			Others		
d.	Frequency		50 HZ		± 2 HZ

6.0 STANDARDS

The latest standards and codes of reputable organizations shall be applicable for the material and equipment specified herein and for installation work. Such organizations to be British Standard Institution (BSS), International Electro technical Commission (IEC), IEEE and NEC. In case the Specifications laid down herein differ from those given in the standards, then the better specifications shall govern. Wherever applicable, the equipment shall also conform to the requirements of Pakistan Standard Institution (PSI).,Pakistan Telecom Authority.

7.0 MATERIALS & WORKMANSHIP

All materials, equipment, accessories, fixtures and fittings, under the scope of this Contract, shall be brand new and in accordance with the Specifications and the specifications of the British Standards Institute and Pakistan standards institute. Samples and detailed manufacturers shop drawings (including dimensional plans, elevation, sections, line and wiring diagrams, foundation details, component characteristics and data etc.), shall be approved by the Engineer before purchase or fabrication. The Engineer shall witness routine tests at the manufacturer's work sites and a test certificate shall be provided to him. Three copies of the test certificates at the manufacturer's works shall be supplied. All workmanship shall be first class and undertaken by workman skilled in the particular type of craft.

8.0 DEVIATIONS

The entire design of the Electrical systems of the project has been carried out to fulfill the Users requirements. The design is based on International standards/norms and practices. Special considerations have been made for ease in operation and maintenance of electrical systems of the project. Deviation may be allowed for the works covered under present scope of work, with the approval of Engineer/Client

9.0 EQUIPMENT AND MATERIALS

The equipment/materials of the Electrical systems of the have been designed using the latest editions of International Standards/Codes such as BS, ICE, NFPA, CP as mentioned in article 6.0 above. In these specifications certain types/makes of equipments/ materials have been specified for the purpose of general reference and guidance of the Bidder. However, names of certain manufacturers/suppliers of electrical equipments/materials have been recommended for this project.

The names and addresses of these recommended manufacturers/suppliers are given in the documents. The Contractor is bound to supply and install the required equipments/ materials only from the recommended manufacturers/ suppliers.
In case, if at a later stage in project, the contractor wishes to substitute the specified equipment or materials, he shall furnish complete details of equipment/ substitute to materials.

The equipment/substitute equipments/materials will only be considered by the Engineer if he is satisfied that the equipment/substitute material have technically equivalent/better specifications .In case if the Engineer feels that the equivalent/substitute materials are of less cost compared to the specified materials then the contractor shall give comparative discount in the contract value of the BOQ items.

In case the cost of equivalent/substitute item is more the than the cost of BOQ item then no cost adjustment shall be made in the relevant BOQ item. Once the equivalent/substitute materials are recommended for approval by the Engineer the same shall be forwarded to the Employer/Client for their approval. The equivalent/substitute materials shall only be accepted after the Client's final approval.

All materials and equipments being provided by the Contractor & the Sub-contractor shall be interchangeable to the maximum extent with respect to makes, types, model etc.

10.0 DRAWINGS, AND DATA TO BE FURNISHED BY THE CONTRACTOR

Submittal

The contractor, after the award of work, shall submit for approval of the Engineer all drawings and cuts of equipment, appliances, fixtures and accessories that are to be furnished under the contract. After final approval of a sufficient number of copies as desired shall be furnished for distribution. Manuals, cuts, catalogues and drawings shall be clearly marked to indicate, the items furnished. Cuts of all fixtures, and not a few, shall be submitted.

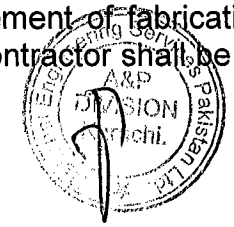
Approval of Drawings and Data

The Contractor shall provide detailed electrical drawings, wiring diagrams, foundation details, etc., for all electrical and other systems etc., for the Engineer's review and approval.

The manufacturing of electrical equipment shall be started only after the above mentioned drawings and data are approved.

The time required for review and approval shall be considered included in the total time of completion of job.

Three sets of drawings and data for each equipment shall be furnished by the Contractor for the Engineer's approval before commencement of fabrication and manufacturing. The drawings to be supplied by the Contractor shall be as follows:



- Arrangements
- Dimensional Plans, elevations and front view
- Foundation Plan, anchors and configuration

- Incoming and outgoing cable termination positions
- Earthing arrangement
- Electrical Drawings showing:

    - Single-Line diagram
    - Detailed wiring diagram
    - All interconnections
    - Other electrical devices including meters instruments and their wiring diagram.
    - Signal and alarm circuit

Shop Drawings

The locations, routing and installation heights of the equipment etc. Which are given on the drawings, are approximate. These drawings depict only the position of various fixtures and outlets. All the detailed planning for electrical and communication systems including conduit routes etc. shall be carried out, well in advance of the actual execution of work, by the Contractor to the satisfaction of the Engineer. For this purpose the Contractor shall prepare shop drawings and obtain prior approval of the Engineer. Three prints of each shop drawings shall be submitted for obtaining approval. No piece of work shall be allowed to be executed at site without the availability of these approved shop drawings. These shop drawings shall clearly depict the load balancing chart of each distribution board. Time required for the preparation and approval of shop drawings shall be considered to have been included in the total time allowed for the completion of the work.

As-Built Drawings

Clearly annotated "As-Built" electrical drawings and diagrams shall be maintained upto date on site on completion of the Job. One reproducible and three prints of each drawing shall be submitted to the Engineer alongwith a recommended maintenance schedule chart and manuals/operating instructions for equipment supplied. The Contractor shall also provide complete detailed identifications of MV incoming and LV outgoing circuits, in the form of line drawings, for each pad mounted transformer. The line drawings shall be made on 20 SWG sheet metal work. The line drawings shall be clearly identified with permanent colors. The MV and LV. circuits shall being different colors. The sheet metal work shall be of suitable dimensions so as to be fixed on the inside of the door of the LV compartment of the pad mounted transformers. The line drawing shall be fixed with the help of rivets for permanent installation.

11.0 PRODUCT DELIVERY, STORAGE AND HANDLING

All equipment shall be boxed, crated or otherwise enclosed and protected during shipment, handling, storage and after installation until final acceptance

of the equipment. Electrical materials shall be delivered in manufacturer's original cartons or containers with seals intact, as applicable. Large multi-component assemblies shall be delivered in sections that facilitate field handling and installation.

Unless designed for outdoor use, all equipment shall be kept dry, off the ground and covered from exposure to weather. Electrical equipment and equipment having anti-friction or sleeve bearings shall be stored in weather tight storage facilities. Heaters in equipment shall be connected and operated until the equipment is placed in operation. The Contractor shall prevent corrosion, contamination or deterioration of stored equipment.

Equipment and materials shall be handled in accordance with manufacturer's recommendations. Large or heavy items shall only be lifted from the designated points. Padded slings and hooks shall be used for lifting to prevent damage.

All equipment shall be protected until final acceptance and all factory surfaces must be protected from impact, abrasion, discolouration and other damage. All damaged equipment must be repaired or replaced before final acceptance.

12.0 MANUFACTURER'S INSTRUCTIONS

The Contractor shall supply to the Engineer Three (3) copies of manufacturer's instruction manuals in properly bound form for installation, testing commissioning, operation and maintenance of the specified equipment including manuals of spare parts and tools of the equipment. One copy of the documents shall be submitted in original. The installation instructions shall be submitted four (4) weeks prior to commencement of installation of each equipment, and operation & maintenance instruction at least two (2) weeks before the time of commissioning. If the contractor fails to provide the documents the Engineer shall withhold issuance of requisite certificates and deduct suitable amount from the payments to the Contractor.

13.0 GUARANTEE

In addition to the Contractor guarantee and liabilities for satisfactory operation of the works, wherever advised by Engineer, the Contractor shall also furnish written guarantee of the manufacturer or supplier with respect to satisfactory performance, of each equipment. Guarantee shall be given for replacement and repair of part or whole of the equipment that may be found defective in material or workmanship. The guarantee shall as a minimum cover the duration of Maintenance Period as defined in the Conditions of Contract. This guarantee shall not relieve the Contractor of his obligations and he will be fully responsible for the repair or replacement of any defective material in time so as not to cause any undue delay in carrying out the repairs and/or replacements.

14.0 INSTALLATION INSTRUCTIONS

The Contractor shall furnish all labor, materials, tools and equipment required to install, connect, test and commission all electrical equipment specified herein, whether or not such equipment is furnished by him or by others.

For all equipment to be installed by the Contractor, the Contractor shall supply and install all erection materials such as foundation bolts, washers, nuts, etc. as required and without any additional costs.

The Contractor shall set out the works himself as per Specifications and Drawings and shall properly position the equipment on specified foundation/location. In general, the manufacturer's instructions for installation shall be followed.

Any defect or faulty operation of equipment due to the Contractor not following the manufacturer's instructions shall be corrected and repaired by the Contractor at his own cost as per these specification and to the satisfaction of Engineer.

For any deviation from the working drawings that are deemed necessary by the Contractor due to site conditions, he shall submit the details and obtain the Engineer's approval before starting such works.

15.0 PRESHIPMENT INSPECTION AND TESTING

15.1 General

All equipment and material covered in scope of this contract are subject to pre-shipment inspection & testing at the manufacturer's factory/works. The Contractor, in coordination with the manufacturers of relevant materials shall arrange for the pre-shipment inspection & testing by the Engineer at the manufacturer's factory/works. The Contractor shall make all necessary arrangements and cater for all expenses in this regard for the traveling, boarding and lodging of the Engineer plus daily allowance @ Rs. 5000 per day per person within Pakistan (minimum 03 persons) and US $ 200 per day per person outside Pakistan (minimum 03 persons), for the pre-shipment inspection and to witness the tests at the manufacturer's factory/works.

15.2 Pre-shipment Factory Tests

15.2.1 MV & LV Switchgear, Generators, Transformers, Maintenance-Bypass Switch & Communication Systems Equipment

All type and routine tests on all equipment, materials and switchgear shall be performed at the manufacturer's works in

the presence of the Engineer or his Representative. Type tests may be waived off in case test certificates, certified by an approved standard laboratory of international repute, approved by the Engineer, are submitted. But merely producing the type test certificates shall not relieve the Contractor and the manufacturer to carry out the required tests.

The Contractor shall obtain from the manufacturer and submit to the Engineer for approval, the complete details of tests to be performed describing the procedures, test observations and expected results.

The Contractor shall ensure availability of all tools, instruments, test equipments, materials, etc., and all qualified personnel required for the testing, setting and adjustment of all equipments and materials including putting the same into operation.

All tests shall be made with proper regard for the protection of the personnel and equipment and the Contractor shall be responsible for adequate protection of all personnel and equipment during such tests. The cost of any damages or rectification work due to any accident during the tests shall be the sole responsibility of Contractor.

The Contractor shall record all test values of the tests made by him on all equipment. Four (4) copies of all test data and results certified by the Engineer shall be given to the Engineer for record purposes. These shall also include details of testing method, testing equipment, diagrams, etc.

The Contractor shall inform the Engineer about the place, date and time of test, of each equipment at least, two (2) weeks in advance. The witnessing of test by the Engineer or his representative shall not absolve the Contractor from his responsibility for the proper functioning of the equipment, and for furnishing the guarantees referred to in clause 8.0. All test results shall be supplied in quadruplicate.

15.2.2 Insulation Resistance Test

Insulation resistance test shall be made on all electrical equipment by using a meggar of 500 volts for circuits upto 250 volts and meggar of 1000 volt for circuits between 250 and 500 volts. The Engineer shall advise the exact testing voltages. The insulation resistance values of cables,

switchgear, etc., shall be as per BSS, IEC, ICEA and Pakistan Electricity Rules.

15.3 Field Tests

15.3.1 General

Upon completion of the installation, the Contractor shall perform field tests on all equipment, materials and systems. All tests shall be conducted in the presence of the Engineer for the purpose of demonstrating equipment and systems compliance with Specifications. The Contractor shall submit for Engineer's approval complete details of tests to be performed describing the procedure test observations and expected results.

The Contractor shall furnish all tools, instruments, test equipment, materials, etc., and all qualified personnel required for the testing, setting and adjustment of all electrical equipment and material including putting the same into operation.

All tests shall be made with proper regard for the protection of the personnel and equipment and the Contractor shall be responsible for adequate protection of all personnel and equipment during such tests. The cost of any damages or rectification work due to any accident during the tests shall be the sole responsibility of Contractor.

The Contractor shall record all test values of the tests made by him on all equipment. Four (4) copies of all test data and results certified by the Engineer shall be given to the Engineer for record purposes. These shall also include details of testing method, testing equipment, diagrams, etc.

The witnessing of any tests by the Engineer does not relieve the Contractor of his guarantees for materials, equipment and workmanship, or as any other obligations of contract.

15.3.2 Insulation Resistance Test

Before making connections at the ends of each cable run or joint between cables, the insulation resistance test of each cable section shall be made. Each conductor of a multicore cable shall be tested individually with each of the other conductor of the group and also with earth. If insulation resistance test readings are found to be less than the specified minimum in any conductor, the entire cable shall be replaced and tests repeated on new cable. If cable joint is provided, then each cable section shall be tested, and joint

made only after the tests have been made satisfactorily. Finally the completed cable length including the joints shall be tested.

All switchgear shall be given an insulation resistance test after installation, but before any wiring is connected. Insulation tests shall be made between open contacts of circuit breakers, switches and between each phase and earth.

If the insulation resistance of the circuit under test is less than the specified value, the cause of the low reading shall be determined and removed. Corrective measures shall include dry out procedure by means of heaters, if equipment is found to contain moisture. Where corrective measures are carried out, the insulation resistance readings shall be taken after the correction has been made and repeated twice at 12 hours interval. The maximum range for each reading in the three successive tests shall not exceed 20% of the average value. After all tests have been made, the equipment shall be reconnected as required.

15.3.3 Earth Resistance Test

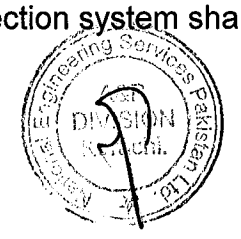
The Contractor shall make Earth resistance tests on the earthing system, separating and reconnecting each earth connection.

If it is indicated that soil treatment or other corrective measures are required to lower the ground resistance values, the Engineer will determine the extent of such corrective measures.

The electrical resistance of the ECC together with the resistance of the earthing leads measured from the connection with earth electrode to any other position in the complete installation shall not exceed one ohm.

Earth resistance test shall be performed as per Electrical Inspector's requirements. Where more than one earth electrodes are installed, the earth resistance test of each electrode shall be measured.

The complete lightning protection system shall be tested for continuity and earth resistance. The combined earth resistance at any point in the lightning protection system shall not exceed ten (10) ohms.



15.4 Completed Tests

After any equipment has been tested, checked for operation, etc., and is accepted by the Engineer, the Contractor shall be responsible for the proper protection of that equipment so that subsequent testing of other equipment do not cause any damage to the already tested equipment.

16.0 ASSOCIATED CIVIL WORKS

The cost of all civil works which are associated with any BOQ item are deemed to have been included in the respective items of Bill of Quantities unless specifically stated otherwise. The civil works shall include excavation, backfilling of earth, complication of the earth, foundation pads, grouting, chiseling, making openings, etc. Such works will also include repair of any damage to civil works caused by the Contractor during electrical installation.

17.0 EXPENSES TO BE BORNE BY THE CONTRACTOR

All expenses regarding travelling, boarding, lodging and witnessing of tests by the Engineer or his representative and/or the owner or his representative including costs for carrying out the required tests shall be borne by the Contractor and are deemed to have been included in the bid.

18.0 TEST CERTIFICATES TO BE FURNISHED BY THE CONTRACTOR

After all field tests have been carried at site, the Contractor shall furnish test certificates for the following equipments and materials as supplied and installed by the contractor;

- Lighting fixtures
- MV & LV Switch Boards & Distribution Boards
- MV & LV Power cables
- Diesel Generator Sets
- Dry Type Transformer (11/0.400kV)
- Earthing system
- Fire Detection & Alarm system

19.0 PAYMENT

No separate payment shall be made for work involved within the scope of this section, unless specifically mentioned in the respective items of Bill of Quantities.

SECTION 8112

UNINTERRUPTIBLE POWER SUPPLY SYSTEMS

1.0 SCOPE

The present specification indicates the characteristics required for the supply of uninterruptible power systems.

The product supplied must be compatible with the specification requirements. Any departure from the specification must be indicated in the bid phase.

2.0 APPLICABLE STANDARDS & CODES

The following Standards are referred to in this Part:

IEC 60647 Low Voltage Switchgear and Control gear
IEC 60948 Low Voltage Control gear

2.1 Submissions

Submit in accordance with General Specification for electrical works

2.1.1 **Shop Drawings**

a) Submit dimensional drawings of the main switchboard, including sections and elevations, showing the following:

i) Sizes and positions of components
ii) Positions and method of fixing cable and boxes
iii) Location of terminal boards
iv) Other pertinent data

2.1.2 **Project Data**

a) Submit

i) Full specifications of the enclosure and the components of the equipment with relevant sheets of manufacturer's catalogues

ii) Confirmation that the equipment complies with the relevant specifications

National Engineering Services Pakistan (Pvt.) Ltd. DIVISION Karachi.

3.0 MATERIAL

3.1 DESCRIPTION OF THE REQUIRED SYSTEM

The UPS system shall be comprise of single rectifier, battery charger and inverter modules:

a) The UPS system shall be designed in such a way that any spare part, printed circuit boards, sub-assembly or component, can be replaced without any adjustment

b) It shall supply clean, uninterrupted power to the critical loads and meet the specifications

c) Transformers shall be manufactured using vacuum pressure impregnated insulation.

The system required is an uninterruptible power system (UPS) with rating mentioned in BOQ with On Line double conversion technology: the load is always powered by the inverter, which supplies a sinusoidal voltage that is filtered and stabilized in voltage, form and frequency. Moreover, the input and output filters significantly increase the immunity of the load against mains interference and lightning.

CHARACTERISTICS

- The system has to provide a power supply that is filtered, stabilized and reliable (On Line double conversion technology in accordance with standard EN50091-3) with filters for the suppression of atmospheric noise.
- The on line technology guarantees maximum protection for the connected loads. A double conversion stage is also required to filter and stabilize the input voltage, by regenerating it and removing mains interference (overvoltages, frequency and voltage fluctuations)
- The UPS must provide the following features:
- Total microprocessor control
- Distributed parallel configuration
- Automatic battery test
- Ups can be connected in parallel and redundant up to 8 units even different power rating
- Protection against battery deep discharge
- Automatic shutdown function when load is absent
- LCD and LEDs display

- Low consumption:
- The UPS must provide various operating modes to reduce consumption. The user must be able to select from the following modes:

  a. **"on line"** operation (in compliance with standard EN50091): to guarantee maximum protection for the load

  b. **"line interactive"** operation (in compliance with standard EN50091): to guarantee minimum consumption

  c. **"automatic line interactive"** operation: the UPS automatically selects line interactive operation, after checking the quality of the mains power supply and running load and mains interference diagnostics

  d. **"back-up"** operation: for the supply of power to emergency lighting

     - Automatic restart when mains power returns
     - Frequency auto-sensing
     - Manual by-pass
     - Monitoring and shut down software included:
     - Network management through TCP/IP protocol:

The system must be provided with the software to guarantee the efficient and intuitive management of the UPS, displaying by means of bar graphs the most important information such as input voltage, applied load, battery capacity, etc.

- External manual by-Pass:

It must be possible to connect the UPS to an external manual by-pass system. Manual bypass switch system of full UPS shall be integrated into the UPS so that load can be transferred to mains supply WITHOUT break for maintenance of UPS. Procedure for transfer to maintenance bypass and back to UPS shall be controlled by the bypass menu of the UPS, thus eliminating possibility of causing disturbance of load by operator who is unaware of correct procedures (it must also be possible to read on the UPS display the signals on the status of the external by-pass).

- Interfacing

Connectors for remote signals and controls

The UPS must provide the following connectors:

connectors for EPO, emergency remote shutdown control, female DB15 (input/output contacts for remote signalling); male DB9 (RS232-1); female

DB9 (RS232-2 for modem connection);

slot for SNMP card

The contractor shall assess the electrical load capacity of the UPS taking into account derating for non-linear and worst case ambient temperature conditions.

The UPS cabinet shall be designed such that all components are removable from the front and cable entry by floor mounted gland plates.

3.2 Rectifier/Charger

The rectifier/charger shall be solid-state type with fully controlled 6-pulse thyristor bridge and anti-harmonic chokes. It shall have 10 sec walk-in ramp for input current, adjustable battery current and voltage. It shall recharge a fully discharge battery in 24 hours. A boost charge facility shall be provided. A normally open contact rated at 220 Vac, 2A, close on boost charge, shall be provided for remote monitoring. Input voltage ratings are as follows:

a) Mains 1 (input to rectifier/charger)
Voltage : 400 volts AC ± 10% / 220 volts AC ± 10%
Wiring : 3-phase, 4 wire + Earth / 1-phase, 2 wire + Earth
Frequency : 50 Hz

b) Mains 2 (input to static switch)
Voltage : 400 volts AC ± 15% / 220 volts AC ± 15%
Wiring : 3-Phase, 4 wire + Earth / 1-Phase, 2 wire + Earth
Frequency : 50 Hz

c) Synchronization Range: ± 0.75 Hz

3.3 Battery

Unless otherwise specified in the Project Documentation, the battery shall be of sealed lead acid maintenance free type and sized for the pre-selected time with the UPS operating at rated load. The battery set shall be installed in similar cabinet finish as the UPS unit.

The battery system shall be sized to maintain full load for a period of 8~10 minutes.

3.4 Inverter

The inverter shall be of transistorized PWM type, for the specified UPS rated power at 0.8 p.f. Output rating shall be as follows:

Wiring	:	3-phase, 4 wire and earth / 1-phase, 2 wire and earth
Voltage	:	400/220 volts (ϕ 1%), 50 Hz
Transient voltage regulation	:	Voltage transients shall not exceed ϕ 5% for a 100% load step change and the return to steady state value shall be in less than 20 milliseconds.
Harmonic distortion	:	Less than 4% THD
Efficiency	:	For 100% load 92%
	:	For 50% load 91%
Audible noise	:	< 65 dBA @ 1.5m

Output synchronized in amplitude, phase & frequency to mains 2 when mains 2 is within tolerance limits. Phase difference between inverter output and mains 2 held below 3 (electrical) in such condition so that the maximum gap while transfer to UPS from Mains 2 and vice versa occurs shall be less than 167 micro seconds.

3.5 Overload Capabilities

a) Inverter shall sustain 125% overload for at least 10 minutes and 150% overloads for 1 minute. After delay, if overload persists, the load shall be transferred to bypass supply without break if Main voltage is within tolerance limits. The UPS shall check the load and if the load is below overload threshold, inverter shall restart automatically and load shall be transferred back to inverter. Facility to inhibit automatic re-transfer shall be provided.

3.6 Monitoring and Control

Monitors

a) The following status information shall be monitored by indicating lights on the front panels of the UPS:

i) rectifier/charger on
ii) load on inverter
iii) load on Mains 2 bypass
iv) alarm

v) inverter shutdown imminent
vi) boost charge

b) an audible alarm shall warn the user of faults or operating problems. The system shall be equipped with an alarm off button. Metering values displayed on an alpha-numeric display.

c) The following measurements shall be available:

i) inverter output voltage (L-L)
ii) Inverter output frequency
iii) inverter output currents
iv) voltage across battery terminals
v) battery current (charge) input voltages
vi) mains 1 rectifier/charger) input voltages (L-L)
vii) rectifier/charger input currents.

3.7 Remote Control and Monitoring

On request, the supplier must be able to guarantee 24 hour remote supervision of the equipment. The products provided must therefore be able to dialogue via modem and to communicate with the authorized support centres that will be able to interrogate the system periodically and verify the present and past operating parameters, and send a report to the user, in fully automatic mode.

The UPS must be able to call the support centres to signal alarms or faults automatically so that the support centre may intervene immediately. Remote transmission shall be possible for all controls, monitors and measurement indication on the UPS unit.

3.8 Protective Devices, Controls and Monitors

The UPS shall be built on modular basis.

The UPS shall include protection against input over voltage, load short – circuits, external or internal over-temperature, vibration and Impacts during transport, etc. The UPS shall stop automatically if the DC voltage drops below a pre-set minimum value.

Signalling on the operating status of the UPS is to be provided by means of a liquid crystal display (LCD) with contrast control and having two(min) rows of atleast 30 characters.

Controls shall be micro processor based and the following main controls shall be possible:

- four luminous report signals: power supply and by-pass lines input
  inverter output by-pass line output
  battery input
- rectifier/charger on/off
- inverter on/off
- forced shutdown
- forced transfer upon forced shutdown of inverter when the bypass power supply is outside tolerances
- self-test

- an acoustic alarm device.

4.0 TESTING

The Ups manufacturer shall provide proof of a stringent Quality Assurance Program. In particular the main equipment manufacturing stages sanctioned by appropriate tests such as: incoming components inspection, discrete sub-assembly tests and complete functional checks on the final product. Equipment shall undergo on-load burn-in laving the factory. Final inspection and calibration operations shall be documented in a report drawn up by the supplier's Quality Inspection department.

TECHNICAL DATA

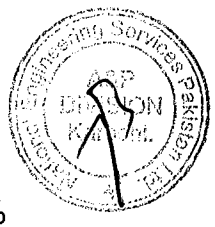
UPS Rating	KVA
INPUT	
Input phases	
Nominal voltage	V
Maximum input tolerance for non-intervention of battery	V
Nominal frequency	Hz
Power factor	
BY-PASS	
Maximum acceptable tolerance for mains switching	%
Configuration of voltage tolerance (from control panel)	%
Maximum frequency tolerance accepted for switching	%
Configuration of configurable frequency tolerance (from control panel)	%
Switching time in Line Interactive mode (by-pass/inverter and vice versa)	ms
Protection against mains back feed	
OVERLOADS ON BY-PASS (xIn)	
1s	
10ms	
Efficiency	%
BATTERY	
Type of battery	
Intervention time (mains failure)	
Nominal power supplied	KW
Compensation of battery voltage with temperature	mV/°C per element
OUTPUT	
Number of phases	
Nominal voltage	V
Field of regulation of the phase/neutral voltage (from control panel)	V
Wave form	
Frequency	Hz
Operation as frequency converter	

Operation as back-up unit (load powered only if mains absent)
Current peak factor (as per standard EN50091-3)

Nominal power (VA)	KVA
Nominal power (W)	KW
Static variation	%
Dynamic variation (with load impact from 0 to 100%)	%
Output frequency variation with mains absent	%
Output frequency variation with mains present	%
Output frequency variation (from mimic panel)	%
Voltage distortion (linear load)	%
Voltage distortion (non-linear load)	%

OVERLOAD TIMES (from inverter)

100%< Load <110%	hrs
110%< Load <125%	min
125%< Load <150%	min
Short circuit current (t<0.5 sec.)	%
Short circuit current (phase/neutral)	In
Short circuit current (phase/phase)	/
Inverter efficiency	%



VARIOUS

AC/AC efficiency (double conversion mode)	%
AC/AC efficiency (Line interactive mode)98%	
Maximum permanent operating temperature	°C
Humidity	%

PROTECTIONS

Noise	dB(A)

DIMENSIONS

Mechanical characteristics	Shielded metal cabinet with applied plastic front
Level of protection	IP
Cables input	Front, from the bottom
Cooling	Forced ventilation, with speed variable according to load

SECTION-8121

11/0.4 KV POWER TRANSFORMER

PART-1 GENERAL

1.01 SCOPE

a. The work under this section consists of design, manufacturing, fabrication, supplying, installation, testing & commissioning of all materials and accessories for the complete Power Transformers as specifications herein and stated in the respective items of the Bill of Quantities.

b. The capacity of transformers to be provided, are mentioned in the respective items of the Bill of Quantities. The transformers shall be complete, with all accessories and attachments as detailed in these specifications or otherwise required for satisfactory operation, service and maintenance.

c. All details, drawings, data, etc. for each type and rating of the Power Transformer shall be furnished with the bid.

d. The Contractor shall discuss the electrical layout with the Engineer and co-ordinate at Site with other services for exact route, location and position of the equipments.

e. Transformer with accessories shall also comply with the General Specifications for Electrical Works, Section-8001 and with other relevant provisions of the Tender Document.

f. The transformer shall be supplied taking into account WAPDA system's requirements.

1.02 APPLICABLESTANDARDS/CODES

Latest editions of the following standards and codes shall be applicable for all materials in scope of this section:

BS90	-	Power transformers
BS14	-	Transformer oil
BS171	-	Specifications for power transformer
BS223	-	High voltage bushings
IEC 60076	-	Power transformers

PART-2 PRODUCTS

2.01 Power Transformer

a. The transformer tank shall be constructed of welded boiler plates and provided with external radiating tubes. The tank and radiating tubes shall be designed to withstand, without developing any deformation, pressure at least 25 % greater than the maximum operating pressure. The steel cover plate shall be bolted to the tank using gasket for

perfect oil seal.

b. Inspection hole with cover shall be provided on top of the tank. Two earth terminals shall be provided at the base of the tank. The tank shall be anti-corrosive painted and finished in gray colour. The oil preservation system shall have a conservator tank fitted with silica gel breather, oil level indicator and a drain valve.

c. The transformer core shall be built of non-aging, cold rolled, electrical silicon steel lamination and each lamination insulated to reduce eddy current losses. The core laminations shall be clamped and bolted effectively to reduce humming. The winding coils shall be of high grade electrolytic copper conductor, flat or round, paper insulated, thoroughly dried and impregnated as required. The medium voltage (MV) lead on indoor transformer shall be brought out to glazed porcelain insulator bushings for external connections to cables. Protective spark gaps of suitable design shall be connected in parallel to the MV bushings to protect the transformer from surge voltages. The three LV and one neutral phase leads shall be brought out and terminated at glazed porcelain insulator bushings for Connection to LV side by copper conductor cables.

d. Off-load tap changer shall be provided on MV side at suitable Location preferably on the side of transformer tank. A clear marking illustrated by diagram shall be provided to indicate the tap positions. Double float Buchholz relay shall be provided on the transformer. It shall have required number of contacts for connection to tripping and alarm circuits.

e. The transformer shall be provided with the following accessories;

- Oil filling valve for vacuum filling of oil
- Oil drain valve with sampling device
- Bi-directional rollers
- Lifting lugs
- Dial type thermometer which shall have maximum temperature indicator pointer
- Stem type thermometer fitted in a pocket for indicating the oil temperature
- Diagram and rating plate
- Jacking pads
- Pressure release safety valve

2.02 Principal Data of Power Transformer

a. The Power transformers shall be fully tropicalized, three phase, step down, oil filled, self cooled, core type, double wound, suitable for parallel operation and for indoor installation.

b. The Power transformers shall meet the minimum technical specifications but not limited to the following:

Description	Data suggested	Data submitted
Type		
Capacity (Rated continuous)	As stated in BOQ	
Voltage ratio at no-load	11000/415 Volts	
Frequency	50 Hz	
Vector group	Dy 11	
Off load tapping arrangement (on HT side)	-7.5%, -5%, -2.5%, 0% +2.5%, +5%,	
HT connection	11 kV Delta	
LT connection	400V with grounded star point.	
Temperature rise of oil over ambient temperature	40^0 C maximum	
Temperature rise of winding over ambient temperature	50^0 C maximum	
Impedance voltage (%)	4	
Voltage regulation for normal operating conditions	Not to exceed 2.5% of no-load	
Voltage regulation at 85% pf at full load (%)	3.5	
Rated maximum voltage HT/LT	15kV/0.6 kV	
Basic insulation level	95 kV	
Power frequency withstand voltage	34 kV	
Rated short-time current (kA)	25	
Switching inrush current (Amps)	6-7 times of HV line current	
Power losses at full load (Watts)	Data to be provided by the supplier	
Iron losses at unity pf		
Iron losses at 0.85 pf		
Copper losses at unity pf		
Copper losses at 0.85 pf		
Efficiency at 0.85 pf %	Data to be provided by the supplier	
At 25% of rated load		
At 50% of rated load		
At 75% of rated load		
At 100% of rated load		
Transformer Weight (Kg)	Data to be provided by the supplier	
Total		
Weight of oil		
Windings		
Transformer Oil	Data to be provided by the supplier	
Type		
Quantity for one complete filling		

PART-3 EXECUTION

a. Transformers shall be installed at locations shown on drawings. All civil works including provision of under-floor cable trench, transformer oil pit, openings in wall, steel channel etc. shall be carried out under civil works. The Contractor shall be responsible for general checking and co-ordination with civil works to ensure compliance with the requirements of transformer manufacturer for installation of equipment. For installation, connecting testing and commissioning of transformers, the Contractor shall provide all required labour, materials, tools and testing equipment.

b. The transformer installation shall be carried out in accordance with specifications and the best-accepted practice. Any loose components supplied by manufacturer shall be assembled, installed and connected in place as to form a complete assembly as per manufacturer instructions. After the transformer is placed in position and aligned for MV & LV termination, the roller wheels shall be locked with the foundation steel channel to avoid any unintentional movement of the wheels.

c. After the transformer is installed and connected, a thorough check shall again be made for the proper fixing of accessories, neutral connections, oil level, etc. The transformer shall be tested before energizing as per instructions contained in the article "Testing" of General specifications for electrical works Section - 8001 of these Specifications.

PART-4 METHOD OF MEASUREMENT

4.01 General

The Manufacturer's bid amount against each Bill of Quantities item as given below shall include supply, installation, testing & commissioning of power transformer including all required accessories as stated in these specifications related to the item.

4.02 Measurement of Power Transformer

Measurement shall be made for each size of Power Transformer including required accessories acceptably designed, manufactured, fabricated, supplied, tested & commissioned by the Contractor as a complete job.

PART-5 BASIS OF PAYMENT

5.01 Payment of Power Transformer

Payment shall be made for the number of each size of units measured as provided above at the Contract unit price each and shall constitute full compensation for design, manufacturing, fabrication, supplying, installation, testing & commissioning of the Power Transformer with all accessories.

SECTION - 8132

LOW VOLTAGE SWITCHBOARDS, MAINTENANCE BY-PASS SWITCH, POWER FACTOR IMPROVEMENT PLANT AND BUS TIE DUCT

1.0 SCOPE OF WORK

The work under this section consists of design, manufacturing, fabricating, supplying, installing, testing, and commissioning of all material and services of the complete LV (LV) (415 Volt) switchboard, Maintenance By-Pass Switch (MBS), Power Factor Improvement (PFI) Plant and Bus Tie Duct (BTD) for indoor installation as specified herein, shown on the Drawings and stated in the Bill of Quantities.

The Contractor shall discuss the electrical equipments and power & control cables layout with the Engineer and co-ordinate at site with other services for exact locations and positions of the electrical lines and equipments.

The LV (415 Volt) switchboards, MBS, PFI Plant and BTD with all other required accessories shall also comply with the General specifications for Electrical Works Section-8001 and with other relevant provisions of the Documents.

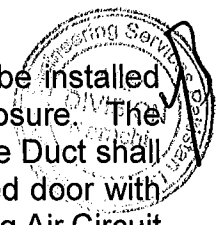
2.0 GENERAL

2.1 Low Voltage (415 Volt) Switchboard

The LV (415 Volt) switchboard shall be sheet steel fabricated. The LV (415 Volt) switchboard shall be free standing cubicles on floor.

The free standing cubicles shall be modular in design with facility and provisions for expansion/ addition of additional cubicles in future

These shall be suitable for indoor installation on cable trenches. The LV (415 Volt) switchboard shall be totally enclosed, dust and damp proof. The LV (415 Volt) switchboard shall be complete in all respects with material and accessories, factory assembled, tested and finished according to the Specifications and to the normal requirements.



All components of LV (415 Volt) switchboards shall be installed on a common mounting plate inside the enclosure. The enclosures of LV (415 Volt) switchboards and Bus Tie Duct shall be provided with rubber gasket and a lockable hinged door with cam fastener. The switching lever of the Main incoming Air Circuit Breaker (ACB)/Moulded Case Circuit Breaker (MCCB) of LV (415 Volt) switchboards shall be accessible from outside of the panel doors in closed position. Switching levers of all outgoing MCCBs and MCBs shall only be accessible with the panel doors in open

position.

The LV (415 Volt) switchboards shall be supplied complete with all installation materials as recommended by the manufacturer. The incoming and outgoing cable connections shall be according to the wiring requirements. If required, an adapter box for LV (415 Volt) switchboards to accommodate the cables and conduits may be provided. The box shall be of the same material and finish as the switchboard.

The cabling inside the switchboard shall be suitably harnessed by means of straps or cords. For the LV (415 Volt) switchboards an earth bar or terminal strips shall be provided for connection of incoming and outgoing earth conductors. The earth bar or terminals shall be permanently connected to the body of switchboard at two points.

The LV (415 Volt) switchboards, in general, shall;

- be suitable for indoor installation & operation
- be suitable for operation and maintenance from front side
- be suitable for 415 Volt, 3 phase 4 wire, 50 Hz system
- have all components rated for insulation class of 600V min
- be designed for flush mounting of all instruments on the front
- be provided with adequate clearance from live parts so flash overs can not be caused by switching, vermin, pests, etc.
- have incoming/outgoing cable termination arrangements. The power cables shall be directly connected to the terminals of TP 500V MCCBs of current ratings of 100 Amps and above. The SP/TP MCBs and/or MCCBs of current ratings upto and including 100 Amps shall be connected to DIN rail mounted wiring terminals of appropriate ratings, numbers and sizes for the outgoing wiring cables
- be provided with name plate on the front side of door for each incoming/outgoing circuits
- be provided with pocket inside of door for safe keeping of the detailed as-built wiring/ shop diagrams of the switchboard
- have provisions for incoming and outgoing cables entry, connections and termination arrangements from top and/ or bottom plates as per site requirements

- have all openable doors grounded with the use of flexible copper cable/strip of 10 sqmm cross-sectional area, at least

2.2 Maintenance By-Pass Switch (MBS)

The Maintenance by-pass switch shall be used for supply of power either from power transformer or DG set in case of faults in AMF Panel.

2.3 Power Factor Improvement (PFI) Plant

The Power factor Improvement Plant shall be used for improving the system power factor to keep the same within the limits as prescribed by WAPDA.

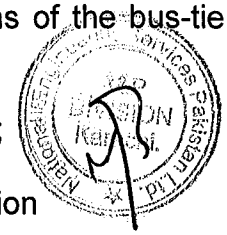
2.4 Low Voltage (415 Volt) Bus Tie Duct (BTD)

The LV (415 Volt) Bus Tie Duct shall be sheet steel fabricated. The LV (415 Volt) Bus Tie Duct shall be suitable for indoor installation. The Bus Tie Duct shall be suitable for indoor mounting on CC wall and RCC columns surfaces as shown on the drawings. The Bus Tie Duct shall be totally enclosed, dust and damp proof.

The Bus Tie Duct shall be designed to withstand a short circuit as specified for the associated LV switchboard. The current rating shall be as given in Bill of Quantities. The Bus-Tie Duct shall be three phase and neutral, rated for 415 Volt, 50 Hz system.

The LV (415 Volt) Bus Tie Duct shall be complete in all respects with material and accessories, factory assembled, tested and finished according to the Specifications and to the normal requirements.

The Contractor shall supply the bus-tie duct keeping in view all the installation, operation and maintenance factors as per site conditions and requirements and shall be solely responsible for the proper design configurations and dimensions of the bus-tie duct for complete alignment.



The LV (415 Volt) Bus Tie Duct, in general, shall;

- be suitable for indoor installation & operation
- be suitable for operation and maintenance from front/ rear sides
- be suitable for 415 Volt, 3 phase 4 wire, 50 Hz system
- have all components rated for insulation class of 600V min
- have name plates on the front & rear sides at every 5 meter

- have suitable provisions for incoming and outgoing cables entry, connections, termination arrangements as per site requirements
- have all openable doors grounded with the use of flexible copper cable/strip of atleast10 mm^2 cross-sectional area

3.0 APPLICABLE STANDARDS/CODES

The latest editions of the following standards and codes shall be applicable for the materials specified within the scope of this Section :

IEC 947	-	Triple pole Air Circuit Breakers
BS 4752-1	-	Triple pole Moulded Case Circuit Breaker
VDE 0641	-	Single and Triple pole Miniature Circuit IEC 947 Breaker
IEC 947	-	LV Switch gear and Control gear
IEC 439	-	Factory Built Assemblies of LV Switchgear
IEC 4752	-	Switch gear and control gear for Voltages upto and including 1 kV
BS 88	-	HRC Fuses
IEC 73	-	Colors for indicator lights and push buttons.
IEC 446	-	Identification of insulated/bare conductors

4.0 MATERIAL

4.1 Low Voltage (415 Volt) Switchboard

4.1.1 Sheet Metal Work

The enclosures for the LV (415 Volt) switchboards shall be fabricated with 14 SWG sheet steel. The front doors shall be fabricated with 12 SWG sheet steel.

The complete sheet steel metal work of the LV (415 Volt) switchboards shall be:

- cleaned down to bare shining metal
- de-rusted and de-greased
- painted with two base coats of anti-corrosive RED oxide paint.

- Two coats of weather proof powder paint in approved colour.

4.1.2 Components

The LV switchboard shall be provided with components as specified in these specifications, mentioned in the Bill of Quantities, as shown on the Drawings required for the satisfactory operation of the switchboard and of the electrical system.

Typical component specifications are given below:-

4.1.2.1 Bus Bars

The bus bars shall be made of high conductivity electrolytic copper and shall be completely isolated and mechanically braced for the specified fault level. The phase identification of bus bars shall be by colours applied on bus bars and these shall be red, yellow and blue for phases and white for neutral. The earth bus bar shall be green.

The bus bars shall be triple pole and neutral and shall be of appropriate size to meet the electrical and mechanical requirements of the system. The temperature rise shall not exceed 45 degrees centigrade at rated current.

4.1.2.2 Moulded Case Circuit Breaker (MCCB)

The MCCB shall be moulded case, triple pole, rated for 415 Volt AC. The Operating current ratings and Rupturing capacities shall be as mentioned in the relevant items of the Bill of Quantities and as shown on the drawings. The MCCBs shall have fixed Magnetic Short circuit and fixed Thermal Overload protections. All incoming Triple pole circuit breakers shall be MCCBs.

The Moulded Case Circuit Breakers shall be installed in the LV switchboards such that the Switching levers of Main Incoming MCCB and all outgoing MCCBs and MCBs shall be accessible from inside the front of the panel with the front door in closed position. Circuit numbers and designation on all circuits shall be clearly marked to facilitate connection and maintenance.

4.1.2.3 Miniature Circuit Breaker (MCB)

The MCBs shall be Single pole 250 Volt and Triple pole 415 Volt of current ratings as shown on the drawings. These shall have fixed magnetic short circuit and fixed thermal overload protections. The Single pole and Triple

pole miniature circuit breakers shall have a 10,000 Amperes short circuit breaking capacity as per International standards IEC 157 Category P2.

The Miniature Circuit Breakers shall be installed such that their switching levers are accessible through the front plate inside the switchboards for operations. Circuit Numbers and Designation on all circuits shall be clearly marked to facilitate connection and maintenance. These Circuit Breakers shall be suitable for working on lighting and power circuits.

4.1.2.4 **Air Break Magnetic Contactors**

The contactors shall be air break, triple pole, 415 Volt suitable for the type of duty to be performed. The main contacts shall be silver tipped, butt type with double break per pole. Each contactor shall be provided with 230 Volt, AC single phase operating coil, and minimum two normally open (NO) and two normally closed (NC) auxiliary contacts wired upto terminals. The number of working auxiliary contacts shall be provided according to the system requirements.

4.1.2.5 **Push Buttons**

Push buttons shall be momentary make break contact type (normally open/normally close). These shall be suitable for flush mounting on switchboard, plastic faceplate etc. Push buttons shall have round/square head. These shall be of red color for 'ON' and green color for 'OFF' operations.

4.1.2.6 **AC Voltmeters**

AC Voltmeters shall be digital type and shall be suitable for flush mounting on front door of the switchboards. The front dimensions shall be 96 mm Wide and 48 mm high. The voltmeters shall have 3-1/2 digit, 0.55-inch display. The AC digital voltmeters shall have measuring range of 0 to 1999 Volt AC. It shall be suitable for power supply of 110/220 Volt AC $\pm$10% at 50/60 HZ.

4.1.2.7 **Ammeters**

AC Ammeters shall be digital type and shall be suitable for flush mounting on front door of the switchboards. The front dimensions shall be 96 mm wide and 48 mm high. The Ampere meters shall have 3-1/2 digit, 0.55-inch display. The AC digital voltmeters shall have measuring ranges as shown on the drawing and given in the Bill of Quantities. It shall be suitable for power supply of 110/220 Volt AC $\pm$10% at 50/60 Hz.

4.1.2.8 Voltmeter Selector Switch

The voltmeter selector switch shall be complete with front plate, grip handle, and RY-YB-BR-OFF-RN positions.

4.1.2.9 Ampere meter Selector Switch

The ampere meter selector switch shall be complete with front plate, grip handle, and R-Y-B-OFF positions.

4.1.2.10 Indicating Lamps

Indicating lamps shall be suitable for flush mounting, complete with base, 230-Volt neon lamp and shall have rosettes of suitable colour.

4.1.2.11 Current Transformers

Air-cooled, ring type current transformers shall be provided having transformation ratio as indicated on the drawings. The current transformers shall be of suitable burden having accuracy class 1.0 and have 5 amps secondary.

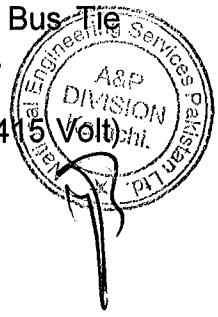
4.1.2.12 Line up Terminals

Line up terminals wherever provided for control of lighting, power and control circuits shall be suitable for voltage and size of conductors as indicated on drawings and as mentioned in the respective BOQ items. The line-up terminals shall be suitable for channel mounting. All necessary accessories such as end-plates, fixing clips, transparent label holder caps and label sheets with marking shall be provided.

4.2 Low Voltage (415 Volt) Bus Tie Duct

4.2.1 Sheet Metal Work

The complete enclosures for the LV (415 Volt) Bus Tie Duct shall be fabricated with 14 SWG sheet steel.



The complete sheet steel metal work of the LV (415 Volt) Bus Tie Duct shall be:

- cleaned down to bare shining metal
- de-rusted and de-greased
- painted with two base coats of anti-corrosive RED oxide paint.
- Two coats of weather proof powder paint in

approved colour.

4.2.2 **Components**

The LV Bus Tie Duct shall be provided with components as specified in these specifications, mentioned in the Bill of Quantities, as shown on the Drawings required for the satisfactory operation of the Bus Tie Duct and of the electrical system.

Typical component specifications are given below:-

4.2.2.1 **Bus Bars**

The bus bars shall be made of high conductivity electrolytic copper and shall be completely isolated and mechanically braced for the specified fault level. The phase identification of bus bars shall be by colours applied on bus bars and these shall be red, yellow and blue for phases and white for neutral. The earth bus bar shall be painted green.

The bus bars shall be triple pole and neutral and shall be of appropriate size to meet the electrical and mechanical requirements of the system. The temperature rise shall not exceed 45 degrees centigrade at rated current.

4.2.2.2 **Insulators**

The insulators for mounting of Busbars shall be suitable for 3 phase, 4 wire, 415 Volt AC operation as shown on the drawings.

4.2.2.3 **Insulating supports**

The insulating supports for mounting of busbars inside the sheet steel enclosure shall be of suitable material and thickness to provide the required insulation. These shall also be suitable to withstand the physical weights of the busbars.

4.2.2.4 **Nuts, Bolts and Washers**

The nuts, bolts and washers for the Bus Tie Duct shall be made of galvanized steel suitable for long life operation.

4.3 **Power Factor Improvement (PFI) Plant**

4.3.1 **Sheet Metal Work**

The complete enclosures for the Power Factor Improvement Plant shall be fabricated with 14 SWG sheet steel.

The complete sheet steel metal work of the Power Factor Improvement Plant shall be:

- cleaned down to bare shining metal
- de-rusted and de-greased
- painted with two base coats of anti-corrosive RED oxide paint
- Two coats of weather proof powder paint in approved colour

4.3.2 Components

The Power Factor Improvement Plant shall be provided with components as specified in these specifications, mentioned in the Bill of Quantities, as shown on the Drawings required for the satisfactory operation of the Power Factor Improvement Plant and of the electrical system.

Typical component specifications are given below:

4.3.2.1 Bus Bars

The bus bars shall be made of high conductivity electrolytic copper and shall be completely isolated and mechanically braced for the specified fault level. The phase identification of bus bars shall be by colours applied on bus bars and these shall be red, yellow and blue for phases and white for neutral. The earth bus bar shall be painted green.

The bus bars shall be triple pole and neutral and shall be of appropriate size to meet the electrical and mechanical requirements of the system. The temperature rise shall not exceed 45 degrees centigrade at rated current.

4.3.2.2 Insulators

The insulators for mounting of busbars shall be suitable for 3 phase, 4 wire, 415 Volt AC operation as shown on the drawings.

4.3.2.3 Insulating supports

The insulating supports for mounting of busbars inside the sheet steel enclosure shall be of suitable material and thickness to provide the required insulation. These shall also be suitable to withstand the physical weights of the busbars.

4.3.2.4 Nuts, Bolts and Washers

The nuts, bolts and washers for the Bus Tie Duct shall be made of galvanized steel suitable for long life operation.

4.3.2.5 Power Factor Regulator

The Power Factor Regulator shall be suitable for sensing power factor in a Three Phase unbalanced load network. The Power Factor meter shall be digital. The regulator shall have provision for Automatic cum Manual operation. The operating voltage shall be same as that for the associated LV switchboard.

The Power Factor Regulator shall be microprocessor controlled for fast computer programming at site. It shall have provisions for sensing connection errors.

4.4 Maintenance By-Pass Switch (MBS)

4.4.1 Sheet Metal Work

The complete enclosures for the Maintenance By-Pass Switch shall be fabricated with 14 SWG sheet steel.

The complete sheet steel metal work of the Maintenance By-Pass Switch shall be:

- cleaned down to bare shining metal
- de-rusted and de-greased
- painted with two base coats of anti-corrosive RED oxide paint
- Two coats of powder paint in approved colour

4.4.2 Components

The Maintenance By-Pass Switch shall be provided with components as specified in these specifications, mentioned in the Bill of Quantities, as shown on the Drawings required for the satisfactory operation of the Maintenance By-Pass Switch and of the electrical system.

Typical component specifications are given below:

4.4.2.1 Bus Bars

The bus bars shall be made of high conductivity electrolytic copper and shall be completely isolated and mechanically braced for the specified fault level. The

phase identification of bus bars shall be by colours applied on bus bars and these shall be red, yellow and blue for phases and white for neutral. The earth bus bar shall be painted green.

The bus bars shall be triple pole and neutral and shall be of appropriate size to meet the electrical and mechanical requirements of the system. The temperature rise shall not exceed 45 degrees centigrade at rated current.

4.4.2.2 **Insulators**

The insulators for mounting of Busbars shall be suitable for 3 phase, 4 wire, 415 Volt AC operation as shown on the drawings.

4.4.2.3 **Insulating supports**

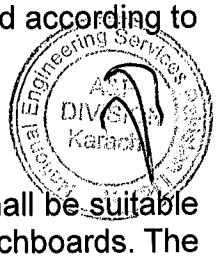
The insulating supports for mounting of busbars inside the sheet steel enclosure shall be of suitable material and thickness to provide the required insulation. These shall also be suitable to withstand the physical weights of the busbars.

4.4.2.4 **Nuts, Bolts and Washers**

The nuts, bolts and washers for the Bus Tie Duct shall be made of galvanized steel suitable for long life operation.

4.4.2.5 **Air Break Magnetic Contactors**

The contactors shall be air break, triple pole, 415 Volt suitable for the type of duty to be performed. The main contacts shall be silver tipped, butt type with double break per pole. Each contactor shall be provided with 230 Volt AC single phase operating coil, and minimum two normally open (NO) and two normally closed (NC) auxiliary contacts wired upto terminals. The number of working auxiliary contacts shall be provided according to the system requirements.



4.4.2.6 **AC Voltmeters**

AC Voltmeters shall be digital type and shall be suitable for flush mounting on front door of the switchboards. The front dimensions shall be 96 mm Wide and 48 mm high. The voltmeters shall have 3-1/2 digit, 0.55-inch display. The AC digital voltmeters shall have measuring range of 0 to 1999 Volt AC. It shall be suitable for power supply of 110/220 Volt AC ±10% at 50/60 HZ.

4.4.2.7 **Voltmeter Selector Switch**

The voltmeter selector switch shall be complete with front plate, grip handle, and RY-YB-BR-OFF-RN positions.

4.4.2.8 **Indicating Lamps**

Indicating lamps shall be suitable for flush mounting, complete with base, 230-volt neon lamp and shall have rosettes of suitable colour.

4.4.2.9 **Line up Terminals**

Line up terminals wherever provided for control of lighting, power and control circuits shall be suitable for voltage and size of conductors as indicated on drawings and as mentioned in the respective BOQ items. The line-up terminals shall be suitable for channel mounting. All necessary accessories such as end-plates, fixing clips, transparent label holder caps and label sheets with marking shall be provided.

5.0 INSTALLATION

5.1 Low Voltage (415 Volt) Switchboard

The location of LV switchboards is shown diagrammatically on the drawings. The actual location shall be determined at site, keeping in view the site conditions and in coordination with other equipment.

LV switchboard for floor mounting shall be installed on already prepared CC cable trenches. The LV switchboards shall be protected to avoid any damage due to the civil work.

All loose parts dispatched separately with the switchboard shall be installed as per manufacturer instructions and all adjustments or setting shall be made as required. All screws, nuts and bolts used for fixing the switchboard shall be galvanized.

The switchboards installation shall include connecting all incoming and outgoing cables. The cable entry in the boards shall be provided from top or bottom as required.

The switchboard body shall be connected to earth as per instructions given in section "Earthing" of these Specifications. The switchboard shall be tested and commissioned in the presence of the Engineer. The LV switchboards shall be tested before energizing as per instructions contained in the article "Testing" of General Specifications for Electrical Works, Section-8001 of these Specifications.

5.2 Low Voltage (415 Volt) Bus Tie Duct (BTD)

The Bus-Tie Duct shall be installed at the locations as shown on the drawings. All installation materials steel hangers brackets supports etc. as required and recommended by the manufacturer for safe erection shall be provided and installed by the Contractor without any additional cost. The bus tie duct shall be carefully aligned and all steel supports made of bolted connections using nuts bolts washers etc. shall be provided by the Contractor. All material and accessories shall be galvanized /rustproof. The section of copper bars of the bus tie duct requiring bolting together shall be thoroughly cleaned at site. A coat of conductive oxide inhibitor compound to be applied on the surface to be connected and the sections bolted together by means of torque wrenches using the bolts provided by the manufacturer. The bus tie duct shall be tested and commissioned in the presence of the Engineer or his representative at the manufacturer's works. After successful completion of tests the contractor shall furnish Test certificates. The bus tie duct shall be tested at site before energizing as per article "Testing" Section - 8001 of these Specifications.

5.3 Power Factor Improvement (PFI) Plant

The location of Power Factor Improvement Plant is shown diagrammatically on the drawings. The actual location shall be determined at site, keeping in view the site conditions and in coordination with other equipment.

Power Factor Improvement Plant shall be installed on already prepared CC cable trenches. The Power Factor Improvement Plant shall be protected to avoid any damage due to the civil work.

All loose parts dispatched separately with the Power Factor Improvement Plant shall be installed as per manufacturer instructions and all adjustments or setting shall be made as required. All screws nuts and bolts used for fixing the Power Factor Improvement Plant shall be galvanized.
The Power Factor Improvement Plant body shall be connected to earth as per instructions given in section "Earthing" of these Specifications.

The Power Factor Improvement Plant shall be tested and commissioned in the presence of the Engineer. The Power Factor Improvement Plant shall be tested before energizing as per instructions contained in the article "Testing" of General Specifications for Electrical Works, Section-8001 of these Specifications.

5.4 Maintenance By-Pass Switch (MBS)

The location of Maintenance By-Pass Switch is shown diagrammatically on the drawings. The actual location shall be determined at site, keeping in view the site conditions and in coordination with other equipment.

Maintenance By-Pass Switch shall be installed on already prepared CC cable trenches. The Maintenance By-Pass Switch shall be protected to avoid any damage due to the civil work.

All loose parts dispatched separately with the Maintenance By-Pass Switch shall be installed as per manufacturer instructions and all adjustments or setting shall be made as required. All screws, nuts and bolts used for fixing the Maintenance By-Pass Switch shall be galvanized.

The Maintenance By-Pass Switch installation shall include connecting all incoming and outgoing cables.

The Maintenance By-Pass Switch body shall be connected to earth as per instructions given in section "Earthing" of these Specifications. The Maintenance By-Pass Switch shall be tested and commissioned in the presence of the Engineer. The Maintenance By-Pass Switch shall be tested before energizing as per instructions contained in the article "Testing" of General Specifications for Electrical Works (Section-8001).

6.0 MEASUREMENT AND PAYMENT

6.1 General

The Contractor's bid amount against each item of Bill of Quantities as given below shall include design, fabrication, supply, installation, testing, commissioning and completion for all works specified herein and/or as shown on the Drawing related to the item.

6.2 Low Voltage Switchboard

6.2.1 Measurement

Measurement shall be made for the number of each type/ designations of LV switchboards acceptably supplied, installed, tested and commissioned by the Contractor as a complete job.

6.2.2 Payment

Payment shall be made for the number of each type/designations of jobs measured, as provided above, at the Contract unit price each for design, fabricating,

supplying, installing, testing, and commissioning of the LV switchboards, including fixing arrangement and accessories for complete installation.

6.3 Low Voltage Bus-Tie Duct

6.3.1 Measurement

Measurement shall be made for the running meters of each type of LV bus-tie duct acceptably supplied, installed, tested and commissioned by the Contractor as a complete unit.

6.3.2 Payment

Payment shall be make for the number of running meters of each type of units measured as provided above at the Contract unit prices each. The payment shall constitute full compensation for supplying, installing, connecting, testing, commissioning and completion of the LV Bus Tie Duct including all installation materials such as hangers, brackets, supports, nuts, bolts, washers, sheet steel covers, ECC etc.

6.4 Power Factor Improvement Plant

6.4.1 Measurement

Measurement shall be made for the number of each type/ designations of Power Factor Improvement Plant acceptably supplied, installed, tested and commissioned by the Contractor as a complete job.

6.4.2 Payment

Payment shall be made for the number of each type/designations of jobs measured, as provided above, at the Contract unit price each for design, fabricating, supplying, installing, testing, and commissioning of the Power Factor Improvement Plant, including fixing arrangement and accessories for complete installation.

6.5 Maintenance By-Pass Switch

6.5.1 Measurement

Measurement shall be made for the number of each type/ designations of Maintenance By-Pass Switch acceptably supplied, installed, tested and commissioned by the Contractor as a complete job.

6.5.2 **Payment**

Payment shall be made for the number of each type/designations of jobs measured, as provided above, at the Contract unit price each for design, fabricating, supplying, installing, testing, and commissioning of the Maintenance By-Pass Switch, including fixing arrangement and accessories for complete installation.

SECTION - 8133

LOW VOLTAGE (LV) DISTRIBUTION BOARDS

1.0 SCOPE OF WORK

The work under this section consists of design, manufacturing, fabricating, supplying, installing, connecting, testing, and commissioning of all material and services of the complete Low Voltage Distribution Boards as specified herein, shown on the Drawings and stated in the Bill of Quantities.

The Contractor shall discuss the electrical layout with the Engineer and co-ordinate at site with other services for exact position of the electrical lines and equipment.

The Low Voltage Distribution Boards shall also comply with the General specifications for Electrical & Communications Works Section-8001 and with other relevant provisions of the Documents.

2.0 GENERAL

The Low Voltage Distribution Boards shall be sheet steel fabricated. These shall be suitable for surface mounting, semi-recessed or recessed in wall mounting. The Low Voltage Distribution Boards shall be totally enclosed, dust and damp proof. The Low Voltage Distribution Boards shall be complete in all respects with material and accessories, factory assembled, tested and finished according to the Specifications and to the normal requirements.

All components shall be installed on a common mounting plate inside the enclosure and protected from the front with screwed sheet steel front plate. The enclosure shall be provided with rubber gasketting and a lockable hinged door with cam fastener.

The distribution board shall be supplied complete with all installation materials as recommended by the manufacturer. The incoming and outgoing cable connections shall be according to the wiring requirements. If required, an adapter box for accommodating the cables and conduits may be provided. The box shall be of the same material and finish as the distribution board.

The cabling inside the distribution board shall be suitably harnessed by means of straps or cords. An earth bar or terminal strips shall be provided for connection of incoming and outgoing earth conductors. The earth bar or terminals shall be permanently connected to the body of distribution board at two points.

The LV Distribution Boards, in general, shall;

- be suitable for indoor installation & operation

- be suitable for operation and maintenance from front side

- be suitable for both 400 Volt AC, three phase 4 wire and 230Volt AC, single phase 2 wire, 50 Hz system

- have all components rated for insulation class of 500V minimum for three phase and 250 Volt for single system

- be designed for flush mounting of all instruments on the front

- be provided with adequate clearance from live parts so flash overs can not be caused by switching, vermins, pests, etc.

- have incoming/outgoing cable termination arrangements. The power cables shall be directly connected to the terminals of TP 500V MCCBs of current ratings of 100 Amps and above. The SP/ TP MCBs and/ or MCCBs of current ratings upto and including 100 Amps shall be connected to DIN rail mounted wiring terminals of appropriate ratings, numbers and sizes for the outgoing wiring cables

- be provided with name plate on the front side of door

- be provided with pocket inside of door for safe keeping of the detailed as-built wiring/ shop diagrams of the switch board

- have provisions for incoming and outgoing cables entry, connections and termination arrangements from top and/ or bottom plates as per site requirements

- have all openable doors grounded with the use of flexible copper cable/strip of at least 10mm^2 cross-sectional area

3.0 APPLICABLE STANDARDS/CODES

The latest editions of the following standards and codes shall be applicable for the materials specified within the scope of this Section :

BS 4752-1 - Triple Moulded Case Circuit Breaker

IEC 947 - Single and Triple Miniature Circuit Breaker

IEC 947 - Low Voltage Switch gear and Control gear

IEC 439 - Factory Built Assemblies of LV Switch gear

IEC 4752 - Switch gear and control gear for Voltages upto & including 1 kV

BS 88 - HRC Fuses

IEC 73 - Colors for indicator lights and push buttons

IEC 446 - Identification of insulated/bare conductors

4.0 MATERIAL

4.1 Sheet Metal Work

The Surface mounting Low Voltage Distribution Board shall be fabricated with 14 SWG sheet steel and the semi-recessed or recessed mounting type shall be fabricated with 16 SWG sheet steel.

The complete sheet steel metal work of the Low Voltage distribution board shall be:

- cleaned down to bare shining metal
- de-rusted and de-greased
- painted with two base coats of anti-corrosive RED oxide paint
- Two coats of weather proof powder paint in approved colour

4.2 Components

The Low Tension Distribution Board shall be provided with components as specified in the specifications, mentioned in the Bill of Quantities, as shown on the Drawings required for the satisfactory operation of the distribution board and of the electrical system.

Typical component specifications are given below:

4.2.1 Bus Bars

The bus bars shall be made of high conductivity electrolytic copper and shall be completely isolated and mechanically braced for the specified fault level. The phase identification of bus bars shall be by colours applied on bus bars and these shall be red, yellow and blue for phase and white for neutral. The earth bus bar shall be green.

The bus bars shall be triple pole and neutral and shall be of appropriate size to meet the electrical and mechanical requirements of the system. The temperature rise shall not exceed 45 degrees centigrade at rated current.

4.2.2 Moulded Case Circuit Breaker (MCCB)

The MCCB shall be moulded case, triple pole, rated for 500 Volt AC. The Operating current ratings and Rupturing capacities shall be as mentioned in the relevant items of the Bill of Quantities and as shown on the drawings. The MCCB's shall have fixed Magnetic Short circuit and fixed Thermal Overload protections. However, the short circuit breaking capacities of triple pole moulded case circuit breaks shall be more than or at least, 25 kA and 50 kA as per IEC category P2, unless specified elsewhere. All incoming Triple pole circuit breakers shall be Moulded Case Circuit Breakers.

The Moulded Case Circuit Breakers shall be installed in the LV switchboards such that the switching lever of the Main Incoming MCCB shall be accessible from the front of the panel with the front door in closed position and the switching levers of all outgoing MCCB's and MCB's are accessible through the front plate inside the switchboards for operations. Circuit Numbers and Designation on all circuits shall be clearly marked to facilitate connection and maintenance.

4.2.3 Miniature Circuit Breaker (MCB)

The MCB's shall be Single pole 250 Volt and Triple pole 500 volts of current ratings as shown on the drawings. These shall have fixed magnetic short circuit and fixed thermal overload protections. The Single pole and Triple pole miniature circuit breakers shall have a 10 kA short circuit breaking capacity as per International standards IEC 157 Category P2.

The Miniature Circuit Breakers shall be installed such that their switching levers are accessible through the front plate inside the Switch Boards for operations. Circuit Numbers and Designation on all circuits shall be clearly marked to facilitate connection and maintenance. These Circuit Breakers shall be suitable for working on lighting and power circuits.

4.2.4 Push Buttons

Push buttons shall be momentary make break contact type (normally open/normally close). These shall be suitable for flush mounting. Distribution board, plastic face plate etc. Push buttons shall have round/square head.

4.2.5 AC Voltmeters

AC Voltmeters shall be Digital type and shall be suitable for flush mounting on front door of the Distribution Boards. The front dimensions shall be 96 mm Wide and 48 mm high. The voltmeters shall have 3-1/2 digit, 0.55 inch display.

4.2.6 Ammeters

AC Ampere meters shall be Digital type and shall be suitable for flush mounting on front door of the Distribution Boards. The front dimensions shall be 96 mm wide and 48 mm high. The Ampere meters shall have 3-1/2 digit, 0.55 inch display.

4.2.7 Voltmeter Selector Switch

The voltmeter selector switch shall be complete with front plate, grip handle, and RY-YB-BR-OFF-RN positions.

4.2.8 Current Transformers

Air cooled, ring type current transformers shall be provided having transformation ratio as indicated on the drawings. The current transformers shall be of suitable burden having accuracy class 1.0 and have 5 amps secondary.

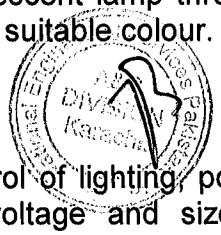
4.2.9 Air Break Magnetic Contactors

The contactors shall be air break, triple pole, 400 Volt suitable for the type of duty to be performed. The main contacts shall be silver tipped, butt type with double break per pole. Each contactor shall be provided with 230 Volt AC single phase operating coil, and minimum two normally open (NO) and two normally closed (NC) auxiliary contacts wired up to terminals. The number of working auxiliary contacts shall be provided according to the system requirements.

4.2.10 Indicating Lamps

Indicating lamps shall be suitable for flush mounting, complete with base, either 230 Volt neon or 12 Volt incandescent lamp through auxiliary transformer and shall have rosettes of suitable colour.

4.2.11 Line up Terminals



Line up terminals wherever provided for control of lighting, power and control circuits shall be suitable for voltage and size of conductors as indicated on drawings and as mentioned in the respective BOQ items. The line-up terminals shall be suitable for channel mounting. All necessary accessories such as end-plates,

fixing clips, transparent label holder caps and label sheets with marking shall be provided.

5.0 INSTALLATION

The location of distribution boards are shown diagrammatically on the drawings. The actual location shall be determined at site, keeping in view the site conditions and in coordination with other equipment.

Low Voltage distribution board for recessed mounting in wall shall be installed such that the door shall finish flush with the surface of wall. The recess mounted distribution board shall be installed before the plastering of walls. The DB shall be protected to avoid any damage due to the civil work.

All loose parts despatched separately with the DB shall be installed as per manufacturer instructions and all adjustments or setting shall be made, as required. All screws, nuts and bolts used for fixing the distribution board shall be galvanized. The distribution boards installation shall include connecting all incoming and outgoing cables. The cable entry in the boards shall be provided from top or bottom as required.

The distribution board body shall be connected to earth as per instructions given in section "Earthing" of these Specifications. The switchboard shall be tested and commissioned in the presence of the Engineer. The LV distribution boards shall be tested before energizing as per instructions contained in the article "Testing" of General Specifications for Electrical Works, Section-8001 of these Specifications.

6.0 MEASUREMENT AND PAYMENT

6.1 General

The Contractor's bid amount against each item of Bill of Quantities as given below shall include design, fabrication, supply, installation, testing, commissioning and completion for all works specified herein and/or as shown on the Drawing related to the item.

6.2 LV Distribution Board

6.2.1 Measurement

Measurement shall be made for the number of each type/designation of LV distribution boards acceptably supplied and installed by the Contractor as a complete job.

6.2.2 Payment

Payment shall be made for the number of each type/designation of jobs measured, as provided above, at the Contract unit price each for design, fabricating, supplying, installing, testing, and commissioning of the LV distribution boards, including fixing arrangement and accessories for complete installation.

SECTION-8150

SPECIFICATIONS OF LED LIGHTS

1.0 SCOPE OF WORK

The work under this section consists of manufacturing, fabricating, supplying, installing, earthing, testing and commissioning of all material with accessories and services for the complete LED fixtures as specified herein and as shown on the drawings and given in the Bill of Quantities.

The Contractor shall discuss the electrical layout with the Engineer and co-ordinate at site with other services for exact locations and positions of the LED fixtures.

The light fixtures with accessories shall also comply with the General Specifications as applicable for Electrical & Communications Works section-8001 and with other relevant provisions of the Documents.

1.1 Type of Light Fixtures

A. Down Lighters

LED based fixture should be suitable for all indoor applications with different mounting provision of recessed & surface.

Luminaire should have color temperature options (3000K, 4000K, 6500K).

Color rendering index should be equal to or greater than 80 with different wattages 15W +/- 3W.Luminaire should have efficacy of more than 90lm/w with a lifetime span of 30000 hours @L70 +/- 5,000 hours and with a power factor not less than 0.85. Overall luminaire system efficiency should be more than 80%.. Earthing provision should be given inside the luminaire with the ingress protection of at least IP20.Standard Deviation of Color Matching (SDCM) shall be less than 5.System efficiency shall be more than 85% and Light output ratio LOR shall not be less than 90%.Luminaire should comply with IEC standards (60598, 62471), EMC test reports and third party certifications and relevant applicable standards.

The down lights which are to be installed for rooms/areas having glass/window and has an effect of external day light shall be dimmable type. The lights output lighting level shall be controlled by the day light sensor.

B. Batten Lights

LED Batten light should be suitable for all indoor applications with mounting

provision of surface.Luminaire should have color temperature options (3000K, 4000K, 6500K).Color rendering index should be equal to or greater than 80 with different wattages from 8 to 32W.Luminaire should have efficacy of more than 85lm/w with a lifetime span of 30000 hours @L70 +/- 5,000 hours and with a power factor not less than 0.85. Overall luminaire system efficiency should be more than 80%.Luminaire should comply with IEC standards (60598, 62471), EMC test reports and third party certifications and relevant applicable standards. Earthing provision should be given inside the luminaire with the ingress protection of at least IP20

C. Bulk Head

LED Bulk Head light should be suitable for all indoor/outdoor applications with mounting provision of surface.Luminaire should have color temperature options (3000K, 4000K, 6500K).Color rendering index should be equal to or greater than 80 with wattages from18W to 25W Luminaire should have efficacy of more than 90lm/w with a lifetime span of 30000 hours @L70 +/- 5,000 hours and with a power factor not less than 0.85. Overall luminaire system efficiency should be more than 80%.Luminaire should comply with IEC standards (60598, 62471), EMC test reports and third party certifications and relevant applicable standards. Earthing provision should be given inside the luminaire with the ingress protection of at least IP20 for indoor and IP 65 for outdoor installations with IK 10.

D. In Ground Recessed Lights

LED Inground recessed lights shall be suitable for uplight effect applications with mounting provision of recessed type. The lifetime shall be within the range of 30,000 hours @L70 +/- 5,000 hours with an efficacy of more than 55 lm/w.Color rendering index shall be more than 80.Standard.Fixture power factor shall not be less than 0.80.

Fixture shall have different color temperature options ranging from 3000K to 5000K as per application requirements. System efficiency shall be more than 85% and Light output ratio LOR shall not be less than 90%. The fixture shall have ingress protection (IP) of atleast 67 and Impact Resistance (IK) 09 or above. It shall comply with EN 60598 and any other international standards as applicable.

E. Post top Lights

LED Post top lights shall be suitable for mounting on poles of height (3m-5m) for area lighting. The lifetime shall be within the range of 30,000 hours +/- 5000 hours with an efficacy of more than 90 lm/w.Color rendering index shall be more than 70.Standard.Fixture power factor shall not be less than 0.80.

Fixture shall have different color temperature options ranging from 3000K to

5000K as per application requirements. System efficiency shall be more than 85% and Light output ratio LOR shall not be less than 90%. The fixture shall have ingress protection (IP) of atleast 66 and Impact Resistance (IK) 09 or above. It shall comply with EN 60598 and any other international standards as applicable.

1.2 Optics

The fixtures for interior lighting shall have flexible optical systems for the wattage range in the respective group.

The fixture shall use high efficiency LED and optics system.

The Light Output Ratio (LOR) shall not be less than 90%.

The fixture shall offer a composite system efficiency not less than 85 lumen/Watt or as specified in the relevant fixtures.

The multilayer optics design shall ensure adequate luminance and illuminanceuniformity in the unlikely event of an individual LED failure.

The fixture shall offer choice of different beam light distribution.

The optical lens system shall feature long life with no discoloration (UV protection), highest possible light transmission and white painted circuit board for high reflectivity for maximum light output.

1.3 Warranty/Maintenance

The LED manufacturer /authorized agent/assembler shall not only be responsible for 5 years of warranty but also during the warranty period maintenance of the fixtures including free of cost replacements of any/all defective components/parts against manufacturing defects with the genuine products/components through the manufacturer/authorized agents under the supervision of the contractor/ maintenance agency.

The involvement of the manufacturer/authorized agent for maintenance/replacement of components is considered important because the warranty of the manufacturer becomes void if genuine product/manufacturer recommended methodology/components installation is not followed. In addition to this it is also necessary that genuine branded products those offered at the time of supply with the fixtures are provided for the 5 years of warranty / component replacement period.

Undertaking in this regard shall be submitted by the contractor as well as manufacturer/authorized agent/assembler to the Client.

Further, if required, the manufacturer/authorized agent/assembler through contractor shall provide the proof of genuineness from the manufacturer for various components provided/installed in the fixtures after fulfilling the technical requirements

1.4 LED Driver/Electronic Control Gear for LED Modules

The LED driver shall be designed to operate luminaries LED with current controlled output through Class I electrical classification. The driver shall be suitable for nominal 230V, +10%, -15%, 50Hz mains supply. The LED driver shall have an efficiency of at least 85%.The relevant test report, as applicable shall be submitted by the manufacturer.

1.5 LED Chip

The LED chip shall be Philips Lumiled, Cree, Nichia,Osram,Samsung, LG make orequivalent in performance. (duly tested as specified and in full conformance to the technical requirements/specifications) as specified.

The LEDs shall:

- be designed for lumen maintenance of L_{70} or 70% at the end of useful life at ambient temperature of 35 deg C.
- have a useful life of(25000-35000 as specified for relevant fixture) burning hours.(± 5000 hrs)
- have a color rendering index (Ra) of 80 (+10/-10)and a color temperature 2700K-6500K.as per application requirements
- have a color consistency within 5 SDCM (standard deviation of color matching) as defined by MacAdam.
- LM 80 Report with TM21 extrapolation graph must be attached.

1.6 Thermal Management

Managing thermal properties in LED fixtures is most critical to ensure optimum performance of LEDs and reliability of the system.

The housing under the circuit board shall be specially designed to ensure perfect contact between the board and the fixture housing for efficient heat dissipation.

PCBs shall be used to maximize heat transfer process and to offer reinforced electrical insulation via dielectric layer. The PCB shall be mounted on the housing using a highly efficient thermal interface material. Use of Silicon glue is not acceptable.

The housing over the driver chamber shall have ribs or any other mechanism

withadequate surface area to ensure fast heat dissipation.

1.7 Photometrics

Fixtures shall have Illumination Engineering Society (IES) files of different distribution patterns.

LM-80 LED and photometric test reports and IES files from a third party testing laboratory shall be available.

1.8 Technical Data and Drawings

Technical and descriptive data and drawings to be submitted shall include but not be limited to the following:

i) Technical data of fixtures and driver

ii) IES photometric file

iii) Customer testimonials

iv) Factory ISO certificate

v) Reports of other type tests stipulated in the respective standards/codes, if any applicable

2.0 INSTALLATION

The installation of LED light fixtures shall be in strict accordance with the manufacturer's instructions/recommendations and these specifications.

3.0 MEASUREMENT AND PAYMENT

i) General

The Contractor's bid amount against each bill of quantities item as given shall include supply, installation, testing, commissioning and completion of all work specified herein and/or shown on the Drawings related to the LED light fixture.

ii) Measurement

Measurement shall be made as complete job for all related equipment such as power supply, driver etc. along with all accessories acceptably supplied and installed by the Contractor as a complete unit.

iii) Payment

Payment shall be made for the number of units measured, as provided alone, at the contract unit price and shall constitute full compensation for supplying installing, testing and commissioning along with all accessories.

LED PANEL LIGHT:

Product: LED Panel light fixture(30 watts- 40 watts) recessed/suspended/surface mounted

Specifications:

The LED light fixture (Panel type) should be recessed/suspended/surface mountedand have capability deliver energy efficiency without sacrificing light quality ingeneral lighting applications.

The system efficacy of the light fixture should at least 90 lm/W.

Luminaire must provide minimum 50% energy-saving compared with conventional Fluorescent light fixture. The system lumens output of the light fixture should not be less than 3500 lumens.

The Color Rendering Index of the fixture should be greater than >80 and SDCM of the light fixture <=5. The color temperature of the light fixture should be more than 5000K

The ambient temp for the light fixture is - 2°C < Ta < 40°C.

The Panel lights which are to be installed for rooms/areas having glass/window and has an effect of external day light shall be dimmable type. The lights output lighting level shall be controlled by the day light sensor.

Housing:

The housing will include integrated heat sink and optical system. The housing will be made of Plastic frame in white color, & the heat sink will make of aluminium for better heat transfer.

The light cover made up of PCPS diffuser + PMMA light guide panel + PET reflector.

Luminaire Optics:

For the better UGR control one, the luminaire optics should fully comply with office lighting norms with UGR value (Unified Glare Rating) < 25.

Optical requirements:

The beam angle of the opticshould be around 120º. The UGR25 version comes with a glare control ring to provide acomfortable light ambiance.

Mounting Type

The luminaire shall have provision of both Recessed, Suspended and surface mounting with dimension compatible to conventional florescent fixture 597 x 597 x 46mm. Suspension kit for suspended version must be available

Electrical requirements:

Power supply: Electronic LED gear for 220 V - 240 V/50~60Hz.
Power Factor of the light fixture >0.9
Electrical Classification Class I

LED:

The LED chip shall be Philips Lumiled, Cree, Nichia, Osram, make or equivalent (duly type tested as specified and in full conformance to the technical requirements/specifications).

The LEDs shall:

- Be designed for lumen maintenance of L70 or 70% at the end of useful life
- Have a useful life of 50,000 burning hours.
- Have a minimum color rendering index (Ra) of 70 (+10/-10) and a color temperature above 5000K .
- Have a color consistency within 7 SDCM (standard deviation of color matching) as defined by MacAdam.
- LM 80 Report with TM21 extrapolation graph must be attached.

LED Driver/Electronic Control Gear for LED Modules

The LED driver shall be designed to operate large array of high powered LEDs through current controlled output. The driver shall be suitable for 230V, +10%, -15%, 50Hz, single phase mains AC supply.

The LED driver shall have an efficiency of at least 85%.

The LED driver shall be of Harvard, TCI, Philips, VOSSLOH Schwabe Make or equivalent (duly type tested as specified and in full conformance to the technical requirements/specifications).

Applicable Standards and Codes

The luminaire should fully conform to the following standards (the supplier/contractors shall furnish the detailed type test reports for the luminaries being offered to establish conformance to the specified requirements) :

1. IEC 60598-1

2. IEC 60598-2-2– Electrical Insulation Class I
3. IEC62031: LED modules for general lighting – Safety specifications
4. LM-79
5. LM 80 Report with TM21 extrapolation graph must be attached.
6. IES Photometry file

All test reports and certificates must be from third party accredited laboratory.

LED Driver Specifications:

The LED driver shall be designed to operate luminaire LED array with current controlled output through Class I electrical classification. The driver shall be suitable for nominal 220V-240V 50/60Hz mains supply. The LED driver shall have an efficiency of at least 90%.

The LED Driver/fixture should fully conform to the following standards (the supplier/contractors shall furnish the detailed type test reports for the luminaries being offered to establish conformance to the specified requirements) :

1. EN 55015 : 2013 – Emission – Electrical lighting and similar equipment
2. EN 61547: 2009 – Immunity – Equipment for general lighting purpose
3. EN 61000-3-2 : 2009 – Limits for harmonic currents emissions.
4. EN 61000-3-3 : 2008 – Limits for voltage fluctuation and flicker.
5. IEC62471 2008 :Photo biological safety of lamps and lamps systems
6. IEC 62778
7. EN 62493 Assessment of lighting equipment related to human exposure to electromagnetic fields

All test reports and certificates must be from third party accredited laboratory.

Warranties

The LED manufacturer /authorized agent/assembler shall not only be responsible for 5 years of warranty but also during the warranty period maintenance of the fixtures including free of cost replacements of any/all defective components/parts against manufacturing defects with the genuine products/components through the manufacturer/authorized agents under the supervision of the contractor/ maintenance agency.

The involvement of the manufacturer/authorized agent(s) for maintenance/replacement of components is considered important because the warranty of the manufacturer becomes void if genuine product/manufacturer recommended methodology/components installation is not followed. In addition

to this it is also necessary that genuine branded products those offered at the time of supply with the fixtures are provided for the 5 years of warranty / component replacement period.
Undertaking in this regard shall be submitted by the contractor as well as manufacturer/authorized agent/assembler to the Client.

Further, if required, the manufacturer/authorized agent/assembler through contractor shall provide the proof of genuineness from the manufacturer for various components provided/installed in the fixtures after fulfilling the technical requirements

Technical and Descriptive Data and Drawings

Technical and descriptive data and drawings to be submitted shall include but not be limited to the following:

- Technical data of fixtures and driver
- IES photometric file
- All detailed type test reports to establish conformance to specified international codes and standards as stipulated above.
- LM-80 test report of LED used
- 3rd Party IEC 60598 test reports specific to the fixtures being offered..
- EMC test report
- Photo- biological safety test report
- Customer testimonials
- Factory ISO certificate
- Reports of other type tests stipulated in the respective standards/codes

International Independent Laboratories

For the specified requirements of type tests and type test reports by an independent authority/independent laboratory (specific to their status/approval for performance of specific test(s) on the fixtures as defined in the project), the following laboratories shall be considered as independent laboratories:

- KEMA Labs, Holland.
- CESI Labs, Italy.
- CRIEPI Labs, Japan.
- Any other laboratory accredited by EA (European Co-Operation for Accreditation) or a member thereof.
- Any other laboratory accredited by ILAC (International Laboratory Accreditation Cooperation) or a member thereof.
- Any other laboratory accredited by IAF (International Accreditation Forum) or a member thereof.

- Any other laboratory accredited by STL (Short-Circuit Testing Liaison) or a member thereof.

SECTION – 8151

LOW VOLTAGE DG SET & AUTO MAINS FAILURE/ STARTUP (AMF/ATS) PANEL AND SYNCRONIZING PANEL

1.0 DESCRIPTION

The work under this section consists of supplying, installation, testing & commissioning of all material & accessories with one (01) year of warranty from the date of installation after successful testing & commissioning for the complete Diesel Generators of Prime rating (at 50°C), duly to be established by the manufacturers derating curves, losses and efficiencies of the engine, alternator and DG Set including but not limited to power cables, Automatic Mains Transfer Switch/Automatic Main Failure Switch Panel, LV Switchgear, fuel tanks (including day and underground storage tanks), control panels, canopy, all accessories as specified here-in, and given in the Schedule of Prices.

The Diesel Generator (Prime rating) set shall be a standard design in accordance with the latest applicable International Standards of a reputed manufacturer, who shall have similar units in operations for similar applications and field conditions.

The DG set shall be of prime rated duty and suitable for indoor/ outdoor (as applicable) installation. It shall be capable for unbalanced loads up to 30% of actual load and for continuous part load operation. The set shall be capable of starting and operating at the rated output as per the climatic conditions (typical range given in the following table) and at an altitude of the site of installation (given level of the site of installation in meters above mean sea level). The power rating shown in the relevant section of Schedule of prices (bill of quantities) is the power rating required to be delivered to load by the diesel generator set after applying all de-rating factors relevant to the site.

The table below shows the ambient temperatures (see definition (1) and the relative humidity rates to which the equipment can be submitted according to the category they belong; the later may be stated by the particular specifications.

Climatic Conditions

Category	I		II		III	
Rated operating range (2)	T1: +15°C	T2: +30°C	T1: -5°C	T2: +45°C	T1: -25°C	T2: +55°C
Maximum operating limits (3)	T3: +5°C	T4: +40°C	T3: -10°C	T4: +60°C	T1: -15°C	T2: +60°C
Maximum relative humidity	75% at +23°C		80% at +23°C		100% at +45°C	
Operating location example	Air conditioned room		Non air conditioned room		Outdoor	

1. Ambient temperature (IEC 60441-02-06)

   Temperature determined within specified conditions of the air which surrounds the whole equipment.

2. Rated operating range:

   Range of values at which equipment performs within specifications.

3. Maximum operating limits:

   Range of values at which equipment can still work without deterioration or degradation of its operating qualities.

The DG set ratings must be substantiated with manufacturer's standard published data. The Diesel Generator set after reducing the power absorbed by the auxiliaries, shall deliver rated power output under the site conditions. All auxiliaries, accessories and connections between systems along with all necessary cables, fittings, hardware, etc., for complete installation of Diesel engine, Generator, control panel, including fuel & oil storage, exhaust system, etc., shall be furnished by the manufacturer.

The engine shall be directly coupled to the generator, and shall have a rated speed of 1500 rpm. The set shall be capable of sustaining without damage, 25% over speed under any abnormal operating condition.

The engine-generator set shall be mounted on suitable rigid steel base frame with vibration isolators. Heavy duty lifting eyes and/or jacking screws shall be provided on the skid. The foundation bolts and all other material/hardware for complete installation of the set, as required, shall be furnished with the set. Any excessive torsional vibration shall be avoided for both engine and alternator. The set shall be suitable for full load starting. When the generator is operating at no-load, the application of full load current, taking into account the surge due to starting of equipment, should be possible with maximum transient voltage drop of 15% of the rated voltage. The time taken to restore the generator voltage to 97% of rated value should not exceed 1.5 seconds. The set shall be capable for starting and accepting full load within 15 seconds after receipt of starting signal. The Manufacturer shall submit the equipment layout and other installation details along with the bid.

The details and technical data concerning Diesel Generator set shall be submitted with bid. Where required the documents from the manufacturer shall be furnished in support of the information furnished.

The alternator and engine shall be as follows:

Alternator Make/Brand:

Siemens, Newage/Stamford/Cummins, Lorrey-Sommer, Cater Pillar/ Olympian or approved equivalent.

Diesel Engine Make/Brand:

Volvo, Perkins, Cummins, Mitsubishi, John Deere, Cater Pillar or approved equivalent.

Operating Console:

DeepSea, Power Wizard, APM, Intli Compact, DataCom or equivalent

Warranty

The DG Sets shall be supplied from the manufacturers/authorized agents or firms having strong local presence duly authorized by the manufacturer for sales, services and after sales back up support system and facilities along with suitable full time operation and maintenance experience with Pakistan.

The manufacturer/ authorized agent shall also have adequate maintenance facilities in the vicinity of Project with mechanically qualified and experienced personnel trained for operation and on-site maintenance of the equipment & materials offered by the Manufacturer in his bid.

To verify the capability of after sales service backup support locally in Pakistan,

following shall be furnished by the contractor with duly verifiable documentary evidence from the supplier:

1) Complete company profile of the supplier, in house testing facilities, testing procedures, testing equipment/tools details.
2) Valid Nomination letter/dealership certificate from the DG set manufacturer for the supplier.
3) Successfully completed project reference list of the DG sets clearly indicating the project names, rating of the DG sets & quantity supplied alongwith the satisfactory performance certificates from the customers/authorities.
4) List of projects for which the supplier already providing O&M services alongwith customer satisfactory operational certificates for O&M.

The projects for which certificates shall be provided must be comparable in terms of quantities of the DG sets maintained.

The DG sets supplier /authorized agent/assembler shall be responsible for providing one (01) year of standard warranty and during the warranty period the supplier /authorized agent/assembler of the DG sets shall be fully responsible for replacements of any/all defective components/parts against manufacturing defects with the genuine products/components through the manufacturer/authorized agents under the supervision of the contractor.

The involvement of the manufacturer/authorized agent for maintenance/replacement of components is considered important because the warranty of the manufacturer becomes void if genuine product/manufacturer recommended methodology/components installation is not followed.

Undertaking in this regard shall be submitted by the contractor as well as manufacturer/authorized agent/assembler to the Client.

2.0 APPLICABLE STANDARDS/CODES

The Diesel Engine and Generator set shall conform to the following standards as applicable.

ISO3046	-	(Reciprocating internal combustion engines)
BS 4999	-	General Requirements for Rotating Electrical Machines.
DIN EN 12285-2;2005	-	Horizontal Steel Tanks for the Storage above Ground of Petroleum Products in Liquid Form.

For other equipment and materials related to the Diesel Generator set, the Manufacturer shall follow relevant international standards.

3.0 MATERIAL REQUIREMENTS

3.1 Diesel Engine

3.1.1 General

The Diesel Engine shall be four strokes, compression ignition, suitable for Emergency supply duty. Starting shall be through motor operated electric starter. The engine shall be equipped with an alternator type automatic charging system to charge the batteries during running of engine. The engine shall be provided with required auxiliaries,

guarantees of fuel consumption, acceptance tests, torsional vibration characteristics.

3.1.2 Air Intake

Air intake shall be through turbo charger and equipped with dry type filter. Suitable attenuators shall be installed to reduce noise at the air inlet. The filter assembly shall be constructed of non-corrosive materials.

3.1.3 Engine Cooling

Engine shall have a forced air draft, water cooled radiator supplied with a core guard. Cooling system shall have an engine driven centrifugal pump for cooling water circulation. Cooling shall be thermostatically controlled. An engine shut down timer shall be provided to keep the engine running on no-load after any operation of set, so that the engine is sufficiently cooled to start again instantly, if required, without rise in temperature above safe limits. The radiator shall be designed to cool the engine at specified output in ambient temperature upto maximum value. Radiator flexible ducting, flange and all necessary ductwork, flexible connections, fittings and supports shall be supplied to extend from the radiator to the exhausts louvers so that hot air from the radiator escapes freely to the outside of the building.

3.1.4 Engine Lubrication

A gear type positive pressure lubrication pump shall be provided with efficient filtration arrangement for the lubrication system. A 230Volt AC mains-operated heater with thermostat shall be provided in the crankcase. The heater shall be designed for automatic switching to ensure that temperature of oil is maintained for proper operation of the engine.

3.1.5 Speed Governor

The speed governor shall be electronic or digital complying with the requirements BS ISO 3046 or latest applicable international standard. Governor shall regulate engine speed so as to maintain the generator frequency within ±2% of the rated frequency. Stable engine speed shall be attained within 15 seconds after the engine has been started. Stable engine speed shall be restored within 10 seconds of any sudden change in load, from no load to full load. During this change of load or surge, the speed shall not vary by more than ±5% of the rated speed. Means shall be provided on the engine to shut down the engine automatically in the event that the engine speed exceeds the "shutdown" speed.

3.1.6 Fuel System

Engine shall operate on Commercial High-Speed Diesel oil. A fuel oil strainer/filter shall be provided in the fuel line along with a water separator. Fuel system for Diesel engine shall not require any priming. The fuel system shall comprise;

- Fuel storage tank(s)

- Day Tanks
- Fuel transfer pumps
- Piping

The fuel day tank shall have capacity to store fuel oil for twenty four (24) hours continuous operation of the set at the rated output. The tank shall have level switch for monitoring low fuel level in the tank. The low-level switch shall provide an annunciation and prevent starting of set and to stop the set when the fuel in day tank is at this level. The tank shall be provided with overflow, vent, supply and discharge valves, inspection cover, drain valve and glass sight gauge.

The fuel day tank shall be designed, fabricated and finished in accordance with the requirements of DIN EN 12285-2;2005 - Horizontal Steel Tanks for the Above Ground Storage of Petroleum Products in Liquid Form. The fuel day tank shall be incorporated in the steel base frame of the DG set. The structural steelwork shall be protected from corrosion.

The fuel piping to be furnished shall include fuel supply pipe from tank to the set, over flow pipe from the set to the tank, level indicator, fuel cap with breather, drain pipe from the tank.

Drain Line: The day tank drain tank shall be accessible and equipped with a shut off valve. Self supporting day tank shall be arranged to allow drainage into a 305mm high bucket. The local fuel fill port on the day tank shall be provided with a screw on cap.

3.1.8 Radiator Exhaust Duct

The radiator exhaust duct shall provided for exhaust of hot air through DG set radiator. The radiator exhaust shall be designed and routed in such a way so as to give minimum resistance to airflow.

3.1.9 Exhaust System

Exhaust system shall be equipped with a **HEAVY DUTY RESIDENTIAL** type silencer complete with muffler, exhaust manifold, flexible connector, exhaust elbow, exhaust pipe, rain cap, and associated fittings. This exhaust line shall be adequately covered with insulation material over its entire length i.e. from the engine to the termination point at rain cap. All supports for exhaust system shall be furnished. Hangs and supports shall be provided for the silencer such that essentially no load is transmitted to the engine.

3.1.10 Battery

Heavy-duty maintenance free lead acid batteries shall be provided with the set and mounted on the skid. The fully charged batteries shall be furnished with the set and connected with the help of heavy duty interconnecting cables.

The batteries shall be of adequate ampere-hour rating/capacity to satisfy the following requirements:-

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a. Crank the engine at firing speed for at least 15 seconds.
b. If the engine does not start on the first attempt, crank the engine two more times for the above duration at an interval of 30 seconds between each cranking operation.

3.2 Alternator

3.2.1 General

The alternator shall be synchronous. The alternator shall be capable of carrying, continuously 10% over load of rated output with the field set for normal rated load excitation for 1 hour in every 12 hours operation.

The alternator shall be rated as follows:

Capacity	:	As stated in BoQ
Voltage	:	400/230 V
Phases	:	3Phase, 4 wire, grounded neutral
Frequency	:	50 Hz
Power Factor	:	0.8 lagging

3.2.2 Excitation

Excitation shall be from brushless rotating diodes mounted on the main shaft for 3-phase full wave rectification.

3.2.3 Windings

Alternator windings shall have Class H insulation and shall be impregnated for tropical use. The temperature rise of winding under normal operating conditions and at rated load shall not exceed the limits specified for Class-B insulation. Anti-condensate heaters shall be provided for windings. The heaters shall be thermostatically controlled for switching **ON** after the set has stopped. The thermostat range shall be adjustable and set to prevent overheating of windings. For protection of windings from damage due to overheating, thermistors shall be embedded to stop the set in case the temperature of winding rises above the safe value.

3.2.4 Deviation Factor

The deviation factor of the open-circuit line to line terminal voltage shall not exceed 0.10.

3.2.5 Voltage Regulation

Voltage regulator shall be solid state with provision for manual setting. Regulator shall be so designed to protect the exciter when the set 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. Transient voltage drop shall be less than 15% at full load and 0.8 power factor. Time required to restore to steady state conditions after transient voltage fluctuation shall not exceed 10sec.

3.2.6 Short Circuit Capability

Generator shall be capable of withstanding without injury, a 30 seconds three phase short circuit at its terminals when operating at rated output and power factor with fixed excitation.

3.2.7 Temperature Rise

Alternator temperature rises at continuous rating in an ambient of 52 degree C shall not exceed 70 degree C by resistance measurement on the field. The exciter temperature rise shall not exceed 52 degree C by resistance measurement on field or armature when the main generator is on continuous rating.

3.2.8 Vibration and Balance

The vibration level of the alternator when coupled to the engine shall not exceed the ISO Specifications or equivalent.

3.2.9 Bearings

The bearings shall preferably be grease lubricated and anti-friction type and shall be selected to provide for long trouble free service.

3.3 Indication/Metering Panels

3.3.1 General

The indication/metering panel shall be designed for front access, completely assembled, wired and tested. The control panels shall conform to the constructional requirements as per international standards and norms.

The panel shall incorporate protection and control equipment, measuring instruments, control and instrument transformers, voltage regulator, governor controls, battery charger, indicating lamps, etc. Engraved nameplates of stainless steel shall be provided on all panels for clearly identifying panels and devices mounted inside of panels. Standard nameplate with black lettering shall be provided.

Cables and capillary tubing shall be tagged with a neoprene disc or approved equivalent, stamped with the cable number or tube function for easy identification.

3.3.2 Moulded Case Circuit Breakers

The Four pole moulded circuit breaker shall be provided with the set. The circuit breaker shall have the Thermal over current and short circuit releases as below:

Ith	=	60 to 100% of Current rating
Isc	=	50 kA (min)

The circuit breaker shall be mounted in a vibration isolated sheet steel box with adequate access for incoming and out going cables.

3.3.3 Magnetic Contactors

The contactors shall be four pole, 400 V AC duty cycle-3. The main contacts shall be silver tipped, but type with double break per pole. Each contactor shall be provided with 230V AC single phase operating coil,and minimum two normally open and two normally closed auxiliary contacts wired upto terminals. But if more number of working auxiliary contacts are required then, these shall be provided according to the system requirements.

3.3.4 Battery Charger

Multi stage intelligent (Digital Microprocessor based with a communication port RS 485) high efficiency battery charger with automatic charging stage selection, capable of charging of a wide range of batteries, when engine is not running. The charger shall be fully capable to recharge a completely discharge battery within four hours at boost/maximum charge. The charger shall be of constant voltage and constant current with maximum current been drawn during charge recovery phase. The charger should automatically return to float/trickle mode when charging is complete.

The charger should have following safety features:

- Input under voltage protection
- Input over voltage protection
- Battery charge over voltage protection
- Battery output over current protection
- Short Circuit protection
- Battery temperature compensation with over temperature protection
- Reverse Polarity protection
- Automatic power derating at high ambient temperatures

Applicable Standards for Battery Charger:

- BS EN 61000 (Electromagnetic compatibility)
- BS EN 60950 (Electrical safety)
- BS EN 60068 (Temperature, Vibration, Humidity and Shock)
- BS EN 60529 (degree of Protection)

3.3.5 Instruments and Controls

i. Ammeter (measuring as required)
ii. Ammeter Phase selector switch
iii. Voltmeter (0-500 volt AC)
iv. Voltmeter phase selector switch
v. Frequency meter
vi. Start / stop key switch
vii. Battery condition voltmeter
viii. DC Voltmeter for batteries
viii. Tachometer for Engine speed in Revolutions Per Minute (RPM)

ix. Lube oil pressure in PSI
x Lube oil temperature in Degrees Celsius
xi. Engine water temperature in Degrees Celsius
xii. Engine operation/ running time in hours

3.5 Safety Devices

3.5.1 Following safety devices shall be provided. The audible alarm shall operate on any fault condition and shall be resetable manually and automatically through a timer after 15 minutes whichever is earlier:

A = Alarm **SD** = Shutdown **TD** = Adjustable Time Delay

i)	Engine Over speed	**A**	**SD**	
ii)	Low lube oil pressure	**A**	**SD**	
iii)	High water temperature	**A**	**SD**	
iv)	Over voltage	**A**	**SD**	**TD** (0-30 Sec.)
v)	Under voltage	**A**		
vi)	Short circuit and tripping of circuit breaker.	**A**	**SD**	**TD** (0-1 min.)
vii)	Low level in fuel storage tank	**A**	**SD**	**TD** (0-5 min.)
viii)	Winding temperature high	**A**	**SD**	**TD** (0-2 min.)
ix)	Over crank	**A**	**SD** (After THREE Successive crankings)	
x)	Low crankcase oil level	**A**		
xi)	High crankcase oil level	**A**		
xii)	Charging alternator failure	**A**		
xiii)	Charger failure	**A**		

For all shut down conditions, the set shall lockout and it shall not be possible to re-start it unless manually reset after the cause of fault has been removed.

3.5.2 Generator Electrical Protections:

Following electrical protections shall be provided in the generator:

1. High AC voltage shutdown	12. Reverse Power shutdown
2. Low AC voltage shutdown	13. Reverse VAR shutdown
3. Over frequency shutdown:	14. Under voltage shutdown:
4. Under frequency shutdown/warning	15. Over voltage shutdown:
5. Over Current warning/Shutdown:	16. Low and high battery voltage warning
6. Loss of sensing voltage shutdown	17. Weak battery warning
7. Field overload shutdown	18. Fail to start (over crank) shutdown
8. Over load (kW) warning	19. Reverse power protection
9. Short circuit protection:	20. Smart starting system
10. Digital Voltage Regulator	21. Battery monitoring system
11. PMG Excitation	

3.6 Auto-Mains Failure/Transfer (AMF/ATS) Panel

The AMF/ATS shall be floor mounted front access, completely assembled, wired and tested. The control panel shall conform to the constructional requirements as stated in these specifications for LV switch boards.

The AMF/ATS shall incorporate automatic changeover system, which will be designed for the following functions:

a) To start the set immediately when the main supply fails

b) To start the set within the 0 to 1 minutes (adjustable) whenever the main supply voltage drops to 360 volts or rise to 440 volts. The setting voltages shall be adjusted within -5 % and + 5% respectively for the lower & upper ranges.

c) To transfer the load from Generator to main supply whenever the main system voltage returns between 90% to 110% of its rated value and persists for at least 3 minutes.

d) To make two successive attempts, in case the set fails to start in the first and second attempt.

e) The system shall provide for immediate transfer of load to the generator, after the rated speed and voltage have been achieved. The Generator should start immediately when the main supply fails

f) The system shall be self resetting after each cycle of operation. To start the set immediately when the main supply fails

g) Two normally open potentially free contacts shall be provided which shall close when the set is started with the operation mode selector switch in auto or manual position. The contacts shall be wired upto the terminals block in control panel.

h) A four position selector switch shall be provided for selecting the operation mode i.e. Automatic-Manual-Test-stop/ Maintenance mode to facilitate the following operation:-

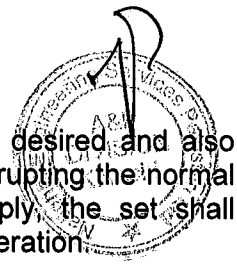
i) **Automatic**
As described in a to d.

ii) **Manual**

Manual starting of the set and load transfer from normal to standby and vice versa.

iii) **Test**

Testing the changeover operation when so desired and also for starting and running the set without interrupting the normal operation. In case of failure of main supply, the set shall automatically revert to automatic mode of operation.



iv) **Stop/Maintenance**

Provision shall be made to isolate the system for trouble shooting and maintenance without interruption of mains power supply. The set shall not be capable of starting in this condition.

3.7 Terminal Blocks and Terminals

Terminal blocks for control wiring shall be General Electric Type Eb stud terminal blocks or approved equivalent. Terminal studs and wires shall be numbered or otherwise marked in accordance with the applicable schematic and wiring diagrams.

Terminal blocks shall be arranged with sufficient room for each connection of incoming cables. Parallel rows of terminal blocks shall be spaced at least 150mm (6") apart.

Blocks shall be mounted in vertical columns along the sides of cubicles or on vertical panels specially provided for terminal blocks. 20% spare blocks distributed over the columns of terminal blocks shall be provided.

Terminals shall be suitable for screw terminals and shall be sized according to the wire being terminated.

Provisions shall be made to terminate and ground the overall copper shields of all incoming cables by a suitable method approved by the Engineer.

3.8 Component Wiring

All internal wiring shall be in accordance with IEC or VDE Standards with annealed copper conductor, thermo-plastic insulated with an overall flame-retardant braid. Wire sizes for control wiring in no case shall be smaller than 2.5 mm2. The wire ends shall be permanently fitted with compression type connectors before attaching to terminal studs.

Wiring between terminals of various devices shall be point to point. All internal wiring shall be neatly trunked in wiring troughs bound and anchored.

All groups of bundled conductors to hinged doors and panels shall use extra-flexible wire arranged so that a twisting rather than a bending motion is imparted to the moving conductor bundle. Each bundle shall be anchored to the fixed member at the opposite end of the hinge axis to the anchoring point on the moving member so that the moving bundle length is the maximum available without loops.

All wires shall be identified at both ends according to the schematic diagram.

3.9 Provision of Integration with IBMS

DG set shall have the provision to integrate with the Integrated Building Management System (IBMS) for local and remote monitoring.

4.0 SPECIFICATIONS OF FUEL TANK, WEATHER PROOF, SOUND ATTENUATED CANOPY AND FOUNDATION PAD

4.1 Fuel Tank

Supply & Installation of backup fuel storage tank, complete with filling cap, vent & suction pipe, minimum 5mm thick, MS sheet and inspection man hole complete in all respect.

4.2 Weather Proof and Sound Attenuated Canopy

Sound and weather proof canopy suitable for the Diesel Generating sets. The canopy shall attenuate the sound level to below 85dB at a distance of 1 meter or less than 75dB at a distance of 3 meters from it. Textured insulation materials, Comprising of fire retardant resin, organic glass/rock fiber to ensure uniform long lasting absorption of sound. The canopy shall be constructed with weather proof corrosion resistant material and shall be modular in design. All sheet components pre-treated with cold fast prior to powder coating. All gas kits/joints be of Edpm (**ethylene propylene diene monomer** (M-class) rubber). The canopy shall be suitable for tropical climates.

a) The enclosure shall allow easy access to the engine, alternator, and radiator filler cap, lube oil filling, filter replacement and control cubicle for easy maintenance purposes.

b) Hinged and lockable doors all around canopy for easy access to D.G. set for routine maintenance and major over hauling.

c) At least 1 foot clearance between the DG Set and Canopy shall be maintained from sites/directions.

d) The enclosure shall be designed to be water and weather- proof.

e) The intake area for air must be 1.8 times the size of radiator.

f) The enclosure base frame should be designed with supports for easy transferred using forklift and crane.

g) Canopy shall be capable of anti-corrosion to withstand high humidity.

h) Proper grouting of both generator and canopy.

i) The thickness of sheet for canopy body must be 4mm (minimum) whereas thickness of and door sheet 2mm (minimum).

j) Glass wool will be of pure fiber.

k) The canvas is to be place between radiator and the canopy that can be easily removed during troubleshooting.

l) GENSET control panel should be visible from outside the canopy by means of plan glass.

m) 4 Nos. Canopy lifting eyes arrangement from top of canopy.

n) Sufficient air intake through Acoustic Louvers from both side & control panel side.

o) Duly painted with good quality water proof and weather proof paint. Painted with 2 coats of zinc oxide primer and finishing with 2 coats of Syntactic Enamel (Burger/ICI) paint.

4.3 Foundation Pad for DG Set

a) Fabrication of RCC Foundation suitable for genset operating weight complete in all respects, foundation to be made according to

generator size and should have all required sleeves for piping, conduiting etc. as per specifications.

b) The pad should be at least 12 inches (300mm) height from and extend at least 6 inches (150 mm) beyond the skid on all sides.

c) The weigh (W) of the foundation should be at least 2 times (and up to 5-10 times) the weight of the set itself to resist dynamic loading. (The weight of fuel in a sub-base fuel tank should not be considered to be contributing to the weight required of a vibration isolating foundation even through the isolators are between the tank and the generator set).

d) The foundation should extend at least 6 inches (150mm) beyond the skid on all sides. This determines the length (l) and width (w) of the foundation.

e) The foundation should be reinforced concrete with a 28-days compressive strength of at least 3000 psi

4.4 Tests:

4.4.1 General

The set furnished by the Contractor under this Contract shall be subject to tests in the shop and at site in the presence of the Engineer for conformity to requirements of the Specifications.

4.4.2 Diesel Engine

All mechanical parts shall be run under simulated operating conditions at the Manufacturer's works.

All tests shall be conducted in accordance with the appropriate codes for testing. The tests to be carried out shall include, but not be limited to, the following:

i) Dynamic balancing together with over speed tests of the generator exciter and rectifiers.

ii) Bench testing of all accessories.

iii) Zero load operation of the diesel engine assemblies to test the following:

- Vibration.
- Lubricating system.
- Fuel system.
- Governor system.
- Temperature control system.
- Over speed trip.
- Individual accessories.

The diesel engine and AC generator shall be test-run continuously for

24 hours to ensure smooth running and satisfactory operation of the machines and accessories. The above tests will be witnessed by the Engineer.
The contractor shall state in his proposal the performance and reliability tests to be carried out in the Works.

Tests on the unit shall not be less than the minimum requirements of ISO standard Practices for equipment.

4.5 Generator

4.5.1 General

The set furnished by the Contractor under this Contract shall be subject to tests in the shop and at site in the presence of the Engineer for conformity to requirements of the Specifications.

4.5.2 Routine Tests

Routine tests on the generator shall be performed at the manufacturing works/workshop of the DG Set manufacturer/Supplier. Routine tests shall include:

a) Resistance of armature and field windings
b) Polarity of field coils
c) Check of mechanical balance
d) Check of no-load field current or exciter field current
e) Voltage balance
f) Phase sequence
g) No-load saturation curve
h) Insulation and high potential tests
i) Over speed test at 125% speed for 1 minute
j) Load Tests (24 hours)

1. Continuous thirty minutes heat run at 25 percent load rating
2. Continuous three hour heat run at 50 percent load rating
3. Continuous eight hour heat run at 75 percent load rating
4. Continuous twelve hour heat run at 100 percent load rating
5. Continuous thirty minutes heat run at 110 percent load rating

Fuel, water and electric power required for "Performance Tests" shall be provided by the Contractor

Where the generator is not completely assembled in the factory, tests (d) to (i) above inclusive may be carried out with the generator coupled to Engine Test (a) to (d) shall also apply to the exciter.

4.5.3 Type Tests

The generator shall have the following tests performed, if required:

a) Short circuit saturation curve.
b) Temperature test.
c) Segregated losses.
d) Voltage deviation factor.
e) Three phase line to line short circuit test at any convenient voltage in the 0.4 to 0.5 p.u. volts.

4.5.4 Characteristics Test Curves

Following completion of type tests, Manufacturer shall provide characteristics curves of the brushless excitation system. These curves shall show:

a) Exciter field amps and volts versus generator line current at 0.80 Pf. and maximum and minimum temperature rises.

b) Exciter field amps and volts versus generator line current at 1.0 Pf and maximum and minimum temperature rises.

c) As for (a) above, but with one diode failed.

The above six curves shall be plotted from no-load to maximum rated load at rated generator voltage. Following approval of curves by the Engineer, they shall be incorporated by the Manufacturer into the Emergency Diesel Generating Set Maintenance Manual.

4.5.5 Performance Tests

At the conclusion of installation of the Emergency Diesel Generating Set at site, commissioning tests shall be carried out by the Contractor/Manufacturer to demonstrate the satisfactory operation of the equipment and to verify the guaranteed performance figures of the diesel unit. The tests shall comprises:

1. Preliminary tests on individual components.

2. Continuous one-hour heat run at 50 percent load rating in parallel with the system.

3. Continuous one-hour heat run at 75 percent load rating in parallel with the system.

4. Continuous four-hour heat run at 100 percent load rating in parallel with the system.

5. Part load heat runs to demonstrate satisfactory operation and establish fuel consumption at the respective loads.
6. The tests shall also include:
   a) Performance of Governing characteristics and protective systems.
   b) Starting characteristics of the units. The units shall start

at least five (5) times in six (6) consecutive starting attempts.

c) Starting power requirements to demonstrate the ability of the machine to start the specified number of times without need to recharge the batteries.

The instrumentation supplied as standard with the equipment will be used during the commissioning tests for measurement of voltage, frequency, temperatures, pressures, etc. normally recorded during commercial operation. Additional instruments required for the measurement of electrical output, fuel flow, vibrations, etc. shall, at no extra charge, be provided by the Contractor.

Tests to be carried out manufacturer's work and at the site shall be to the satisfaction of the Engineer. Seven copies of test certificates shall be forwarded to the Engineer immediately following each test. The site test report shall include a list of final settings and adjustments carried out during commissioning.

If the tests show that the set does not reasonably comply with Bid, the Contractor/Manufacturer shall, at his own expense, make all necessary corrections to the unit. Additional tests shall then be made to demonstrate the effectiveness of these corrections. Until the necessary corrections have been made, the conditions of the contract shall not be considered fulfilled.

Fuel, water and electric power required for "Performance Tests" shall be provided by the Contractor.

Seven (7) copies of the Final Performance Test Report shall be submitted to the Engineer not later than one (1) month after completion of the performance tests.

4.6 Diesel Generator Set

4.6.1 Measurement

Measurement shall be made for one No. of diesel generator set (as per rating mentioned in BOQ), alongwith all its allied accessories acceptably supplied and installed by the Contractor as a complete job.

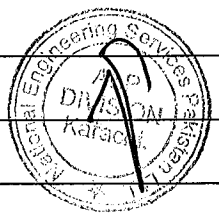
4.6.2 Payment

Payment shall be made for one No. of DG Set alongwith all its allied accessories, as provided above, at the Contract unit price each for design, fabricating, supplying, installing, testing, and commissioning of the of diesel generator set (as per rating mentioned in BOQ), including fixing arrangement and accessories for complete installation.

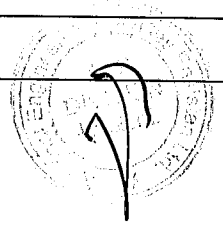
SUPPLY, INSTALLATION AND TESTING

SCHEDULE OF TECHNICAL DATA TO BE FILLED IN FOR EVERY TYPE/RATING OF DG SETS AND SEALED/STAMPED BY THE MANUFACTURER- (MANDATORY)

Sr. No	Data Required	Data To Be Submitted (By Bidder)
1	**ENGINE**	
	Manufacturer's Name/ Country of Origin	
	Model	
	Maximum Engine Rating -(BHP)	
	Continuous Output Rating -(BHP)	
	Derating Factor:	
	(i) For Altitude of 1250 meters above MSL	
	(ii) For inlet Air Temperature of	
	(iii) Others if any	
	Engine Rating at Site-(BHP)	
	Period of maximum Engine Rating in Hours	
	Operating speed-RPM	
	Piston Speed (m/s)	
	Bore & Stroke-Inches	
	No. of cylinders	
	Arrangement of Cylinders (in line/v)	
	Engine Capacity-Cu.in./cc	
	Compression Ratio	
	Coupling Type	
	Mounting Arrangement	



Sr. No	Data Required	Data To Be Submitted (By Bidder)
	Cooling System	
	Ignition System	
	Overload Capability	
	Governor Type And Make	
	Efficiency at 0.85 pf % At 25% of rated load At 50% of rated load At 75% of rated load At 100% of rated load	– – – –
	Lube oil consumption (Liters/hr) At 0% of rated load At 25% of rated load At 50% of rated load At 75% of rated load At 100% of rated load	– – – – –
	Specific Fuel consumption (Liters/hr) At 0% of rated load At 25% of rated load At 50% of rated load At 75% of rated load At 100% of rated load	– – – – –
	Lubrication system nominal oil pressure (kg/cm^2)	
	Lubrication system minimum oil pressure (kg/cm^2)	
	Lubricating oil Sump capacity (ltr.)	
	Radiator capacity (ltr.)	
	Compusion air intake at 50 Hz (cm^3)	
	Engine heat radiation (K cal/min.)	
	Exhaust gas temperature at manifold, deg C.	
	Exhaust gas rate (ltr/sec.)	
	Starting system voltage (v)	
	Specific Feature if any	



Sr. No	Data Required	Data To Be Submitted (By Bidder)
2	**GENERATOR**	
	Manufacturer's Name/ Country of Origin	
	Model	
	Design Rating -(KVA)	
	Continuous Output Rating -(KVA)	
	Net electrical Output at site -(KVA)	
	Rated Voltage-volts	
	Power Factor	
	Speed-(RPM)	
	Frequency-Hz	
	Type designation	
	Time delay	
	(i) Manufacturer	
	(ii) Type designation	
	Timing	
	(i) Manufacturer	
	(ii) Type designation	
	Tripping	
	Insulation class	
	Stator Rotor Exciter	
	Overload Capability %	
	Harmonic Content %	
	Temperature Rise ^{0}C	
	Voltage Regulation	

Sr. No	Data Required	Data To Be Submitted (By Bidder)
	Type	
	Regulator	
	Regulation %	
	Voltage Dip %	
	Response Time (Sec)	
	Frequency Regulation -%	
	Deviation Factor %	
	Efficiency at 0.85 pf % At 25% of rated load At 50% of rated load At 75% of rated load At 100% of rated load	
	Exciter	
	Type	
	Rated Voltage-Volts	
	Full load current -Amps.	
	Radio Frequency Interference	
	Telephone interference factor	
	Charge Capacity	
	Batteries Type Rating-AH	
	Noise output level of Set (dB) At 0 % of rated load At 25% of rated load At 50% of rated load At 75% of rated load At 100% of rated load	

Sr. No	Data Required	Data To Be Submitted (By Bidder)
	De-rating Factor	
	For Altitude of given height in meters above MSL of the site of installation	
	For ambient temperature of	
	others ,if any	
	Special features, if any	
3	**ACCESSORIES**	
	(Contractor to state if any of the following accessories will be supplied - give details) Crankcase Heater Automatic water Makeup System Ducting for radiator Exhaust System Silencer Fuel Day Tank Fuel Piping System Fuel pump	
	Meters/Gauges to indicate: Engine speed in rpm Lube oil Pressure in Bars Lube oil temperature in ^{0}C Engine running hours in hrs. Battery Charging current in Amps.	
	Alarm/Indicating lamps for Engine Overspeed Low lube oil pressure High engine water temperature Over voltage Under voltage Short-circuit/tripping of main circuit breaker low fuel level	

Sr. No	Data Required	Data To Be Submitted (By Bidder)
	High fuel level Winding temperature high Over cranking Low oil level High oil level Charging alternator failure	
	Safety devices for instantaneous shut down due to Engine over speed Low lube oil pressure High water temperature shut down	
	Safety devices for adjustable delayed shut down, through shut down timer, due to: Over voltage Short circuit/tripping of main circuit breaker Low fuel oil in tank Winding temperature high	

Note: To be filled for each rating of DG Set from the Manufacturer.

SECTION – 8152

CABLE TRAYS

1.0 GENERAL

The work under this section consists of supplying, installing, and commissioning of all material and services of the complete cable trays as specified herein, shown on the Drawings and stated in the Bill of Quantities.

The Contractor shall discuss the layout with the Engineer and co-ordinate at Site with other services for exact route, location and position of the cable trays for electrical lines.

The cable trays with accessories shall also comply with the General Specifications for Electrical Works and with other relevant provisions of the Document.

The extent of works shown on the drawing does not indicate the exact position of cable trays. The Contractor shall ensure exact location and route of cable trays in coordination with other services drawings, as per site requirements and as directed by the Engineer.

The Contractor should deliver, store and handle materials and products in a manner to prevent damage.

2.0 APPLICABLE STANDARDS/CODES

Latest editions of the following standards / codes shall be applicable for the materials in scope of this Section:

BS 729 Hot dip galvanized coating on iron and steel articles

3.0 PRODUCTS

3.1 The cable tray system shall be of one manufacturer and shall include factory-made trays, tray fittings, connectors and necessary accessories and supports to form a complete cable support system.

The cable tray system shall include the following factory -made tray elements:

(a) straight cable trays and ladders

(b) fittings as horizontal and vertical bends of various angles, crosses, tees, wyes, reducers, vertical riser elements

(c) connectors

(d) all necessary fixing accessories.

3.2 Manufacturer's standard accessories shall be used and site fabrication shall not be permitted.

3.3 Horizontal run of cables laid on cable tray and exposed to direct sunlight shall be provided with covering at higher level to allow for ventilation. Cable tray shall be raised 15 cm from finished floor level.

4.0 MATERIALS

4.1 The whole of the tray work, trays, fittings, supports shall be of mild steel hot dipped galvanized after manufacture to BS 729. The thickness of the protective sheath on any element shall not be less than 55 microns.

4.2 Cable trays shall be constructed from mild steel hot dip galvanized and of minimum thickness of 1.5mm.

4.3 Insert elements, bolts, screws, pins, etc., shall be mild steel cadmium plated.

4.4 Tray work shall have oval perforations. Ladder type trays shall be used for vertical runs as approved by the Engineer.

4.5 All trays (straight and fittings) shall be welded construction and be a heavy duty returned-flanged, perforated type, unless specified otherwise. The minimum thickness of heavy duty returned flanged cable trays shall be 1.5mm.

4.6 Tray components shall be accurately rolled or formed to close tolerances and all edges rounded. Flanges shall have full round smooth edges.

4.7 Ladder racks shall be of similar construction. The rungs shall be spaced at maximum 300 mm. The system shall allow for installing additional rungs and for replacement of rungs.

4.8 For all trays, flanges shall be a minimum of 50 mm deep, unless otherwise specified.

4.9 Cable tray width and radius of curved sections shall be selected to suit the number of cables as shown on drawings and to the approval of the Engineer

4.10 Cable trays and accessories installed in hazardous and extremely corrosive environments shall be heavy duty GRP or 316 S31 grade stainless steel.

5.0 INSTALLATION

5.1 Installation

5.1.1 Drilling, machining or cutting shall not be carried out after application of protective coat, unless previously agreed by the Engineer. If cutting or drilling is necessary, edges shall be cleaned up and painted with zinc based paint before erection.

5.1.2 Installation of vertical runs of tray along the line of vertical expansion joints in structure of the facility shall not be allowed.

5.1.3 Cables shall be fixed to the trays by means of PVC covered saddles or straps secured with brass or cadmium plated bolts, nuts and washers.

5.1.4 20% spare capacity shall be maintained once all cables have been installed on trays. Double banking of cables shall not be permitted space between adjacent cables shall be not less than the radius of the bigger cable.

Trays shall not be smaller than the minimum size stated on the Drawings or specified later and shall be so sized; if not specified, the Contractor shall calculate the size of the tray and submit to the Engineer for approval. The Contractor shall check the minimum size as specified is large enough for his requirements and provide 20% spare capacity for future use.

5.2 ERECTION

5.2.1 Cable trays arranged one above the other shall have spacing in relation to their width not exceeding a ratio of 1:2 with a minimum distance of 150 mm.

5.2.2 **Supports**

Install fixings and supports:

(a) at 3 meter centres
(b) 50 mm from bends, tees, intersections and risers
(c) as close as practicable to joints
(d) each side of expansion joints.

5.2.3 Supports shall be selected from the following types, to suit the site conditions:

(a) M12 steel threaded drop rods fixed to ceilings complete with GI channels or brackets
(b) wall support brackets

(c) cantilever arms
(d) steel channels

5.2.4 The cable trays shall be fixed in accordance with site conditions and manufacturer's recommendations.

5.2.5 Join cable tray and accessories with hardware per manufacturer's recommendations.

5.2.6 Avoid mid-span joints.

5.2.7 The Contractor shall submit, as required, all calculations relating to tray work and tray supports demonstrating acceptable mechanical stresses and sag.

5.2.8 Cable trays installed on roofs shall be supported using GI brackets or concrete blocks. Removable cable tray cover shall be fitted.

5.2.9 Access shall be available at all times to remove or replace cables with a minimum of 400 mm between trays and physical obstructions, A/C ductwork etc.

5.3 EARTHING

5.3.1 Cable trays and accessories shall be electrically and mechanically continuous throughout their length.

5.3.2 The entire cable tray system shall be bonded and 12 mm x 2.5 mm tinned copper links shall be bolted across each joint in the system by means of bronze nut and bolts, complete with flat and spring washers.

5.3.3 All cable trays shall be provided with earth continuity copper tape along the whole route of cable trays which shall be bonded to the main earthing system of the facility. The earth continuity copper tape shall be fixed on cable tray by means of PVC covered saddles or by other means approved by the Engineer.

6.0 MEASUREMENT AND PAYMENT

6.1 General

The Contractor's bid amount against each Bill of Quantities item as given below shall include supplying, installation and completion for all work specified herein and as shown on the drawing related to the item.

6.2 Cable Trays

6.2.1 **Measurement**

Measurement shall be made for the number of running feet or running meters of cable trays acceptably supplied and installed by the Contractor as a complete unit.

6.2.2 **Payment**

Payment shall be made for the total numbers of units measured, as provided above, at the Contract unit price each. The payment shall constitute full compensation for supplying, installing and completion of the laying of the cable trays including jointing materials and accessories.

* All equipment shall comply with the standard ANSI/ASHRAE/IESNA 90.1-2010 for points in LEED evaluation and subsequent Platinum LEED award. After the completion of final design the contractor shall perform Load Modelling through a professional load modeler (LEED Manual V4.1) to ensure energy savings.

SECTION - 8212

LOW VOLTAGE CABLE

1.0 SCOPE OF WORK

The work under this section consists of supplying, installing, testing and commissioning of all material and services of Low Voltage cables and the accessories as specified herein or as shown on the Drawings and in the Bill of Quantities.

The Contractor shall discuss the electrical layout with the Engineer and coordinate at site with other services for exact route, location and position of the electrical lines.

The LV cables with accessories shall also comply with the General Specifications for Electrical Works Section-8001 and with other relevant provisions of the Document and latest WAPDA specifications.

2.0 GENERAL

All single core PVC insulated cables for the following shall be of 450/750 volt grade copper conductor cables;

- wiring of light circuits
- switch to point wiring
- light point to light point wiring
- wiring of circuits for 5 amps, 250 volt, 2&3 pin switch socket unit
- wiring between 5 amps, 250 volt, 2&3 pin switch socket units
- wiring of push buttons & Between Push Buttons
- wiring of light circuits controlled by push buttons
- wiring between light circuits controlled by push buttons

All single core PVC insulated power cables for the following shall be copper conductor and of 450/750 volt grade:

- wiring of circuits for 15 amps, 250 volt, 3 pin switch socket unit
- wiring between 15 amps, 250 volt, 3 pin switch socket units
- wiring of circuits for 20 amps, 250 volt, 3 pin switch socket unit

All multicore unarmoured control cables shall be copper conductor and

of 300/500 volt grade.

All multicore unarmoured power cables shall be copper conductor and of 600/1000 volt grade.

All multicore armoured power cables shall be copper conductor and of 600/1000 volt grade.

3.0 APPLICABLE STANDARDS/CODES

The latest editions of the following standards and codes shall be applicable for the materials within the scope of this section:

BS 6004	-	PVC insulated cables (non-armoured) for electric power & lighting
BS 6346	-	PVC insulated cables for electricity supply
BS 6746	-	PVC insulation and sheath of electric cables
BS 6360	-	Conductors for insulated cables
IEC 228	-	Conductors for insulated cables
BS 6500	-	Insulated flexible cords

4.0 MATERIAL

4.1 General

The power, lighting and control cables shall be furnished and installed in accordance with the details shown on the drawings. The general guide lines and criteria for reference is given below:

4.1.1 Phase Identification

All cables shall have phase identification colors on insulation of each core. The colour code for three phase circuits shall be;

- Red, Yellow and Blue for phase conductors.
- Black for neutral conductor.
- Green for earth conductor where PVC insulated cable is installed.

Single phase circuits shall have insulation of;

- Red colour for phase/line
- Black colour for neutral
- Green colour for earth conductor.

All DC circuits shall have insulation of;

- Red colour for positive conductor
- Black colour for negative conductor
- Green colour for earth conductor.

4.1.2 Cable Accessories

All accessories shall be provided for the complete cabling and wiring systems. These shall include but not limited to items such as saddles, clamps, fixing channels, connectors, cable joints (where necessary and as approved by the Engineer), clips, lugs, tapes, solder, identification tags, bushes, glands, etc.

5.0 INSTALLATION

5.1 Conduit Wiring

The wiring through conduit shall be started only after the conduit system is completely installed and all outlet boxes, junction boxes, etc., are fixed in position.

The wires shall be pulled in conduit with care, preferably without the use of any lubricant. Where necessary and after approval of Engineer, the cable manufacturer's recommended lubricant shall be used. Use of any kind of oil or soap will not be permitted. Where several wires are to be installed in the same conduit, they shall be pulled together alongwith the earth conductor. All wires of same circuit shall be run in one conduit.

The wires shall not be bent to a radius less than ten times the overall diameter of the wire, or more if otherwise recommended by the manufacturer.

The wiring shall be continuous between terminations and looping-in system shall be followed throughout. Any joint in wires shall not be allowed. The use of connectors shall only be allowed at locations where looping-in is rendered difficult. The consent of the Engineer shall be required for using connectors.

The connector shall be of suitable rating having porcelain body, sunk-in screw terminals. The connector shall be wrapped with PVC insulation tape after its installation. A minimum of 150 mm extra length of cable/wire shall be provided at each termination to facilitate repairs in future.

5.2 Cables on Surface

All cables for installation on surface of wall, column, ceiling, etc., shall be fixed to the surface by means of galvanized steel clips secured to a steel channel by means of suitable stud plate, nuts and washer. The distance between each cable clip to be such, so as to support the entire weight of the cable and that, distance between the cable and surface and also the vertical clearance between two adjacent cables at any point is 50mm minimum. Common mounting channels are to be furnished for cable along the same route. The Engineer before commencement of installation shall approve alternate cable fixing arrangement, which the Contractor can offer.

5.3 Cables in flexible/rigid conduits on surface

All cables for on surface conduits shall be installed through the conduits without the use of lubricants. The flexible/rigid conduits shall be fixed to wall/ceiling surface by means of cable clamps using rawl plays and galvanized screws.

5.4 Underground Cable

The cables to be installed directly underground shall be laid in trench in single ties. The depth of cable under ground, shall be three feet minimum, measured from the top of the largest cable to the general ground level. The burial depth may be increased as required due to site conditions or when crossing other service pipes and roads. Burial depth less than three feet and more than five feet shall require Engineer's approval.

When cables cross road, paved area, other services or other cables, they shall be laid in protective pipes of required size. Cables entering the buildings shall also be laid in protective pipes. The protective pipe ends, after installation of cables shall be plugged water tight by means of bituminised resin or equivalent method as approved by the Engineer. A minimum clearance of ten inches vertically and 20 inches horizontally shall be maintained between cables and other services.

Cable identification tags of corrosion resistant material shall be tied to cables with bronze wire at a maximum of 65 feet interval along the cable length for identification of cable and circuit. Above ground cable markers of 8 SWG (4 mm) sheet steel and

200 mm^2 shall be erected at 100 feet intervals along the straight trench, and at each bend and joint box for indication of presence of underground cable. For more than three feet wide trenches, cable markers shall be provided at both edges of the trench. The cable marker shall be finished in gray heavy enamel paint over two base coats of anti-rust red oxide paint, with the necessary instructions indicated in approved colours.

The Contractor shall furnish samples of cable marker for approval of Engineer before installation. The marker shall be welded to an angle iron fixed to the ground on a cement concrete base or as directed by the Engineer. The earth continuity conductor shall be laid in the trench with the cables. The Contractor shall submit to the Engineer for approval, schedule of cable markers showing location of marker and instructions on each.

The cable trench shall be excavated as per route and location shown on the drawing. Before laying of cables in the trench, the bed of the trench shall be leveled and filled with a four inch thick layer of fine sand (1/32 inch diameter maximum particles size). The sand layer shall be leveled and the cables placed thereon, the cables shall be covered with a layer of fine sand Four inch thick measured above the top of the largest cable.

The cable protective bricks placed above the top of sand cover shall be of Class - C cement concrete, minimum Two inch thick and 12 inches x 12 inches square or as approved by the Engineer. The bricks shall be placed over the sand layer end to end to cover the entire length and breadth of the cable trench, after the concrete bricks are placed, the remainder of the trench shall be backfilled with earth in layer 16 inches thick. Each layer shall be thoroughly tamped and compacted.

Sufficient slack shall be left in cables for which purpose the cut lengths of cables shall also about 3% more in the measured lengths between terminations. At underground joint box, ample slack shall be left to prevent straining of cable joints due to settlement of the cable trench.

The cut lengths of cables wherever stated are only as a guide. The Contractor shall measure actual lengths between terminations of each circuit and if the discrepancy between measured lengths at site and where given on the drawing differ by more than $\pm$10% the Contactor shall report to Engineer and act as directed. Cables, whether installed underground, or in cement concrete trenches, shall not be bent to a radius less than that recommended by the cable manufacturers.

Conduits/ pipes/ ducts for electrical, PSD & ITS etc cables shall be

properly sealed with the water proofing material "Plastic Polyurethane Foam" as per relevant ASTM standard to avoid rain water entry to the conduits. The contractor shall also provide the technical data of the sealant material before the execution of the work.

6.0 MEASUREMENT AND PAYMENT

6.1 General

The Contractor's bid amount against each Bill of Quantities item as given below shall include supply, installation, testing, commissioning and completion for all work specified herein and/or as shown on the Drawing related to the item.

6.2 Light Circuit Wiring

6.2.1 Measurement

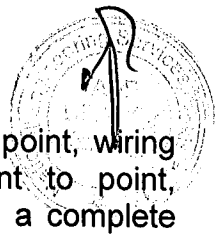
Measurement shall be made for the total number of light circuit wiring from LV distribution board/LV switchboard to point/switch including wiring between switches on same circuit, acceptably carried out by the Contractor as a complete unit.

6.2.2 Payment

Payment shall be made for the total numbers of units measured, as provided above, at the Contract unit price each. The payment shall constitute full compensation for supplying, installing, connection, testing, commissioning and completion of the circuit wiring from the LV switchboard/LV distribution board to point/switch including wiring between switches on same circuit complete with conduit, wire/cable, earth continuity conductor, accessories, etc.

6.3 Light/Fan Point/Point to Point Wiring

6.3.1 Measurement



Measurement shall be made for each light point, wiring between the light point and switch, point to point, acceptably carried out by the Contractor as a complete unit.

6.3.2 Payment

Payment shall be made for the total numbers of units measured, as provided above, at the Contract unit price

each. The payment shall constitute full compensation for supplying, installing, connecting, testing, commissioning and completion of the wiring between light point to switch and point to point including required size of cable, conduit, earth continuity conductor, flexible cable, ceiling rose, accessories, etc.

6.4 Wiring of Lights Directly Controlled from Distribution Board/Local MCBs/Wiring of Push Buttons

6.4.1 Measurement

Measurement shall be made for wiring of each light point directly controlled from distribution board or local MCBs type switch and wiring of push buttons acceptably carried out by the Contractor as a complete unit.

6.4.2 Payment

Payment shall be made for the total numbers of units measured, as provided above, at the contract unit price each. The payment shall constitute full compensation for supplying, installing, testing and commissioning of wiring of light points directly controlled from distribution boards or local MCB type switches and wiring of push buttons including required size of wire, conduit, earth continuity conductor, flexible cable, ceiling rose, accessories, etc.

6.5 Wiring of 5Amps, 250Volt Combined 2 & 3 pin Switched Socket Unit from LV switchboard/Distribution Board

6.5.1 Measurement

Measurement shall be made for number of points for wiring of 5Amps, 250 Volt, combined 2 & 3 pin switched socket unit acceptably carried out by the Contractor as a complete unit.

6.5.2 Payment

Payment shall be made for the total numbers of units measured, as provided above, at the contract unit price each. The payment shall constitute full compensation for supplying, installing, connecting, testing, commissioning and completion of wiring for 5 Amps 250 Volt, combined 2 & 3 pin switched socket unit from LV switchboard/ distribution board including specified size of single core PVC cables including conduit, ECC, PVC conduit, accessories etc. complete in all respects.

6.6 Wiring between 5Amps, 250Volt Combined 2 & 3 pin

Switched Socket Units

6.6.1 **Measurement**

Measurement shall be made for number of points for wiring between 5Amps, 250 Volt, combined 2 & 3 pin switched socket unit acceptably carried out by the Contractor as a complete unit.

6.6.2 **Payment**

Payment shall be made for the total numbers of units measured, as provided above, at the contract unit price each. The payment shall constitute full compensation for supplying, installing, connecting, testing, commissioning and completion of wiring between 5 Amps 250 Volts, combined 2 & 3 pin switched socket unit including specified size of single core PVC cables including conduit, ECC, PVC conduit, accessories etc. complete in all respects.

6.7 **Wiring of 15Amps, 250Volt 3 pin Switched Socket Unit from LV Switchboard/Distribution Board/Bus Bars**

6.7.1 **Measurement**

Measurement shall be made for number of points for wiring of 15Amps, 250 Volt, 3 pin switched socket unit acceptably carried out by the Contractor as a complete unit.

6.7.2 **Payment**

Payment shall be made for the total numbers of units measured, as provided above, at the contract unit price each. The payment shall constitute full compensation for supplying, installing, connecting, testing, commissioning and completion of wiring for 15 Amps 250 Volt, 3 pin switched socket unit from LV switchboard/distribution board/Bus Bars including specified size of single core PVC cables including conduit, ECC, PVC conduit, accessories etc. complete in all respects.

6.8 **Wiring between 15Amps, 250Volt 3 pin Switched Socket Units**

6.8.1 **Measurement**

Measurement shall be made for number of points for wiring between 15 Amps, 250 Volt, 3 pin switched socket

unit acceptably carried out by the Contractor as a complete unit.

6.8.2 **Payment**

Payment shall be made for the total numbers of units measured, as provided above, at the contract unit price each. The payment shall constitute full compensation for supplying, installing, connecting, testing, commissioning and completion of wiring between 15 Amps 250 Volt, 3 pin switched socket units including specified size of single core PVC cables including conduit, ECC, PVC conduit, accessories etc. complete in all respects.

6.9 Wiring of 20Amps, 250Volt 3 pin Switched Socket Unit from LV Switchboard/ Distribution Board

6.9.1 **Measurement**

Measurement shall be made for number of points for wiring of 20 Amps, 250 Volt, 3 pin switched socket unit acceptably carried out by the Contractor as a complete unit.

6.9.2 **Payment**

Payment shall be made for the total numbers of units measured, as provided above, at the contract unit price each. The payment shall constitute full compensation for supplying, installing, connecting, testing, commissioning and completion of wiring for 20 Amps 250 Volt, 3 pin switched socket unit from LV switchboard/ distribution board including specified size of single core PVC cables including conduit, ECC, PVC conduit, accessories etc. complete in all respects.

6.10 LV Cables

6.10.1 **Measurement**

Measurement shall be made for the number of running feet for each size and type of LV cable acceptably supplied and installed by the Contractor.

6.10.2 **Payment**

Payment shall be made for the number of running feet of each size of cable measured, as provided above, at the Contract unit price each and shall constitute full compensation for supplying, installing, connecting, testing

and commissioning of the LV cables including all accessories.

6.11 Excavation of Cable Trench

6.11.1 Measurement

Measurement shall be made for the number of cubic feet for excavation of each size of cable trench acceptably carried out by the Contractor.

6.11.2 Payment

Payment shall be made for the number of cubic feet of excavation for each size of cable trench measured, as provided above, at the Contract unit price each and shall constitute full compensation for excavation of the LV cable trench in ordinary soil and slightly rocky site.

6.12 Backfilling of Cable Trench

6.12.1 Measurement

Measurement shall be made for the number of cubic feet of backfilling for each size of cable trench acceptably carried out by the Contractor.

6.12.2 Payment

Payment shall be made for the numbers of cubic feet of backfilling for each size of cable trench measured, as provided above, at the Contract unit price each. The payment shall constitute full compensation for four-inch thick sand bed, four inch thick sand cover, cable protective tiles/bricks, backfilling of already excavated earth, watering, compaction, consolidating, etc. complete to the satisfaction of the Engineer.

SECTION - 8220

SWITCH FITTINGS & ACCESSORIES

1.0 SCOPE OF WORK

The work under this section consists of supplying, installing, and commissioning of all material and services of the complete switch fittings and accessories as specified herein, as shown on the Drawings and stated in the Bill of Quantities.

The Contractor shall discuss the electrical layout with the Engineer and co-ordinate at site with other services for exact location and position of all electrical equipments.

The switch fittings and accessories shall also comply with the General Specifications for Electrical & Communications Works Section-8001 and with other relevant provisions of the Documents.

2.0 GENERAL

The Light control switches, switch socket units, Fan Controllers, Industrial socket units, etc. shall be of following ratings;

- Light Switches rated for 10A, 250 Volt
- Fan dimmers rated for 100W, 250 Volt,
- Shuttered 3 pin rated for 15A, 250 Volt,
- Shuttered 3 pin rated for 20A, 250 Volt,

The locations of the switch fittings & accessories such as sockets, switches etc. are tentatively shown on the drawings. The Contractor shall ensure the exact positions and locations of wiring accessories in coordination with other services drawings, as per site requirements and as directed by the Engineer.

3.0 APPLICABLE STANDARDS/CODES

The latest edition of following standards codes shall be applicable for the materials within the scope of this section:

BS 2135	-	Capacitors for radio interference suppression.
BS 546	-	3 pin plugs, socket outlets and socket outlet adapter for circuits up to 250 volts.

BS 67	-	Two and three terminal ceiling roses.
BS 4934	-	Safety requirements for electric fans and regulators.
BS 5060	-	Performance of circulating fans and their regulators.

4.0 MATERIAL

4.1 One Way Switches - Indoor type

Switches for controlling light points shall be single pole, rated for 10 Amps, 250 Volt AC. The body of the switches shall be suitable for flush mounting on PVC back box/outlet box. The switches shall have screw contacts and shall operate with snap action.

4.2 Two Way Switches - Indoor Type

Two way switches for control of lights shall be of same make and specifications as for one way switches above, except these shall be of use to control light circuits from two different locations.

4.3 Switched Socket Outlets

Switched Socket units shall be of the following combinations and ratings:

- Shuttered 3 pin rated for 15A, 250 Volt,
- Shuttered 3 pin rated for 20A, 250 Volt,

Front face plate shall conform to the requirements stated above for switches - Indoor type. The outlets shall be heavy duty type suitable for mounting on PVC outlet box. The 3 pin 15 amps and 3 pin 20 Amps sockets shall have shrouded live contacts and designed such that the earth pin of plug is engaged to socket earth before mating of live contacts.

4.4 Fan Controller

Fan Controller for fan speed regulating shall be suitable for Ceiling fans, rated for 10 Amps, 250 Volt AC. The body of the fan Controller shall be suitable for flush mounting on PVC back box/ outlet box. The fan Controller shall have ON/OFF switch that shall operate with click action.

4.5 Outlet Box

The outlet boxes for installation of switches, Dimmers and socket outlets shall be of PVC having appropriate dimensions. The box shall have suitable arrangement for receiving the conduit.

5.0 INSTALLATION

5.1 General

The mounting heights of all wiring accessories fixtures are stated on the drawings. In case the mounting height is not mentioned, the instructions of the Engineer Incharge shall be obtained before fixing.

5.2 Light Control Switches

The Light Control Switches shall be installed directly on back boxes/outlet boxes recessed in CC/RCC walls or columns. The fixing of Light Control Switches shall be by means of screws provided with them so as to finish flush with the surface.

5.3 Switched Socket Outlets

The Switched Socket Outlets shall be installed directly on back boxes/outlet boxes recessed in CC/RCC walls or columns. The fixing of Switched Socket Outlets shall be by means of screws provided with them so as to finish flush with the surface.

5.4 Fan Controllers/Light Dimmers

The Fan Controllers/Light Dimmers shall be installed directly on back boxes/outlet boxes recessed in CC/RCC walls or columns. The fixing of Fan Controllers/Light Dimmers shall be by means of screws provided with them so as to finish flush with the surface.

6.0 MEASUREMENT AND PAYMENT

6.1 General

The Contractor's bid amount against each Bill of Quantities item as given below shall include supply, installation, testing, commissioning and completion for all work specified herein and/or as shown on the Drawing related to the item.

6.2 Light Control Switches

6.2.1 Measurement

Measurement shall be made for the number of each item acceptably supplied and installed by the Contractor as a complete unit.

6.2.2 Payment

Payment shall be made for the total number of units measured, as provided above, at the Contract unit price each and shall constitute full compensation for supplying, installing, connecting, testing and completion of each type and rating of the Light Control Switch including PVC outlet box, nuts, bolts and other accessories as required for complete installation.

6.3 Switched Socket Outlets

6.3.1 Measurement

Measurement shall be made for the number of each item acceptably supplied and installed by the Contractor as a complete unit.

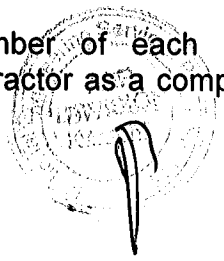
6.3.2 Payment

Payment shall be made for the total number of units measured, as provided above, at the Contract unit price each and shall constitute full compensation for supplying, installing, connecting, testing and completion of each type and rating of the Switched Socket outlet including PVC outlet box, nuts, bolts and other accessories as required for complete installation.

6.4 Fan Controllers

6.4.1 Measurement

Measurement shall be made for the number of each item acceptably supplied and installed by the Contractor as a complete unit.



6.4.2 Payment

Payment shall be made for the total number of units measured, as provided above, at the Contract unit price each and shall constitute full compensation for supplying, installing, connecting, testing and completion of each type and rating of Fan Controller unit including PVC outlet box, nuts, bolts and other accessories as required for complete installation.

6.5 Light Dimmers

6.5.1 Measurement

Measurement shall be made for the number of each item acceptably supplied and installed by the Contractor as a complete unit.

6.5.2 Payment

Payment shall be made for the total number of units measured, as provided above, at the Contract unit price each and shall constitute full compensation for supplying, installing, connecting, testing and completion of each type and rating of Light Dimmer unit including PVC outlet box, nuts, bolts and other accessories as required for complete installation.

SECTION - 8230

CONDUITS AND PIPES

1.0 SCOPE OF WORK

The work under this section consists of supplying, installing, and commissioning of all material and services of the complete conduits and pipes as specified herein, shown on the Drawings and stated in the Bill of Quantities.

The Contractor shall discuss the layout with the Engineer and co-ordinate at Site with other services for exact route, location and position of the conduits and pipes for electrical lines.

The conduits and pipes with accessories shall also comply with the General Specifications for Electrical Works Section-8001 and with other relevant provisions of the Document.

2.0 GENERAL

The extent of works shown on the drawing does not indicate the exact position of conduits and pipes. The Contractor shall ensure exact location and route of conduit and pipes in coordination with other services drawings, as per site requirements and as directed by the Engineer.

3.0 APPLICABLE STANDARD/CODES

Latest editions of the following standards / codes shall be applicable for the materials in scope of this Section:

BS 6099	-	PVC conduits and accessories.
BS 3595	-	PVC pipes & accessories.
BS 4346	-	Cement Solvent for jointing

4.0 MATERIAL

4.1 PVC Conduits and Accessories

The heavy gauge PVC conduits and accessories conforming to BS6099 shall be generally used. The PVC conduits and accessories of light gauge may be used on the project with the concurrence of the Engineer.

The PVC bends, sockets, elbows, couplings, etc. shall conform to the same specifications as for the conduits. The PVC bends shall have

enlarged ends to receive conduit without any reduction in the internal diameter at joint. Manufactured smooth bends shall be used where conduit changes direction. Bending of conduits by heating or otherwise will not be allowed in any situation. The use of sharp 90-degree bends and tees will not be allowed for concealed wiring.

The round PVC junction boxes for ceiling light or fan points shall have minimum dimensions of 63-mm diameter and depth. The junction boxes for wall light points shall have minimum dimensions of 63-mm diameter and 38 mm deep. Round junction boxes shall be provided with one piece PVC cover plate fixed to the box by means of brass screws.

4.2 PVC Pipe and Accessories

The PVC pipe shall be rigid. All pipes shall be minimum Class D (Working pressure - 12 bar), unless otherwise stated on drawings or bill of quantities. The buried PVC pipe should be able to withstand the external load acting upon it by continuous movement of heavy duty vehicles such as trucks. Cranes, forklift, etc. Where pipe change direction, manufactured smooth bends shall be used. Bending of pipes by heating or otherwise will be allowed in special cases only. Bending of pipes by heating shall be carried out by first filling the pipe with sand inside and then immediately removing the sand. The use of sharp 90-degree bends and tees will not be allowed. The bends shall conform to same specifications as given for PVC conduits. for joining of pipe all precautions and procedures recommended by manufacturer shall be followed.

5.0 INSTALLATION

5.1 Concealed Conduits

Where concealed conduit system as stated on drawings, the conduit shall be installed concealed in roof, wall, column, etc. Conduits shall be laid underfloor only where specifically stated.

When concealed the conduit shall have a minimum of 32-mm cover of concrete measured from the top of conduit to finished surface. In the reinforced cement concrete (RCC) work the conduit shall be laid before pouring of Concrete. Under no circumstances shall chases be made in the RCC structure for concealing conduit and Accessories after pouring of concrete. The conduit shall be supported on top of bottom reinforcement of slab. All outlet boxes to be firmly supported and installed such that they finish flush with the soffit of slab or beam.

Where conduits have to be concealed an cement concrete (CC) work after concreting or in block masonry chase shall be made with appropriate

tools and shall not be made deeper than required. The conduit shall then be fixed firmly in the recess and covered with cement concrete mixture. The work of cutting in the cement concrete work or block masonry work shall be coordinated with the civil work. The Contractor shall obtain approval from the Engineer before starting chasing and cutting.

The termination of conduits at or near the equipment switchboard as shown diagrammatically on the drawings. The exact locations of the termination shall be coordinated with the equipment/switchboard to be installed. Any extension of conduit to suit the site condition shall be made without any extra cost. Conduit ends pointing upwards or downwards shall be properly plugged in order to prevent the entry of foreign materials. All openings through which concrete may leak shall be carefully plugged and boxes shall be suitably protected against falling with concrete. At all terminations of conduit sharp edges of conduit ends shall be prevented to avoid the cutting or damaging of wire or cables during pulling through the conduits.

Underfloor conduit shall be installed at a minimum depth of 2 inches from the finished floor level or as shown on the drawings. The conduits shall be installed empty before finishing of floor or in RCC work with a 18 SWG steel wire drawn through the conduit for pulling cable. No conduits shall be laid under floor in bathroom.

The entire conduit system shall be installed and checked before wiring as carried out. Any obstruction found shall be cleared before the installation of cable. Pull boxes and adaptable boxes shall be provided an conduit runs wherever required to facilitate pulling operation. The drawings are diagrammatic and do not indicate the position and spacing of pull boxes or adaptable boxes. However, these shall meet the following requirements.

- Pull boxes

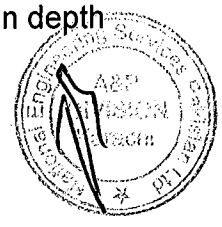
  For straight runs the spacing shall not be more than 180 feet

  For runs with one 90degree bend the spacing shall not be more than 90feet

  For runs with two 90degree bends the spacing shall not be more than 40feet

- Adaptable boxes

  For conduit upto 1-inch dia. the boxes shall be 2 inch in depth



For conduit upto 1-1/2 inch dia. the boxes shall be 2-1/2 inch in depth

For conduit upto 2-inch dia. the boxes shall be 3-1/2 inch in depth

The rectangular inspection boxes or pull boxes shall be 18 SWG heavy gauge sheet steel of suitable design to receive conduits. The box shall be painted inside and outside with black enamel paint over a base coat of red oxide primer paint. The minimum length of inspection box shall not be less than four tames the cable manufacturer's recommended Bending radius of the cable. All concealed type pull boxes shall have a white plastic sheet of appropriate size fixed to the box by means of galvanized screws.

Adaptable boxes shall be 18 SWG sheet steel and painted and finished to the same quality as the Lighting distribution boards.

Wherever the conduit lengths cross the expansion joint either along the columns or slab suitable arrangement shall be provided so that when the conduit lengths in the expansion joint are stressed the conduit shall not crack or break.

Conduits/ pipes/ ducts for electrical, PSD & ITS etc cables shall be properly sealed with the water proofing material "Plastic Polyurethane Foam" as per relevant ASTM standard to avoid rain water entry to the conduits. The contractor shall also provide the technical data of the sealant material before the execution of the work.

5.2 PVC Pipe

Rigid PVC pipes shall be installed under roads and paved areas, at crossing with other services and at cable entering building as shown on the drawings. The depth of the pipe shall vary according to the conditions at site, and approval of Engineer shall be obtained prior to installation. In general the pipes shall be installed underground at the following depths measured from the top of the pipe:

a)	Under roads and paved surface	900 mm below the finished surface
b)	When crossing other services for the crossing length.	250-mm vertical clearance. 500 mm horizontal clearance with CC protective cover.

The trench of required dimensions shall be excavated and the bottom of trench cleaned and leveled. A Four-inch thick bed of fine sand shall be provided over which the PVC pipes installed after proper alignment. Where two or more pipes are installed in the same trench the clearance

between pipes shall not be less than Two inches. After laying of pipe the trench shall be backfilled with clean-screened earth in layer of Four inches. Each layer shall be properly compacted.

Where underground cables enter connection terminal boxes the PVC pipe shall be installed on surface by means of PVC clamps at a maximum interval of Eighteen inches.

After installation, the ends of the pipe shall be plugged with material impervious to water and chemicals. All joints shall be sealed adequately to prevent entry of foreign elements.

The installation of pipes shall be completed in all respects including its fixing at terminations, before cabling work is started. All sharp edges and burrs shall be removed by using reamer or any approved device. The pipe shall be thorough cleaned of dirt and dust from inside. the pipes shall be installed in proper co-ordination with other works.

6.0 MEASUREMENT AND PAYMENT

6.1 General

The Contractor's bid amount against each Bill of Quantities item as given below shall include supplying, installation and completion for all work specified herein and as shown on the drawing related to the item.

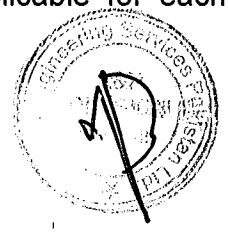
6.2 PVC Conduits

6.2.1 Measurement

Measurement shall be made for the number of running feet or running metres of conduits acceptably supplied and installed by the Contractor as a complete unit.

6.2.2 Payment

Payment shall be made for the total numbers of units measured, as provided above, at the Contract unit price each. The payment shall constitute full compensation for supplying, installing and completion of the laying of the conduits including jointing materials and accessories. The complete work wherever applicable shall include cutting/ chasing of civil work, for concealed conduit system, excavation and backfilling of ground for underground pipes painting, plugging, bitumen coating, etc., as applicable for each type of work.



6.3 PVC Pipes

6.2.1 Measurement

Measurement shall be made for the number of running feet or running metres of pipes acceptably supplied and installed by the Contractor as a complete unit.

6.2.2 Payment

Payment shall be made for the total numbers of units measured, as provided above, at the Contract unit price each. The payment shall constitute full compensation for supplying, installing and completion of the laying of the PVC pipes including jointing materials and accessories.

SECTION 8240

EARTHING
(AS APPLICABLE)

1.0 SCOPE OF WORK

The work under this section consists of supplying, installing, testing and commissioning of all material and accessories of the complete earthing system as specified herein, as shown on the Drawings and given in the Bill of Quantities.

The Contractor shall discuss the electrical layout with the Engineer and Co-ordinate at Site with other services for exact route, location and position of the electrical lines and equipment.

The earthing system shall also comply with the General Specifications for Electrical Works Section-8001 and with other relevant provisions of the Documents and latest WAPDA Specifications.

2.0 GENERAL

The earthing system consists of earth electrodes, earthing leads, earth connecting points, earth continuity conductors and all accessories necessary for the satisfactory operation of the associated electrical system.

3.0 APPLICABLE STANDARDS/CODES

The latest editions of following standards/codes shall be applicable for the materials in scope of this section:-

BS 951	-	Earthing Clamps
CP 1013	-	Earthing
BS 2874	-	Nuts, bolts, washers, screws & rivets fixing for use on Copper
BS 1433	-	Hard drawn bare copper conductor for earthing
BS 6346	-	PVC insulated cables

4.0 MATERIAL

Item 4.1 to 4.3 shall be selected as per design/drawings and BOQ of the projects.

4.1 Earth Electrode (Plate Type)

The earth electrode shall comprise a two feet x two feet and 1/8 inch thick electrolytic copper plate. The surface of the plate shall be tinned for protection. The plate shall have four terminals for connecting of the earthing leads. Nuts, bolts and washers, shall be either of brass or tinned copper.

4.2 Earth Electrode (Rod Type)

The earth electrode shall comprise ten feet long, 5/8 inch dia. copper deposited steel rod having flat head at drive end and pointed conical tip at the driven end. The tip shall be hardened to facilitate driving. At the top of the rod, a clamp for bolted connections shall be provided suitable for connection to the down conductor.

4.3 Earth Electrode (BoreType)

The earth electrode shall comprise of Tinned copper earth spike having dimension as show in the drawing. At the top of the pipe, a clamp for bolted connections shall be provided suitable for connection to the down conductor.

4.4 Earthing Lead

The earthing lead shall connect the earth electrode to earth connecting point and on the metallic part. It shall be round hard drawn bare electrolytic copper of size as shown on the Drawings.

4.5 Earth Continuity Conductor

Earth continuity conductor (ECC) shall be hard drawn bare copper wire or single core PVC insulated copper conductor cable of sizes indicated on the Drawings.

The specifications for single core PVC insulated or PVC/PVC cables used as ECC shall be same as those in relevant sections of Technical Specifications.

4.6 Earth Connecting Point

Earth connecting points shall comprise tinned copper bar, rectangular in shape, having dimensions of 350 x 50 x 6 mm. Atleast, six terminals for connection shall be arranged on the bar, which can be increased or decreased as required by the engineer.

The terminals shall have brass or tinned copper bolts, nuts and washers for protection against corrosion. Two holes shall be provided off centre of the copper bar for fixing to the wall by means of 10 mm dia. nut and bolt/ rawal bolt and shall be insulated by means of rubber gaskets/washers/ insulators.

5.0 INSTALLATION

5.1 General

Complete earthing systems as shown on the Drawing shall be installed by the Contractor. The earthing system shall have earth resistance, including the resistance of soil, earth leads and ECC preferably than **One(01)** ohm but not greater than three (03) ohm.

At all connections of earth continuity conductor to high mast or any other metallic body, proper size copper 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 terminations 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 in general run in cable trench or in conduits/pipes as shown on the Drawings. For under floor runs, these shall be installed in pipe/conduit of appropriate sizes. Where laid along underground cables, these shall be laid directly underground in unpaved areas and in pipes under paved areas.

5.2 Earth Electrode (Plate Type)

The electrode plate shall be installed at a minimum depth of 15 feet from finished ground level or 3 feet below permanent water level whichever is less. The minimum horizontal distance between earth electrodes shall be 12 feet. Proper mixture of lime and charcoal shall be made and buried alongwith the copper plate in the ground to increase the soil conductivity. The earthing leads shall be installed in proper size G.I. pipes. The electrode shall be installed as per details shown on the Drawings. At the ground level an inspection chamber of cement concrete shall be

constructed having dimensions as shown on the Drawings. The inspection chamber shall have a cover supported on angle iron frame. The cover shall be approved by the Engineer and shall finish flush with the ground level. At the ground level an inspection chamber of cement concrete shall be constructed having dimensions as shown on the Drawings. The inspection chamber shall have a cover supported on angle iron frame. The cover shall be approved by the Engineer and shall finish flush with the ground level. The earthing system shall be installed as per BOQ and drawings of the same.

5.3 Earth Electrode (Bore Type)

The earth electrode/spike shall be placed after bore at site. The bore shall be made upto permanent water level of 80 feet which ever is less. The earth electrode shall be connected to the earthing conductor of suitable size as shown in the drawings/BOQ. The earthing conductors shall be laid in a perforated GI pipe of suitable size.

In case the soil conditions at site permit, the earth electrodes may be installed by hammering the electrode in soil, until the top of the rod is about 12 inches below the proposed ground level. If hammering down is not possible due to site conditions, a pit shall be first excavated in bare ground upto the required depth and electrode shall be installed upright in the pit. The excavated pit shall be backfilled in layers of 20 inches, each layer tamped and compacted. At the ground level an inspection chamber of cement concrete shall be constructed having dimensions as shown on the Drawings. The inspection chamber shall have a cover supported on angle iron frame. The cover shall be approved by the Engineer and shall finish flush with the ground level. The earthing system shall be installed as per BOQ and drawings of the same.

5.4 Earth Electrode (Rod Type)

In case the soil conditions at site permit, the earth electrodes may be installed by hammering the electrode in soil, until the top of the rod is about 12 inches below the proposed ground level. If hammering down is not possible due to site conditions, a pit shall be first excavated in bare ground upto the required depth and electrode shall be installed upright in the pit. The excavated pit shall be backfilled in layers of 20 inches, each layer tamped and compacted. At the ground level an inspection chamber of cement concrete shall be constructed having dimensions as shown on the Drawings. The inspection chamber shall have a cover supported on angle iron frame. The cover shall be approved by the Engineer and shall finish flush with the ground level. The earthing system shall be installed as per BOQ and drawings of the same.

5.5 Earth Continuity Conductor

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 equipment. The body of all switchboards shall also be connected to earth by specified size of ECC. All other metal work shall also be connected to earth by specified size of ECC.

At any joint or terminations, the ECC shall be connected using proper accessories. No connection shall be made by twisting of earth conductors.

5.6 Earth Connecting Point

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.

6.0 MEASUREMENT AND PAYMENT

6.1 General

The Contractor's bid amount against each Bill of Quantities item as given below shall include supplying, installation, testing and commissioning of all work specified herein, as shown on the Drawing related to the item.

6.2 Earth Electrode

6.2.1 Measurement

Measurement shall be made for each type of earth electrode acceptably supplied and installed by the Contractor as a complete unit.

6.2.2 Payment

Payment shall be made for the total number of units measured, as provided above, at the Contract unit price each, and shall constitute full compensation for supplying, installing, testing, commissioning and completion of earth electrodes including earthing leads, excavation, backfilling, inspection chamber with cover, G.I. pipes for earthing leads, nuts, bolts, washers, lugs, brazing and all related civil works.

6.3 Earth Continuity Conductor

6.3.1 **Measurement**:

Measurement shall be made for the number of running feet for each size of earth continuity conductor (ECC) acceptably supplied, installed and tested by the Contractor.

6.3.2 **Payment**

Payment shall be made for the total number of running feet of each size of ECC measured, as provided above, at the Contract unit price each and shall include full compensation for supplying, installing, connecting, testing and completing of ECC including all accessories, such as sockets, thimbles, lugs, bolts, nuts, brazing etc.

6.4 Earth Connecting Point

6.4.1 **Measurement**

Measurement shall be made for each earth connecting point acceptably supplied and installed by the Contractor as a complete unit.

6.4.2 **Payment**

Payment shall be made for the total number of units measured, as provided above, at the contract unit price each and shall constitute full compensation for supplying, installing and completion of earth connecting point and all other associated accessories such as nuts, bolts, washers, lugs etc.

SECTION - 8250

LIGHTNING PROTECTION SYSTEM

1.0 SCOPE OF WORK

The work under this section consists of supplying, installing, testing and commissioning of all materials and accessories of the complete Lightning Protection System as specified herein, as shown on the Tender Drawings and given in the Bill of Quantities.

The Contractor shall discuss the electrical layout with the Engineer and co-ordinate at Site with other services for exact route, location and position of the lightning protection system.

The lightning protection system with accessories shall also comply with the General Specifications for Electrical Works Section - 8001 and with other relevant provisions of the Tender Documents.

2.0 GENERAL

The Contractor shall install the system as specified herein and in accordance with the referred standard. The extent of work specified or shown on the drawings is schematic and does not indicate the exact position of testing terminals, conductor connections, etc. However, the Contractor shall ensure that the system is complete in all respect as intended by the specifications. The earthing resistance of lightning protection system at any point in the system shall not exceed TEN OHMS.

3.0 APPLICABLE STANDARDS/CODES

The latest editions of following standards / codes shall be applicable for the materials specified within the scope of this section:

BS 6651 - Protection of structures against lightning.

CP 326 - Protection of structures against lightning (code of practice)

BS 2873 - Copper and copper alloys

BS 2874 - Copper and copper alloys - Rods and section (other than forging stock)

BS 1433 - Hard drawn bare copper conductor for earthing

4.0 MATERIAL

The installation of lightning protection system shall comprise;

- Lighting Arrestor / Air Terminal System
- Down conductors.
- Testing terminals.
- Earth electrode (Copper Clad Steel Rod Type)
- Concrete Inspection pit with cover

4.1 Lighting Arrestor / Air Terminal System

The system shall comprise of all necessary components i.e. arrestor/ equipment, expansion mast, solid copper conductor and fixing support arrangement at Highest Point and as indicated on drawings.

The structural design shall be submitted by the contractor for review in accordance with wind & seismic loads given in the relevant sections.

4.2 Down Conductors

The down conductors for lightning protection system shall be 70 sq.mm. bare solid soft drawn tinned copper conductor. All connections between metal work on the roof shall be with the same conductor sizes and material as for roof conductor. All accessories for fixing of copper conductor to concrete surface shall be of copper or brass as approved by the Engineer.

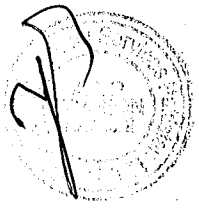
Alternatively, the down conductors shall be cad welded at the top & bottom with reinforcing bars of the column; Steel Structures etc. to be used as all or part of the down conductor system provided they are appropriately connected to the air and earth termination network and test shall be carried out at each step/levels to ensure good electrical conductivity.

4.3 Testing Terminals

For each down conductor, a testing terminal shall be provided. It shall be installed 1.5 metres above the finished floor level or as convenient for testing purposes and as directed by the Engineer. The testing terminals shall have removable connections.

4.4 Earth Electrode (Copper Clad Steel Rod Type)

This type of earth electrode shall comprise a 3.00 meter long, 20 mm dia. copper clad steel rod in section of 1.5 m with copper coupling having flat head at drive end and pointed conical tip at the driven end. The tip shall be hardened to facilitate driving. At the top of the rod, a brass clamp for bolted connections shall be provided suitable for connection to the down conductor or earthing lead as required.



The inspection chamber with C.I. cover shall be provided as specified for plate type earth electrode.

5.0 INSTALLATION

5.1 Lighting Arrestor / Air Terminal System

The base of the air terminal shall be properly fixed to roof of the building and all roof/down conductors properly bolted. The threaded air terminal shall than be placed. The entire assembly shall be installed in compliance to wind loading / structural calculations.

5.2 Down Conductor

The down conductor shall be installed along the shortest possible route from roof to earth electrode. It shall be secured on the surface of wall by means of clamps at a maximum interval of 300 mm. Alternatively the down conductors shall be cad welded at the top and bottom of the column reinforcing bars, steel structures to be used as all or part of the down conductors system.

In general, bends shall be avoided along the routes of down conductor and maximum possible bending radius will be provided at turns. All joints between conductors shall be electrically and mechanically strong and effective. Straight joints in the down conductor shall be bolted. The joint shall be given a coat of anti corrosive paint after connection. All accessories such as nuts, bolts, washers, solder, paint etc. shall be furnished by the Contractor.

For each down conductor a removable terminal shall be provided for testing purpose at approximately 1.5 metre height. The location of testing terminals are not shown on the drawings. The Contractor must ensure that testing terminals are installed so as to facilitate testing. The testing terminals shall be bolted type and made in accordance with the specifications for straight bolted joints. The connecting earth lead from testing terminals to earth electrodes shall be continuous without any joint. All metal work, pipes etc., at the roof and within 2 metres along the route of Down conductor shall be bonded to the lightning protection system. The bonding shall be effective and approval of the Engineer shall be obtained for the bonding method.

5.3 Earth Electrode (Copper Clad Steel Rod Type)

In case the soil conditions at site permit, this type of earth electrode may be installed by hammering the electrode in soil, using driving stud until the top of the rod is about 300 mm below the proposed finished ground level. If hammering down of rod is not possible due to site conditions, a pit shall be first excavated in bare ground upto the required depth and electrode shall be installed upright in the pit. The excavated pit shall be backfilled in layers of 500 mm, each layer tamped and compacted to ensure a good and firm contact between electrode and earth.

6.0 MEASUREMENT AND PAYMENT

6.1 General

The Contractor's bid amount against each Bill of Quantities item as given below shall include supplying, installation, testing, and commissioning and completion of all work specified herein, as shown on the Tender drawing related to the item.

6.2 Lighting Arrestor / Air Terminal System

6.2.1 **Measurement:** Measurement shall be made for the total number of air terminal acceptably supplied and installed by the Contractor.

6.2.2 **Payment:** Payment shall be made for the total number of air terminal measured, as provided above, at the Contract unit price each, and shall constitute full compensation for supplying, installing, testing, commissioning and completion of the air terminal including all accessories, such as sockets, thimbles, lugs, bolts nuts, brazing, etc.

6.3 Down Conductors

6.3.1 **Measurement:** Measurement shall be made for the total running metre of down conductors acceptably supplied and installed by the Contractor.

6.3.2 **Payment:** Payment shall be made for the total running metre of down/roof conductors measured, as provided above, at the Contract unit price each, and shall constitute full compensation for supplying, installing, testing, commissioning and completion of the down/roof conductors including all accessories, such as sockets, thimbles, saddles, lugs, bolts nuts, brazing / cad welding etc.

6.4 Earth Electrode (Copper Clad Steel Rod Type)

6.4.1 **Measurement:** Measurement shall be made for the total number of copper clad steel rod type earth electrode acceptably supplied, installed and tested by the Contractor as a complete unit.

6.4.2 **Payment:** Payment shall be made for the number of units measured, as provided above at the Contract Unit Price each, and shall constitute full compensation for supplying, installing, testing, commissioning and completion of the copper clad steel rod type earth electrode including testing terminal, earthing lead from testing terminals to earth electrodes, excavation, backfilling, compaction, civil works for inspection chamber, cast iron cover, G.I. pipe for earthing lead etc. and all accessories, such as sockets, thimbles, lugs, saddles, bolts nuts, brazing, etc.

6.5 Cad Welding

6.5.1 **Measurement :** Measurement of cad welding of down conductors with the reinforcing bar of the column and welding of bar to bar shall be made for the total number of points acceptably done and completed by the Contractor.

6.5.2 **Payment:** Payment shall be made for the number of cad welding points completed as provided above at the contract unit price each, and shall constitute full compensation for execution and completion of the cad welding including testing at each step/level for good electrical conductivity.

*** End of Section 8250 ***

SECTION - 8290

MISCELLANEOUS ITEMS

1.0 SCOPE OF WORK

The work under this section consists of supplying, installing, testing and commissioning of all material and accessories for Miscellaneous Items as specified herein and/or shown on the drawings and given in the Bill of Quantities.

The Contractor shall discuss the electrical layout with the Engineer and co-ordinate at site with other services for exact locations and positions of the Miscellaneous Items.

The Miscellaneous Items with accessories shall also comply with the General Specifications for Electrical Works Section - 8001 and with other relevant provisions of the Document and latest WAPDA Specifications.

2.0 GENERAL

The miscellaneous items as described in this section shall comply with other sections of these specifications as applicable. No specific reference to any manufacturer has been made and the Contractor shall ensure that all the miscellaneous items be supplied/fabricated from the reputable manufacturers, who have already supplied/fabricated similar items.

3.0 APPLICABLE STANDARDS/CODES

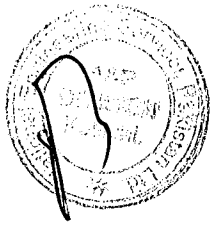
The latest editions of the following standards/codes shall be applicable to the material specified within the scope of this Section:

BS 4934	-	Safety requirements for electric fans and regulators.
BS 5060	-	Performance of circulating fans and their regulators.
BS 4752	-	Switchgear & controlgear for voltages upto 1000 volt.
IEC 439	-	Factory built assemblies of LV switchgear & controlgear.

4.0 MATERIAL

4.1 MCB/MCCB Enclosed in Sheet Steel Box

The single pole 250 volts and triple pole 500 volts moulded case circuit breakers (MCCB) are used for supplying single phase/three phase power to the equipment shown on the drawings and given in the Bill of Quantities.



The MCCB shall conform to the same specifications as given in section LV distribution boards of these specifications. It shall be installed in a 14 SWG sheet steel box of such a size which can easily accommodate the MCCB and incoming/outgoing wires or cables. Sufficient numbers of PVC connectors shall also be provided inside the sheet steel box for terminating the earth continuity conductors and neutral wires. The front plate fixed on the sheet steel box shall be of sheet steel fixed with G.I. screws having an opening for operating the ON-OFF lever of MCCB.

4.2 Ceiling Fan

Ceiling fan shall be capacitor type, suitable for 250 Volt AC. The air displacement shall be 12,000 cfm for 56" (1422 mm) sweep and 10,000 cfm for 48" (1219 mm) sweep at maximum speed. The fan motor shall be capacitor type and bearing shall be groove type to give noiseless operation.

The down rod of ceiling fans shall be appropriate length such that the ceiling fan motor and blades are minimum 12 inches below false ceiling.

4.3 Ceiling Hook for fan

The fan hook shall be made of 16 mm diameter mild steel rod. It should be in the form of a loop about 75 mm long and about 50 mm wide. The rod should be bent to have at least 200 mm extension on both sides for tying to reinforcement steel of slab. The fan shall be deluxe model, of any reputable make.

4.4 Wall Bracket Fan

Fan motor shall be capacitor type and bearing shall be groove type to give noiseless operation. The fan regulator shall be built-in type with high grade steel laminations and shall have five speed marks and one "OFF" mark. The fan shall be finished in white colour matching the ceiling and shall be of any reputable make.

4.5 Exhaust Fans

Exhaust fans shall be of plastic body and blades. The 6" dia fans shall have circular frame suitable for fixing in window glass. It shall have a card control shutter. The 9" and 12" exhaust fans shall have square shaped plastic body and blades. It shall be suitable for installation in wall openings. The fan shall have a card switch for reversible operation.

5.0 INSTALLATION

5.1 General

The mounting heights of all the miscellaneous items are stated on the drawings or in general notes. In case the mounting height is not mentioned, the instructions of the Engineer shall be obtained before fixing the item.

5.2 MCB/MCCB Enclosed in Sheet Steel Box

The miniature/moulded case circuit breakers (MCB/MCCB) shall be installed on 1.63 mm (16 SWG) thick sheet steel box with screws or some suitable arrangements as approved by Engineer. White face plate for sheet steel box shall be fixed by means of flat head galvanized screws sunk in the plastic plate so as to finish flush with the wall surface. The edges of the plate shall be chamfered.

5.3 Ceiling Fan

Fan hook shall be installed in the RCC ceiling and to the reinforcement before pouring of concrete. The installation of fan shall include fixing of blades, down-rod, clamp, canopy, including testing and commissioning.

The down rod shall be of required length having long threads and shall be provided with check nuts to secure it firmly with the clamp and with the body of the fan. A split pin shall be provided both at the fan body end and at the clamp for safety. Any scratches on the body of the fan or fan rod appearing during installation shall be cleaned and painted properly with the same quality paint as provided by the manufacturer.

Wiring between the ceiling rose and the fan terminals shall be three core 1.5 .mm^2 PVC insulated, PVC sheathed flexible cable.

5.4 Wall Bracket Fan

Wall bracket fan shall be installed on wall at locations shown on the drawings as per manufacturer's recommendations. Wiring between wall fan point and fan shall be with 3 core 1.5 mm^2 PVC insulated, PVC sheathed flexible cable.

5.5 Exhaust Fans

The exhaust fans shall be installed in window glass or in wall openings as required.

6.0 MEASUREMENT AND PAYMENT

6.1 General

The Contractor's bid amount against each Bill of Quantities item as given below shall include supply, installation, testing, commissioning and completion for all work specified herein, as shown on the Drawings and given in the Bill of Quantities related to the item.

6.2 MCB/MCCB Enclosed in Sheet Steel

6.2.1 Measurement

Measurement shall be made for the number of each item acceptably supplied and installed by the Contractor as a complete unit.

6.2.2 Payment

Payment shall be made for the number of units measured as provided above at the Contract unit price each and shall constitute full compensation for supplying, installing, connecting, testing and completion of each item including sheet steel outlet box, plate and accessories as required.

6.3 Ceiling Fans

6.3.1 Measurement

Measurement shall be made for each type of Ceiling fan & accessories acceptably supplied and installed by the Contractor as a complete unit.

6.3.2 Payment

Payment shall be made for the number of units measured as provided above at the Contract unit price each and shall constitute full compensation for supplying, installing, connecting, testing and commissioning of Ceiling fans including mounting, accessories such as nuts, bolts, hooks, down rod of appropriate length etc., and wiring between ceiling rose and fan terminals complete in all respects.

6.3 Wall Bracket Fans

6.3.1 Measurement

Measurement shall be made for each type of wall Bracket fan & accessories acceptably supplied and installed by the Contractor as a complete unit.

6.3.2 Payment

Payment shall be made for the number of units measured as provided above at the Contract unit price each and shall constitute full compensation for supplying, installing, connecting, testing and commissioning of wall Bracket fans including mounting, accessories such as nuts, bolts, hooks, etc., and wiring between ceiling rose and fan terminals complete in all respects.

6.3 Exhaust Fans

6.3.1 Measurement

Measurement shall be made for each type of Exhaust fan & accessories acceptably supplied and installed by the Contractor as a complete unit.

6.3.2 Payment

Payment shall be made for the number of units measured as provided above at the Contract unit price each and shall constitute full compensation for supplying, installing, connecting, testing and commissioning of Exhaust fans including mounting, accessories such as nuts, bolts, etc., and wiring between ceiling rose and fan terminals complete in all respects.

TELECOMMUNICATION WORKS

SECTION – 8312

STRUCTURED CABLING NETWORK

1.0 SCOPE OF WORK

The work under this section consists of supplying, installing, testing and commissioning of all material and services for provision of Structured Cabling Network as specified herein, as shown on Bidding Drawings and stated in the Bill of Quantities.

The Contractor shall discuss the Structured Cabling Network Layout with the Engineer and co-ordinate at site with other services for exact route, location and position of the system.

The Structured Cabling Network work with accessories shall also comply with the General Specifications, Section – 8001 and with other relevant provisions of the Bidding Document.

2.0 GENERAL

To ensure optimum performance, components of the structured cabling network shall be sourced from the one manufacturer. This shall eliminate potential problems such as electrical and mechanical mismatch between different manufacturers.

The characteristics of the cabling system shall support all application including Gigabit Ethernet.

The system shall be of 'star' topology and shall consist of the following:

- Horizontal cable; consolidation point (CP);
- Consolidation point cable (CP cable)
- Multi-user Telecommunications Outlet (MUTO);
- Telecommunication outlet (TO).

The suggested system is independent of the manufacturer of the active data or telecommunications equipment.

This will support analogue and digital applications, data, local area network, and video on a common platform including Ethernet, Token Ring, Fast Ethernet, 100 BaseT, ATM at 155Mbps and transmission speeds of 622Mbps and transmission speeds of 622Mbps and Gigabit Ethernet.

3.0 APPLICABLE STANDARDS AND CODES

The following standards and all "normative addendums" shall be applicable to this document and must be adhered to for any installation work performed.

ISO/IEC 11801	Information technology – Generic cabling for customer premises.
ISO/IEC/TR3 8802-1	Information technology - Telecommunication and information exchange between systems - local and metropolitan area networks - Specific requirements - Part 1 overview of Local

Area Network Standard.

ISO/IEC 8802-3	Information technology - Telecommunication and information exchange between systems - local and metropolitan area networks - Specific requirements - Part 3 Carrier sense multiple access with collision detection access method and physical layer specifications.
ISO/IEC 61935-1	Generic specification for the testing of generic cabling in accordance with ISO/IEC 11801 – Part 1: Installed cabling.
IEC 60364-1	Electrical installation of buildings – Part 1: Scope, object and fundamental principles.
IEC 60950	Safety of information technology equipment, including electrical business equipment.
EN50173	Information technology – Generic cabling for customer premises.
EN50174-1	Information technology – Cabling installation. Specification and quality assurance.
EN50174-2	Information technology – Cabling installation. Installation panning practices inside buildings.
ANSI/TIA/EIA-568	Commercial Building Telecommunications Cabling Standard.
ANSI/TIA/EIA-569	Commercial Building Standard for Telecommunications Pathways and Spaces.
TIA/EIA TSB-72	Centralized Optical Fibre Cabling Guidelines.
TIA/EIA TSB-75	Additional Horizontal Cabling Practices for Open Offices.

This list is not restrictive. The contractor shall have to take account of the new standards which could come into effect during the progress of design and installation.

4.0 MATERIALS

4.1 Copper Connectors

The copper jacks must comply with EN 60603-7 and EN 28877 and be of the insulation displacement type. They are must be capable of terminating 0.50 to 0.65 solid and 7 x 0,15 to 0,20 mm stranded wires.

The jacks have the following features:

- Keystone fixing;
- Tool less assembly
- Capable of being wired to both 568B and 568A
- Flexible cable entry
- UTP version as appropriate
- Category 6
- Integral shutter

The jacks have the following performance:

- Lead-through resistance 17 mΩ <Resistance <20 mΩ
- Insulation resistance > 10 mΩ
- Maximum diameter of the wire sheath 1,60mm
- Cat 6 (at 250 MHz)

  - Attenuation < 0.3dB
  - Return loss >= 16dB
  - NEXT >= 47.5dB

4.2 Fibre Connectors

The fibre connectors must comply with IEC 61754

The fibre socket must have the following features:

- Small form factor connector
- Duplex
- High density
- Field terminated in under two minutes
- Integral shutter for dust protection and optical safety
- Plastic body parts

The connection should have the following typical performance:

		Insertion Loss (dB)		Return Loss (dB)	
		850mm	1300mm	850mm	1300mm
62.5 / 125	Mean	0.3	0.2	27	29
	Limit	<= 0.75	<= 0.75	>= 20	>= 20
50 / 125	Mean	0.19	0.29	33	33
	Limit	<= 0.75	<= 0.75	>= 20	>= 20

The connection should comply with the following mechanical and environmental tests:

PARAMETER	TIA/EIA Fibre Optic Test Procedure	IEC 61300 Series Test Method	SEVERITY	PERFORMANCE
Attenuation	171	3-4	n/a	≤0,75dB max, 0.3dB typical
Return Loss	107	3-6	n/a	>20dB
Mating Durability	21	2-2	500 cycles	≤0,75dB max, >20dB RL
Impact	2	2-12	8 drops at 1,5m	≤0,75dB max, >20dB RL
Plug Cable Retention/Side Pull	6	2-4	66N at 0 degree 6,6N at 90 degree	≤0,75dB max, >20dB RL
Strength of Coupling	185	2-6	33N	≤0,75dB max, >20dB RL
Plug Cable Flexing	1	n/a	±90degrees, 0,5kg 100cycles	≤0,75dB max, >20dB RL
Plug Cable Twist	36	2-5	±2,5 revolutions, 15N	≤0,75dB max, >20dB RL
Cold	188	2-17	-10C, 96 Hours, Sample functioning	≤0,75dB max, >20dB RL ≤0,3dB change
Heat	4	2-18	+60C 14 days, Sample functioning	≤0,75dB max, >20dB RL ≤0,3dB change
Humidity	5	2-19	+40C, 90-95%RH, 96 Hours Sample functioning	≤0,75dB max, >20dB RL ≤0,4dB change
Thermal Cycling	n/a	2-22	-10C to +60C 5 cycles	≤0,75dB max, >20dB RL ≤0,3dB change
Vibration	n/a	2-1	10-55Hz, 30min each axis	≤0,75dB max, >20dB RL ≤0,3dB change

4.3 **Telecommunication Wall Outlets**

Wall outlets must be available to suit the local needs with at least two RJ45 sockets. The wall outlets should be fully shuttered. The copper outlets must be capable of being flush mounted. Wall outlets must have space for visibly labeling each jack or socket.

4.4 **Patch Panels**

19" panels must be available to take a minimum of 24 copper RJ45 jacks or 24 duplex fibre connections per IU. Other connection densities must be available.

Copper : 16, 24, 48 per panel
Fibre : 24, 28, 72 per panel

The panels will be designed for keystone fitting of the jacks / sockets.

The copper panels will have cable management and tie down points (where required) for copper cable.

The fibre panels will have cable management, fibre management and slack storage for fibre cables and ensure that the minimum bend radius is not exceeded.

Fibre panels must be able to manage a range of cable sizes from 2 fibre nits to 96 fibre cables. They must be sliding or front loading to ensure easy access to the fibre.

For fibre wall mounted options for 6, 12 and 24 fibres must be available for SOHO or backbone installation.

Panels must have the facility to label each socket/jack.

Coloured identifiers should be available in at least 4 colours to allow visible identification of jacks / sockets.

Blanking plugs for unused ports must be available to suit the patch panel colour.

4.5 **Patched Organization**

IU Patchcord management panels should have a minimum of 5 rings to accommodate up to 72 patchcords.

4.6 **Patch Cables**

100 Ohm RJ-45 copper patchcords shall be Category 6 and provides transmission performance meeting Category 7 specification. The EMC level should also match for UTP cables UTP patchcords should be use, for shielded systems shielded patchcords should be used.

The copper patchcords must be made from stranded wires for full flexibility. They must comply with ISO 11801. The patchcords must be available in a range

of lengths to facility easy patchcord management.

The fibre patchcords must be made from duplex ruggedised cable. The fibre core and cladding sizes must be of the same nominal value as the cable to ensure lowest channel loss. The plugs on the ends must be appropriate for those on the permanent link and on the active equipment. The following connectors must be available as patchcords or hydbrid patchcords: ST, SC, LC. The patchcords must be available in a range of lengths to facility easy patchcord management.

4.7. **Copper Cable**

Copper cable will be 100 Ohm impedance. The cable will be Category 6 in UTP to match the system specification. The cables will be available in 4 pair or 2 x 4 pair.

The cable shall have the following performance:

Cable Performance Category 6 UTP

Frequency [MHz]		1	4	10	16	20	31.25	62.5	100	200	250	300
Max attenuat.	Typical value	1.9	3.6	5.7	7.3	8.3	10.3	14.8	19.0	27.3	31.0	34.0
[dB/100 m]	Cat 6 (max.)	2.1	3.8	6.0	7.6	8.5	10.8	15.5	19.9	29.2	33.0	-
Min.NEXT	Typical value	77.0	68.0	62.0	59.0	57.0	55.0	50.0	47.0	42.0	41.0	40.0
[dB]	Cat 6 (min.)	75.0	66.0	60.0	57.0	56.0	53.0	48.0	45.0	41.0	39.0	-
Min.ACR	Typical value	75.1	64.4	56.3	51.7	48,7	44.7	35.2	28.0	14.7	10.0	6.0
[dB]	Cat 6 (min.)	73.3	62.5	54,3	49.7	47.3	42.2	32.9	25.4	11.6	6.3	-
PS NEXT	Typical value	74.0	65.0	59.0	56.0	54.0	52.0	47.0	44.0	39.0	38.0	37.0
[dB]	Cat 6 (min.)	72.3	63.3	57.3	54.3	52.8	49.9	45.4	42.3	37.8	36.3	-
ELFEXT	Typical value	80.0	73.0	65.0	61.0	59.0	55.0	49.0	45.0	39.0	37.0	35.0
[dB]	Cat 6 (min.)	68.0	56.0	48.0	44.0	42.0	38.0	32.0	28.0	22.0	20.0	-
PS ELFEXT	Typical value	77.0	70.0	62.0	58.0	56.0	52.0	46.0	42.0	36.0	34.0	32.0
[dB]	Cat 6 (min.)	65.0	53.0	45.0	41.0	39.0	35.0	29.0	25.0	19.0	17.0	-
Return Loss	Typical value	25.0	25.0	25.0	25.0	25.0	25.0	23.8	23.0	21.0	20.0	20.0
[dB]	Cat 6 (min.)	20.0	23.0	25.0	25.0	25.0	23.6	21.5	20.1	18.0	17.3	-

Conductor resistance at 20° C (max.)	:	98, 6 Ω / km
Dielectric strength at 50 Hz	:	1 kV / 1 min
Insulation resistance (min.)	:	5000 mΩ / km
Velocity (nom.)	:	66%
Characteristic impedance	:	100 +/-15Ω (1 to 100 MHz) 100 +/-18Ω (100 to 250 MHz)
Mutual capacitance	:	<55 pF/m nom.
Propagation delay skew	:	<20 ns/100m
External diameter of the sheath	:	6.4 mm (nom.)

4.8 **Fibre Cable**

Optical Fibre cable should be available with 50 / 125 fibre and single mode options (or 62.5/125 fibre for legacy systems). Cable must be available for indoor use and indoor / outdoor use for campus backbones. Rodent resistant cable and armoured must be available for use where required.

The cable should have the correct number of pairs appropriate for the position of the cable in the network. For horizontal cabling two pairs of fibres should be available, for backbone and campus network cable sizes up to 96 fibres should be available. Individual fibres must be capable of being easily identified by colour coding.

The multimode cable must operate at both 850nm and 13000nm with the following minimum performance. The fibre must be suitable for operation according to IEEE 802.3z (Gigabit Ethernet) on distances exceeding 500m at 1300nm.

Optical performance of the Cable:

- Single mode cable (1310 / 1550nm) : ≤ 0,7 / 0.7 dB / km
- 50 / 125µm cable (850/1300nm) : ≤ 3,5 / 1,2 dB / km
- 62.5/125µm cable (850 / 1300nm) : ≤ 3,5 / 1,0 dB / km

Mechanical Performance:

- Cable minimum bend radius

  - Indoor cable:
    20 times cable diameter, during installation and 10 times cable diameter, after installation.

  - Indoor / outdoor:
    25 times cable diameter, during installation and 20 times cable diameter, after installation.

- Minimum bend radius in the TO : 20mm
- Operating temperature range: 10 to +60° C
- Rated LSZH

The system designer will supply the main contractor with a specification and plans of the work to be undertaken.

The contracting company will approve and modify (if necessary) these plans according to its pre-installation inspection of the site.

4.9 **19" Cabinet**

Cabinet shall be 19 inch, 12U with tie and retainers for cabling system, 800 x 800mm cabinet shall be suitable to install:

- Optical patch panel for fibre optic;
- Copper patch panel for twisted pair Cat 6 cable;
- A cabling guide system in each internal side of the cabinet for the front side;
- A cabling guide system in each internal side of the cabinet for the backside;
- An earthing point, multi-socket strip for supply power to the active equipment;
- Metallic door shall be provided with key locking capabilities.

5.0 **INSTALLATION**

5.1 Conformance of the Installation to Specification

The contractor will:

Install all the cable plant in accordance with the manufacturer's guidelines and relevant specification.

Ensure all the steps have been taken to ensure that the terminal equipment can be installed to specification and mount any equipment or electronics as close to the wiring wall fields (if appropriate) as possible, taking into consideration future growth, to facilitate administration and service.

Provide a test report to ensure that the cabling meets the required specification (Class E):

Ensure that the patch cables or cross connections must have the same impedance characteristics as the cable.

Not place any distribution cabling alongside power lines, or share the same conduit, channel or sleeve with electrical apparatus.

Ensure that the maximum pulling tensions of the cables are not exceeded at any time during the placement of the facilities.

Use correct cable basket or tray work according to IEC 50174-1.

Use appropriate installation equipment, specified by the equipment manufacturer, or equivalent, to install all cables, panels, TOs and patchcords.

Plug conduits and entrance holes where the cabling has been installed by the installation contractor in the main equipment room, manholes, riser and other cable entrance locations with re-unutterable duct seal or flame retardant putty.

Provide an approved ground at all newly distribution frames and other locations insuring proper bonding to any existing facilities. The contractor shall also be responsible for ensuring ground continuity by properly bonding all appropriate cabling, closures, cabinets, service boxes and framework. All grounds shall consist of appropriate gauge copper wire and shall be supplied from an approved building ground and bonded to the main electrical ground.

5.2 Installation Handover

The cabling system will be handed over to the purchaser or the purchaser representative. A manufacturer's system warranty shall be applied for:

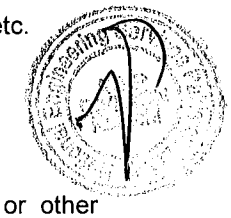
Where appropriate, the documentation supplied includes component acceptance test documentation. Such documentation includes:

a. Evidence of conformance of cables, connectors, cable assemblies etc.

b. Cable acceptance test records and other information;

c. Cable assembly acceptance test records and other information;

d. Delivery information (e.g. dates of receipt and batch numbers or other unique product identifiers of cables and accessories).



5.3 Final Cable Documentation

On completion, the contractor will provide final cabling documentation which will include:

- Site plans to include the identifications and locations of nodes, pathways, cables, termination points, closures, patch panels, protection devices;
- As-built information to include nodal, route and cable connectivity, closures (in a schematic or report based format);
- Installed cabling acceptance test records;
- Evidence of conformance to the installation specification from cabling installer or main contractor;
- Handover certificate;
- Earthing and equipotential bonding details.

6.0 TESTING AND COMMISSIONING

6.1 System Tests

All permanent links shall be tested. Acceptance is in accordance with standard ISO 11801:

The horizontal copper cabling system must be tested in accordance with the procedure described below. Tests shall be performed using a level II filed tester as defined in ISO/IEC 11801 – an automatic tester or scanner. The following parameters of the link shall be verified:

- Headroom report (The worst-case margin for a parameter determined by the selected standard (this may be NEXT, ACR, PSNEXT or another measurement).
- Wire map
- Resistance
- Link length
- Insertion loss
- Return loss
- Near end crosstalk (NEXT)
- Power sum near end crosstalk (PSNEXT)
- Equal level far end crosstalk (ELFEXT)
- Power sum equal level far end crosstalk (PSELFEXT)
- Attenuation to crosstalk ratio (ACR)
- Power sum attenuation to crosstalk ratio (PS ACR)
- Delay skew
- Impedance
- DC loop resistance

The insertion loss of fibre permanent links shall be tested using either a light source and power meter or an OTDR. Tests shall be performed at either 850nm and / or 13000nm. When tests are conducted using a power meter and stabilized light source, testing in one direction is sufficient. When tests are conducted using an OTDR, testing in both directions is required. In both cases, 100% of installed links shall be tested.

The following shall also be confirmed:

- Continuity
- The link length does not exceed the authorized maximum value;

- Radius of curvature of the cables conforms to values in the design guide;
- Cable preparation and the assembly of the jacks is to the manufacturer's instructions
- Cables ties and confinement are tight enough without squeezing the cable
- The insulation of the copper wires is continuous.
- The earthing and bonding of all metallic pathway systems is undertaken according to the installation specification.
- The metal racking, distribution panels and patch panels are bonded at both ends.
- The metal continuity of the farms of the same distributor is carried out.
- The screens of the cables (where applicable) are connected to earth at both ends.
- The main earthing and bonding is to EN 50174-1.

All cables and cords, distribution frames and outlet locations must be labeled according to industry standards. Labels should be computer generated or typewritten.

6.2 Commissioning

After handover the installation will be commissioned and brought into service.

A probationary period may be defined, during which the installer will be expected to correct any defects appearing in the installation.

All components of the Structured Cabling Network should be sourced from one manufacturer to ensure minimal impedance mismatch and best possible NEXT performance and to guarantee the Category-6 performance from end to end.

The Structured Cabling Network should operate without introducing or being affected by electromagnetic radiation from other sources. Maintaining segregation from other services or screening are to be ensured to achieve acceptable immunity.

7.0 MEASUREMENT AND PAYMENT

7.1 General

The Contractor's bid amount against each Bill of Quantities item as given below shall include supply, installation, testing, commissioning and completion for all work specified herein and/or as shown on the Bidding Drawings related to the item.

7.2 RJ45 Connectors

7.2.1 Measurement

Measurement shall be made for the total number of Connector acceptably supplied and installed by the Contractor as a complete unit.

7.2.2 Payment

Payment shall be made for numbers of units measured as provided above at the contract unit price each and shall constitute full compensation for supplying, installing and completion of the Connectors.

7.3 Patch Panels / Patch Cable

7.3.1 Measurement

Measurement shall be made for the total number of each patch panel / patch cable acceptably supplied and installed by the Contractor as a complete unit.

7.3.2 Payment

Payment shall be made for number of unit measured as provided above at the contract unit prices each and shall constitute full compensation for supplying, installing, testing, commissioning and completion of the patch panel/cable including interconnecting cable trays between racks and all accessories.

7.4 Patch Organization

7.4.1 Measurement

Measurement shall be made for the total number of patch organization acceptably supplied and installed by the Contractor as a complete unit.

7.4.2 Payment

Payment shall be made for number of unit measured as provided above at the contract unit prices each and shall constitute full compensation for supplying, installing, testing, commissioning and completion of the patch organization including interconnecting cable trays between racks and all accessories.

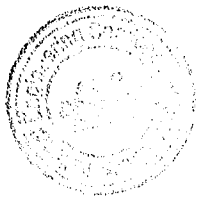
7.5 Wiring of Telecommunication Outlet

7.5.1 Measurement

Measurement shall be made for the total number of wiring of Telecommunication outlets acceptably carried out by the Contractor as a complete unit.

7.5.2 Payment

Payment shall be made for the total no. of units measured, as provided above at the Contract unit prices each and shall constitute for supplying, installing connecting, testing, commissioning and completion of the wiring between Telecommunication outlet and patch panel.



SECTION - 8320

TELEPHONE SYSTEM

1.0 SCOPE OF WORK

The work under this section consists of supplying, installing, testing, commissioning of all material and services of complete telephone system as specified herein, as shown on the Tender Drawings and stated in the Bill of Quantities.

The Contractor shall discuss the telephone system layout with the Engineer and co-ordinate at site with other services for exact route, location and position of the system.

The telephone system with accessories shall also comply with the General Specifications, Section 8001 and with other relevant provisions of the Tender Document.

The work shall be undertaken in accordance with applicable rules and regulations of Pak Telecomm Corporation Limited. Any approval/NOC required from PTCL shall be contractors' responsibility.

2.0 GENERAL

The system shall comply with the general requirements for telephone system as specified by the Pakistan Telecommunication Authority (PTA). The system shall be capable of accepting analog as well as digital incoming signals. The system shall be capable of connecting telefax / teletext etc.

3.0 APPLICABLE STANDARDS AND CODE

The latest editions of the following standards/codes shall be applicable for the materials covered within the scope of this section:

DIN 47614	-	Terminal Strips
DIN 40040	-	Class and Reliability of units in Telecommunication
DIN 57800	-	Regulations for installation and operation of telecommunication.
DIN 57804	-	Telecommunications, Manufacture and Test of Apparatus.
		CCITT recommendations for ISDN system and Local PTCL/PTA regulations.
ISO 9000-Series Certified	-	Manufacturer for quality control

4.0 EQUIPMENT

4.1 Conduit and Conduit Accessories

The specifications for conduit and conduit accessories shall be same as given in section "Conduits and Pipes" of these specifications.

4.2 Telephone Cable

Cat-5 UTP cable shall be provided for telephone network.

4.3 Telephone Socket Outlet (RJ45)

The telephone socket outlet back boxes shall have appropriate dimensions made of 16 SWG (1.63mm) sheet steel and suitable arrangement for termination of conduits or of teak wood for installation in dry partitions.

The telephone outlet shall be type RJ45 single/two/three ports as required. The outlet shall be of Clipsal Australia or 'MK' UK make or approved equivalent.

4.4 Distribution Box

Telephone distribution box shall be made of 16 SWG (1.63mm) sheet steel having required dimensions to accommodate the terminal strips with adequate space available for wiring. The terminal strips shall have provision for tag numbers for telephone extension and with suitable capacity for terminating all incoming and outgoing cables including direct lines. The strip shall be installed on insulated material sheet inside the sheet steel boxes. The termination strip shall provide Insulation Displacement Contact (IDC) technique for easy and quick connection for 0.6 mm. wire size. The termination strip shall have following minimum specifications:

Insulation Resistance	> 105 ohm
Dielectric Strength	> 2 kVrms
Termination Resistance	< 1 ohm
Capacitance between adjacent Contacts.	< 5 pF
Current Carrying Capacity	Disconnection Contact 5 kA 8/20U Sec. Connection Contact 10 kA 8/20U Sec.
Contacts	Silver plated brass alloy
Material	Self extinguishing plastic Component according to UL94

The steel box shall be provided with a lockable hinged door. The distribution box shall be suitable for recess mounting.

The distribution box shall be of Krone make or approved equivalent.

5.0 INSTALLATION

5.1 Conduit

The telephone conduit shall be installed in accordance with the instructions and details given in section "Conduit, and Pipes" of these Specifications. Telephone and data conduit shall be laid 150mm away from the electrical conduits or cables, and wherever electrical conduits or cables, and telephone and data conduits cross each other, they shall do so at right angles.

Identification marking shall be given at the termination or free end of conduit so that it may not be confused with the electrical conduits. The marking shall be both by colour and by attaching an approved brass tag using brass or bronze tie wire. Each tag shall be clearly stamped with "T" for telephone conduit.

5.2 Telephone Distribution Box

Distribution boxes for telephone cables shall generally be recessed type. The frame of the telephone distribution box shall finish flush with the surface of wall. However, surface type telephone distribution box shall also be acceptable with the approval of the Engineer.

All screws, nuts and bolts used for fixing the box shall be galvanized. Soft metal bushes shall be used at conduit entries in the box.

5.3 Telephone Socket Outlet

These shall be installed on the outlet box fixed in the wall, partition and floor.

5.4 Telephone Cable

The telephone cable shall be installed as outlined in section `L.T. Cables' of these specifications. All cables shall be provided with plastic identification tags at termination, which shall be clearly shown on the As-Built drawings. The complete wiring shall be checked for continuity, identification and insulation before connections are made.

6.0 MEASUREMENT AND PAYMENT

6.1 General

The Contractor's bid amount against each Bill of Quantities item as given below shall include supply, installation, testing, commissioning and completion for all works specified herein and/or as shown on the Tender Drawings related to the item.

6.2 Conduits / Pipes

6.2.1 **Measurement**: Measurement shall be made for the total running feet of each size of conduits/pipes acceptably supplied and installed by the Contractor.

6.2.2 **Payment:** Payment shall be made for the total running feet of conduit measured as provided above at the Contract unit price and shall constitute full compensation for supplying, installing & completion of the laying of the conduits/pipes including jointing materials and accessories, cutting chasing of civil works, excavation and backfilling of ground for under ground PVC conduits, painting, plugging, tagging, etc., as applicable for each type of work.

6.3 Telephone Cable

6.3.1 **Measurement:** Measurement shall be made for each size and type of telephone cable including earth wire as shown on drawing and given in BOQ acceptably supplied and installed by the Contractor between MDF and telephone distribution box as a complete unit.

6.3.2 **Payment:** Payment shall be made for the total number of each type of unit measured as provided above at the Contract unit price each and shall constitute full compensation for supplying, installing, testing and commissioning of the required pair of telephone cables including earth wire installed between MDF and telephone distribution box as shown on the drawing and all accessories.

6.4 Telephone RJ45 Socket Outlet

6.4.1 **Measurement:** Measurement shall be made of the total number of telephone RJ45 socket outlet acceptably supplied and installed by the Contractor as a complete unit.

6.4.2 **Payment:** Payment shall be made for number of units measured as provided above at the contract unit price each and shall constitute full compensation for supplying, installing, testing, and commissioning of the telephone RJ45 socket outlet including civil works and all accessories.

6.5 Telephone Distribution Box / Intermediate Distribution Frame

6.5.1 **Measurement:** Measurement shall be made of the total number of each type of telephone distribution box/intermediate distribution frame as given in BOQ acceptably supplied and installed by the Contractor as a complete job.

6.5.2 **Payment:** Payment shall be made for the number of job measured as provided above at the Contract unit price each and shall constitute full compensation for supplying, installing and completion of the telephone distribution box/intermediate distribution frame including civil works and all accessories.

6.6 Cabling of RJ45 Outlets

6.6.1 **Measurement:** Measurement shall be made for the cabling of RJ45 outlet to the relevant IDF acceptably carried out by the Contractor as a complete unit.

6.6.2 **Payment:** Payment shall be made for the total number of units measured, as provided above at the contract unit price each, and shall constitute for supplying, installing, connecting, testing, commissioning and completion of the cabling between RJ45 outlet and relevant IDF including required pair of multi-core data cable.

SECTION - 8331

INTELLIGENT ADDRESSABLE FIRE ALARM SYSTEM

1.0 SCOPE OF WORK

The work under this section consists of supply, installation, configuring, programming, testing, commissioning and training of all equipment, material, accessories and services for Fire Alarm System shall be complete in all respect as described in these specifications, drawings, B.O.Q and in accordance with International Organization for Standardization (ISO).

The Contractor will discuss the intelligent addressable fire alarm system layout with the Engineer and coordinate at site with other services for exact route, location and position of electrical lines and equipments.

The intelligent addressable fire alarm system with accessories shall also comply with the General Specifications for Electrical Work, General Technical Requirements for Communication Works and with other relevant provisions of the Contract Document.

2.0 GENERAL

All outlet boxes shall be considered part of the devices installed on them and shall be supplied alongwith the devices.

The system shall operate on 24 VDC from a battery charger with standby batteries. The incoming supply shall be 230 VAC from emergency circuit.

All the active items of the Fire Alarm System shall ideally be listed as a product of a single manufacturer.

Contractor shall provide following information on wall chart mounted near FACP.

- Complete layout of fire alarm system showing locations of all fire zones in a loops.
- Standby battery specification, including ampere-hour capacity Voltage per Cell, number of Cells, and the battery type.
- Operating and maintenance instruction in BLACK colour.
- Emergency instructions in RED colour.
- Name, address & telephone number of the servicing contractor.

The characters of written instructions shall be minimum 6 mm high.

Intelligent addressable fire alarm system shall interface with Public Address System in accordance with NFPA72.

Intelligent addressable fire alarm system shall interface with Access Control System in accordance with NFPA101.

Fire alarm control panel shall have a provision for remote parallel monitoring of individual devices for fire and fault etc.

3.0 APPLICABLE STANDARDS/CODES

The following standards & codes shall be applicable for the materials covered within the scope of this section:

NFPA 72	-	National Fire Alarm Code
NFPA 101	-	Life Safety Code
BS 5839	-	Fire Code British Standard

Each and all items of the Fire Alarm System shall be listed as a product of a single fire alarm system manufacturer under the appropriate category by under writers laboratories (UL) & shall bear the UL label / LPBC/ EN54 approved or British Standard.

4.0 MATERIAL

4.1 Analogue Addressable Fire Alarm Control Panel

The main FACP shall perform the following functions:

4.1.1 Supervise and monitor all intelligent addressable detectors and monitor modules connected to the system for normal, trouble and alarm conditions.

4.1.2 Supervise all initiating signaling and notification circuits throughout the facility by way of connection to addressable monitor and control modules.

4.1.3 Detect the activation of any initiating device and the location of the alarm condition. Operate all notification appliances and auxiliary devices as programmed.

4.1.4 Visually and audibly annunciate any trouble, supervisory, alarm condition on panel display and annunciators.

a. When a fire alarm condition is detected and reported by initiating devices or appliances, the following functions shall immediately occur:

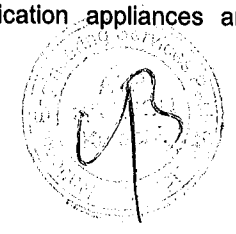
i. The system alarm LED shall flash.

ii. A local audible device in the control panel shall sound a distinctive signal.

iii. The LCD display shall indicate all information associated with the fire alarm condition, including the type of alarm point and its location within the protected premises.

iv. Printing and history storage equipment shall log and print the event information along with a time and date stamp.

v. All system outputs assigned via preprogrammed equations for a particular point in alarm shall be executed, and the associated outputs (alarm notification appliances and/or relays) shall be activated.



b. When a trouble condition is detected and reported by one of the system initiating devices or appliances, the following functions shall immediately occur:

i. The system trouble LED shall flash.

ii. A local audible device in the control panel shall sound a distinctive signal.

iii. The LCD display shall indicate all information associated with the trouble condition, including the type of trouble point and its location within the protected premises.

iv. Printing and history storage equipment shall log and print the event information along with a time and date stamp.

v. All system outputs assigned via preprogrammed equations for a particular point in trouble shall be executed, and the associated outputs (trouble notification appliances and/or relays) shall be activated.

c. When a supervisory condition is detected and reported by one of the system initiating devices or appliances, the following functions shall immediately occur:

i. The system trouble LED shall flash.

ii. A local audible device in the control panel shall sound a distinctive signal.

iii. The LCD display shall indicate all information associated with the supervisory condition, including the type of trouble point and its location within the protected premises.

iv. Printing and history storage equipment shall log and print the event information along with a time and date stamp.

v. All system outputs assigned via preprogrammed equations for a particular point in trouble shall be executed, and the associated outputs (notification appliances and/or relays) shall be activated.

d. When a pre-alarm condition is detected and reported by one of the system initiating devices or appliances, the following functions shall immediately occur:

i. The system pre-alarm LED shall flash.

ii. A local audible device in the control panel shall sound a distinctive signal.

iii. The LCD display shall indicate all information associated with the fire alarm condition, including the type of alarm point and its location within the protected premises.

iv. Printing and history storage equipment shall log and print the event information along with a time and date stamp.

v. All system outputs assigned via preprogrammed equations for a particular point in alarm shall be executed, and the associated outputs (alarm notification appliances and/or relays) shall be activated.

4.1.5 **Acknowledge Switch**

a. Activation of the control panel acknowledge switch in response to new alarms and/or troubles shall silence the local panel piezo electric signal and change the alarm and trouble LEDs from flashing mode to steady-ON mode. If multiple alarms or trouble conditions exist, depression of this switch shall advance the LCD display to the next alarm or trouble condition.

b. Depression of the Acknowledge switch shall also silence all remote annunciator sounders.

4.1.6 **Signal Silence Switch**

Depression of the Signal Silence switch shall cause all programmed alarm notification appliances and relays to return to the normal condition. The selection of notification circuits and relays that are silence able by this switch shall be fully field programmable within the confines of all applicable standards. The FACP software shall include silence inhibit and auto-silence timers.

a. **Drill Switch**

Depression of the Drill switch shall activate all programmed notification appliance circuits. The drill function shall latch until the panel is silenced or reset.

b. **System Reset Switch**

Depression of the System Reset switch shall cause all electronically latched initiating devices to return to their normal condition. Initiating devices shall re-report if active. Active notification appliance circuits shall not silence upon Reset. Systems that de-activate and subsequently re-activate notification appliance circuits shall not be considered equal. All programmed Control-By-Event equations shall be re-evaluated after the reset sequence is complete if the initiating condition has cleared. Non-latching trouble conditions shall not clear and re-report upon reset.

c. **Lamp Test**

The Lamp Test switch shall activate all local system LEDs, light each segment of the liquid crystal display and display the panel software revision for service personal.

d. **Scroll Display Keys**

There shall be Scroll Display keys for FIRE ALARM, SECURITY, SUPERVISORY, TROUBLE, and OTHER EVENTS. Depression of the Scroll Display key shall display the next event in the selected queue allowing the operator to view events by type.

e. **Print Screen**

Depression of the PRINT SCREEN switch shall send the information currently displayed on the display to the printer.

4.1.7 **System Capacity and General Operation**

a. The control panel shall be capable of expansion. Each module loop shall support minimum 135 analog/addressable devices.

b. The Fire Alarm Control Panel shall include a full featured operator interface control and annunciation panel that shall include a backlit liquid crystal display, individual, status LEDs, and a QWERTY style alphanumeric keypad for the field programming and control of the intelligent addressable fire alarm system.

c. All programming or editing of the existing program in the system shall be achieved without special equipment and without interrupting the alarm monitoring functions of the fire alarm control panel.

d. NFPA 72 Smoke Detector Sensitivity Test: The system shall provide an automatic smoke detector test function that meets the requirements of NFPA 72.

e. On-line or Off-line programming: The system shall provide means to allow panel programming either through an off-line software utility program away from the panel or while connected and on-line. The system shall also support upload and download of programmed database and panel executive system program to a Personal Computer/laptop.

f. History Events: The panel shall maintain a history file of the events, each with a time and date stamp. History events shall include all alarms, troubles, operator actions, and programming entries. The control panels shall maintain a 1000 event Alarm History.

g. Drill the system shall support means to activate all silenceable fire output circuits in the event of a practice evacuation or "drill". If enabled for local control, the front panel switch shall be held for a minimum of 2 seconds prior to activating the drill function.

h. Passwords and Users: The system shall support two password levels, master and user. Minimum 4 user passwords shall be available, each of which may be assigned access to the programming change menus, the alter status menus, or both. Only the master password shall allow access to password change screens.

i. Environmental Drift Control: The system shall provide means for setting Environmental Drift Compensation by device. When a detector accumulates dust in the chamber and reaches an unacceptable level but yet still below the allowed limit, the control panel shall indicate a maintenance alert warning. When the detector accumulates dust in the chamber above the allowed limit, the control panel shall indicate a maintenance urgent warning.

4.1.8 Loop (Signaling Line Circuit) Control Module

a. The Loop Control Module shall monitor and control fire alarm loop devices.

b. The Loop Control Module shall contain its own microprocessor and shall be capable of operating in a local/degrade mode (any addressable device input shall be capable of activating any or all addressable device outputs) in the unlikely event of a failure in the main CPU.

c. The Loop Control Module shall provide power and communicate with all intelligent addressable detectors and modules on a single pair of wires. This SLC Loop shall be capable of operating as a NFPA Style 4 and 7 Class A and B) circuit.

d. The SLC interface board shall receive analog or digital information from all intelligent detectors and shall process this information to determine whether normal, alarm, or trouble conditions exist for that particular device. Each SLC Loop shall be isolated and equipped to annunciate an Earth Fault condition. The SLC interface board software shall include software to automatically maintain the detector's desired sensitivity level by adjusting for the effects of environmental factors, including the accumulation of dust in each detector. The analog information may also be used for automatic detector testing and the automatic determination of detector maintenance requirements.

4.1.9 Enclosures

a. The control panel shall be housed in a UL-listed cabinet suitable for surface or semi-flush mounting. The cabinet and front shall be corrosion protected, given a rust-resistant prime coat, and manufacturer's standard finish.

b. The back box and door shall be constructed of 0.060 steel with provisions for electrical conduit connections into the sides and top.

c. The door shall provide a key lock and include a transparent opening for viewing all indicators. For convenience, the door shall have the ability to be hinged on either the right or left-hand side.

d. The control unit shall be modular in structure for ease of installation, maintenance, and future expansion.

4.1.10 Power Supply

a. The Addressable Main Power Supply shall operate on 230 VAC, 50 Hz, and shall provide all necessary power for the FACP.

b. The Addressable Main Power Supply shall provide a battery charger for 4 hours of standby using dual-rate charging techniques for fast battery recharge. The supply shall be capable of charging batteries within a 48-hour period.

c. The Addressable Main Power Supply shall provide a very low frequency sweep earth detect circuit, capable of detecting earth faults.

d. The Addressable Main Power Supply shall be power-limited per 1995 UL864 requirements.

4.1.11 Printer

a. Printers shall be of the automatic type, printing code, time, date, location, category, and condition.

b. The printer shall provide hard-copy printout of all changes in status of the system and shall time-stamp such printouts with the current time-of-day and date. The printer shall be standard carriage with 80-characters per line and shall use standard pin-feed paper. The printer shall be enclosed in a separate cabinet suitable for placement on a desktop or table and UL, ULC listed for use. The printer shall communicate with the control using an interface complying with Electrical Industries Association standard EIA-232D.

c. Thermal printers are not acceptable.

d. The system shall have a strip printer capable of being mounted directly in the main FACP enclosure. Alarms shall be printed in easy-to-read RED, other messages, such as a trouble, shall be printed in BLACK. This printer shall receive power from the system power supply and shall operate via battery back up if AC mains are lost. The strip printer shall be UL 864 listed.

e. Adequate number of printer paper rolls shall be provided.

4.1.12 Field Programming

a. The system shall be programmable, configurable and expandable in the field without the need for special tools, laptop computers, or other electronic interface equipment. There shall be no firmware changes required to field modify the system time, point information, equations, or annunciator programming/information.

b. It shall be possible to program through the standard FACP keyboard all system functions.

c. All field defined programs shall be stored in non-volatile memory.

4.2 Notification Appliances

4.2.1 Audible visual sounders shall operate on 24 VDC nominal.

4.2.2 Audible visual shall be field programmable without the use of special tools, at a sound level of at least 10 dBA above the ambient noise level.

4.2.3 Shall be flush or surface mounted as shown on plans.

4.2.4 Strobe lights shall meet the requirements of the ADA, UL Standard be fully synchronized.

4.2.5 Audible Visual Combination Devices

a. Shall meet the applicable requirements of Section A listed above for audibility.

b. Shall meet the requirements of Section B listed above for visibility.

4.3 Addressable Devices - General

4.3.1 Addressable devices shall provide an address-setting means using rotary decimal switches.

4.3.2 Detectors shall be analog and Addressable, and shall connect to the fire alarm control panel's Signaling Line Circuits.

4.3.3 All sensors, call points and sounders shall also have an integral short circuit isolator, which in the event of a single cable fault will isolate the "culprit" piece of cable and retain all devices on loop operationally in less than 1 second

4.3.4 Addressable smoke and thermal detectors shall provide status LED. LED shall flash under normal conditions, indicating that the detector is operational and in regular communication with the control panel, and LED shall be placed into steady illumination by the control panel, indicating that an alarm condition has been detected. If required, the flashing mode operation of the detector LED can be programmed off via the fire control panel program.

4.3.5 The fire alarm control panel shall permit detector sensitivity adjustment through field programming of the system. Sensitivity can be automatically adjusted by the panel on a time-of-day basis.

4.3.6 Using software in the FACP, detectors shall automatically compensate for dust accumulation and other slow environmental changes that may affect their performance. The detectors shall be listed by UL as meeting the calibrated sensitivity test requirements of NFPA Standard 72, Chapter 7.

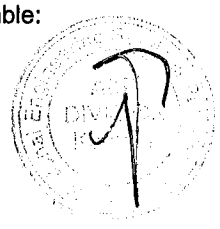
4.3.7 The detectors shall be ceiling-mount and shall include a separate twist-lock base, which includes a tamper proof feature.

4.3.8 The following bases and auxiliary functions shall be available:

a. Sounder base rated at 85 DBA minimum.

b. Form-C Relay base rated 30VDC, 2.OA

c. Isolator base



4.3.9 The detectors shall provide a test means whereby they will simulate an alarm condition and report that condition to the control panel. Such a test may be initiated at the detector itself (by activating a magnetic switch) or initiated remotely on command from the control panel.

4.3.10 **Addressable Manual Call Station with built-in isolator module**

a. Addressable Manual Station shall, on command from the control panel, send data to the panel representing the state of the manual switch and the addressable communication module status. They shall use a key operated test-reset lock, and shall be designed so that after actual emergency operation, they cannot be restored to normal use except by the use of a key.

b. All operated stations shall have a positive, visual indication of operation and utilize a key type reset.

c. Manual stations shall be constructed of Lexan with clearly visible operating instructions provided on the cover. The word FIRE shall appear on the front of the stations in raised letters, 1.75 inches (44 mm) or larger.

4.3.11 **Intelligent Addressable Multi Optical and Heat Detector with base, built-in isolator module**

a. The intelligent Addressable Multi Optical and Heat Detector shall be an' addressable device that is designed to monitor a minimum of photoelectric and thermal technologies in a single sensing device. The design shall include the ability, to adapt to' its environment by utilizing a built-in microprocessor to determine it's environment and choose the appropriate sensing settings. The detector design shall 'allow a wide sensitivity window, no less than 1 to 4% per' foot obscuration. The detectors shall utilize advanced electronics that react to slow smoldering fires and thermal properties all within a single sensing device.

b. The microprocessor design shall be capable of selecting the appropriate sensitivity levels based on the environment type it is in (office, manufacturing, kitchen etc.) and then have the ability to automatically change the setting as the environment changes (as walls are moved or as the occupancy changes).

c. The intelligent Addressable Multi-sensor detection device shall include the ability to combine the signal of the thermal sensor with the signal of the photoelectric signal in an effort to react hastily in the event of a fire situation. It shall also include the inherent ability to distinguish between a fire condition and a false alarm condition by examining the characteristics of the thermal and smoke sensing chambers and comparing them to a database of actual fire and deceptive phenomena.

4.3.12 **Intelligent Addressable Thermal / Heat Detector with Base, Built-in Isolator Module**

Thermal / Heat detectors shall be intelligent addressable devices rated at 135 degrees Fahrenheit (58 degrees Celsius) and have a -

rate-of-rise element rated' at 15 degrees F (9.4 degrees C) per minute. It shall connect via two wires to the fire alarm control panel signaling line circuit.

4.3.13 **Addressable Dry Contact Monitor Module**

a. Addressable monitor modules shall be provided to connect one supervised IDC zone of conventional alarm initiating devices (any N.O. dry contact device) to one of the fire alarm control panel SLCs.

b. The monitor module shall mount in a 4-inch square (101.6 mm square), 2-1/8 inch (54 mm) deep electrical box.

c. The IDC zone shall be suitable for Style D or Style B operation. An LED shall be provided that shall flash under normal conditions, indicating that the monitor module is operational and in regular communication with the control panel.

d. For difficult to reach areas, the monitor module shall be available in a miniature package and shall be no larger than 2-3/4 inch (70 mm) x 1-1/4 inch (31.7 mm) x 1/2 inch (12.7 mm). This version need not include Style D or an LED.

4.3.14 **Addressable Control Module**

a. Addressable Control Modules shall be provided. For fan shutdown and, other auxiliary control functions, the control module may be set to operate as a dry contract relay.

b. The control module shall mount in a standard 4-inch square (101.6 mm square), 2 1/8 inch (54 mm) deep electrical box, or to a surface mounted back box.

4.4 Batteries and External Charger

4.4.1 Battery

a. Shall be 12 volt, Gell-Cell type.

b. Battery shall have sufficient capacity to power the Intelligent addressable fire alarm system for not less than 24 hours plus 5 minutes of alarm upon a normal AC power failure.

c. The batteries are to be completely maintenance free and shall be provided as per manufacturer's recommendation. No liquids are required. Fluid level checks refilling, spills and leakage shall not be required.

4.4.2 External Battery Charger:

a. Shall be completely automatic, with constant potential charger maintaining the battery fully charged under all service conditions. Charger shall operate from a 120/240-volt 50 hertz source.

b. Shall be rated for fully charging a completely discharged battery within 48 hours while simultaneously supplying any loads connected to the battery.

c. Shall have protection to prevent discharge through the charger.

d. Shall have protection for overloads and short circuits on both AC and DC sides.

4.5 Wiring and Cabling

Wiring and cabling of Fire and alarm system shall be carried out in conduits. Fire resistant enhanced cables with LSZH outer sheath shall be provided for the Intelligent addressable fire alarm system. The cable shall be work for 120 minutes in fire condition.

All wires and cables shall be color-coded, tagged and checked for open, short or ground faults. No transposition of colors will be permitted. All wiring shall be made on terminal blocks of proper size and type for the services involved. Cable joints shall only be allowed on the detector bases.

5.0 INSTALLATION

5.1 Intelligent Addressable Fire Alarm System Equipment

The installation of Intelligent addressable fire alarm system equipment shall be in strict accordance with the manufacturer's instructions / recommendations and these specifications.

The testing of Fire Alarm equipment shall be in compliance with the relevant standards and regulations. During testing of equipment, emphasis shall be laid on the following:

- Operational Safety
- Regular functioning of the system and devices
- Protection against false alarms

Various detectors like smoke, heat, manual call point etc. shall be subjected to the basic tests and sensivity tests. The automatic detectors shall be tested in various ways to check real and false alarm behaviors.

6.0 TRAINING

A training session shall be presented by a fully qualified, trained representative of the equipment manufacturer/supplier who is thoroughly knowledgeable of the specific installation. The training shall be given to personnel responsible for operation and maintenance of the system.

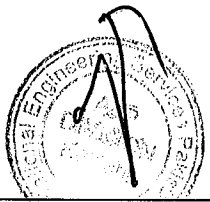
The training session shall include but not limited to the following:

6.1 Detailed explanation of wall charts as mentioned in Article 2.0 of this section.

6.2 Function of each control switch

6.3 Periodic operational testing of panel/devices.

6.4 Maintenance of fire log book supplied by manufacturer.



6.5 Actions to be taken upon receiving following signals:

6.5.1 False alarm indication

6.5.2 Trouble on any initiating or indicating devices

6.5.3 Common alarm or common trouble indication

6.5.4 Low battery voltage indication

6.6 Field modifiable programming.

7.0 MEASUREMENT AND PAYMENT

7.1 General

The Contractor's bid amount against each Bill of Quantities item as given below shall include supply, installation, testing, commissioning and completion of all work specified herein and/or as shown on the Tender Drawing related to the item.

7.2 Intelligent Addressable Multi & Heat Detectors with built-in isolator module

7.2.1 **Measurement:** Measurement shall be made for the total number of each type of automatic multi & heat detectors with built-in isolator module acceptably supplied and installed by the Contractor as complete unit.

7.2.2 **Payment:** Payment shall be made for the number of units measured as provided above at the contract unit price and shall constitute full compensation for supplying, installing, configuring, testing, commissioning and completion of each type of the intelligent addressable automatic multi & heat detectors with built-in isolator module including bases and back boxes as required including all mounting & installation accessories.

7.3 Intelligent Addressable Manual Call Point with built-in isolator module

7.3.1 **Measurement:** Measurement shall be made for the total number of each type of intelligent addressable manual call point with built-in isolator module acceptably supplied and installed by the Contractor as complete unit.

7.3.2 **Payment:** Payment shall be made for the number of units measured as provided above at the contract unit price and shall constitute full compensation for supplying, installing, configuring, testing, commissioning and completion of each type of the intelligent addressable manual call point with built-in isolator module including bases and back boxes as required including all mounting & installation accessories.

7.4 Audio Visual Sounder with built-in isolator module

7.4.1 **Measurement:** Measurement shall be made for the number of Audio Visual Sounder with built-in isolator module acceptably supplied and installed by the Contractor as complete unit.

7.4.2 **Payment:** Payment shall be made for the number of units measured as provided above at the Contract unit price and shall constitute full

compensation for supplying, installing, configuring, testing, commissioning and completion of each type of Audio Visual Sounder with built-in isolator module including all mounting accessories like outlet boxes etc.

7.5 **Loop Powered Control Module / Monitor Module**

7.5.1 **Measurement:** Measurement shall be made for the number of Loop Powered Control Module / Monitor Module / Interface Module acceptably supplied and installed by the Contractor as complete unit.

7.5.2 **Payment:** Payment shall be made for the number of units measured as provided above at the Contract unit price and shall constitute full compensation for supplying, installing, configuring, testing, commissioning and completion of each type of Loop Powered Control Module / Monitor Module / Interface Module as required for interfacing of various system / devices including interconnecting wiring up to the relevant interface point with all mounting accessories like outlet boxes etc.

7.6 **Intelligent Addressable Fire Alarm Control Panel**

7.6.1 **Measurement:** Measurement shall be made for fire alarm control panel including all related equipment as given in BOQ such as power supply, built-in printer, relays, batteries, batteries charger, LAN card, etc. alongwith all accessories acceptably supplied and installed by the Contractor as a complete job

7.6.2 **Payment:** Payment shall be made for the complete job measured as provided above at the contract unit price and shall constitute full compensation for supplying, installing, programming, configuring, testing, commissioning and completion of fire alarm control panel along with maintenance free batteries, battery charger, power supply, printer LAN Ethernet / remote interface etc. as mentioned in BOQ along with all mounting an installation accessories for satisfactory operation of the entire system. Complete in all respect.

7.7 **Wiring of Fire Alarm Loops**

7.7.1 **Measurement:** Measurement shall be made for the total running feet of wiring of fire alarm loops with 2 x1.5 sq mm / 2 x2.5 sq mm fire resistant (120 mins) enhanced cable and the required number of junction boxes acceptably supplied and installed by the Contractor.

7.7.2 **Payment:** Payment shall be made for the total running feet measured as provided above at the contract unit price each and shall constitute full compensation for supplying, installing, connecting testing and commissioning of fire alarm loops with 2 x1.5 sq mm / 2 x2.5 sq mm fire resistant (120 mins) enhanced cable wiring including junction boxes and all accessories.

*** End of Section 8331 ***

SECTION - 8335

CLOSED CIRCUIT TELEVISION SYSTEM (CCTV)

1.0 SCOPE OF WORK

The work under this section consists of supplying, installing, testing, connecting and commissioning of all materials and services of the complete IP CCTV system as specified herein, or as given in the Bidding Drawings and stated in the Bill of Quantities.

The Contractor shall discuss the IP CCTV layout with the Engineer and co-ordinate at the site with other services for exact route, location and position of the electrical lines and equipment.

The IP CCTV system with accessories shall also comply with the General specifications for Electrical Works, Section - 8001 and with other relevant provisions of the Bidding Documents.

2.0 GENERAL

The CCTV System shall be used for general surveillance. All the active items of the CCTV System shall be listed as a product of a single manufacturer.

The power to all main equipment of the CCTV system shall be supplied by an uninterruptible power supply, which shall have an autonomy of five minutes.

Proposed CCTV system shall be an open standard based integrated system with IP network and management architecture aimed at providing high-speed manual/automatic operation for best performance.

System shall have Digital CCD Colour Video Cameras with individual IP address, with Fixed or P/T/Z Lens, Network Video Recorders (NVR/CAMERA SERVER), Network Attached Storage (NAS) / Riad backup device for recording, Application Software, Colour Video displays, Keyboards with Joystick Controllers / Mouse-Keyboard, software based Video Matrix Switcher, Workstation for System Administration / Management / Maintenance etc.

The NVR / Camera Server can be embedded type or server based. However the NVR / Camera Server Software shall run on common off the shelf available servers (Camera Server & Database Server). Each NVR shall be able to handle 16 or more cameras.

Network Video Recorder shall offer both video stream management and video stream storage management. Recording frame rate & resolution in respect of individual channel shall be programmable.

System should ensure that once recorded, the video can not be altered, ensuring the audit trail is intact for evidential purposes.

System shall provide sufficient storage of all the camera recordings for a period of 30 days @ 25 FPS, at 4 CIF or better quality using necessary compression techniques for all cameras (extended capacity of cameras i.e. present capacity +

25%). The recording resolution and frame rate for each camera shall be user programmable. Remote online viewing option through internet shall be available.

Surveillance CCTV System shall operate on 230 V, 50 Hz single phase power supply. Power for all the equipment will be conditioned using on-line UPS with minimum 30 minutes or more back up. If any equipment operates on any voltage other than the supply voltage and supply frequency, necessary conversion/correction device for supply shall be supplied along with the equipment. IP cameras shall receive power from POE switch.

All the control equipments e.g. servers, NVR/CAMERA SERVER, NAS/Raid backup device, decoders etc. shall be provided in standard 19" racks.

All the indoor cameras & control equipment shall be suitable for operation from 10°C to 40°C and relative humidity up to 80%. Cameras & other equipment, meant for outdoor installations, shall be suitable to work from (-) 10°C to (+) 50°C with RH upto 90% non-condensing. All outdoor cameras shall be Day/Night cameras.

Housing of cameras meant for indoor use shall be of IP 42 rating whereas outdoor camera housing shall be of IP 65 or better rating. These must be integrated by the camera manufacturer. Outdoor cameras shall be provided with washer, wiper and sunshield.

System must provide built-in facility of watermarking or digital certificate to ensure tamperproof recording so that these can be used as evidence at a later date, if so desired. The recording shall support audit trail feature.

All camera recordings shall have Camera ID & location/area of recording as well as date/time stamp. Camera ID, Location/Area of recording & date/time shall be programmable by the system administrator with User ID & Password.

Facility of camera recording in CIF, 2CIF, 4CIF as well as in any combination i.e. any camera can be recorded in any quality – selective or group of cameras must be available in the system.

System to have facility of additional camera installation beyond the originally planned capacity.

In order to optimize the memory, while recording, video shall be compressed using MPEG-4 or better standard and streamed over the IP network. Once on the network, video can be viewed on a control room workstation or on analog monitor using a hardware decoder (MPEG-4/compatible standard Receiver) and shall be recorded on NVR/CAMERA SERVER and shall be backed up on NAS/RAID Backup device.

System shall be triplex i.e. it should provide facility of Viewing, Recording & Reply simultaneously.

The offered system shall have facility to export the desired portion of clipping (from a desired date/time to another desired date/time) on Portable hard drive. Viewing of this recording shall be possible on standard PC using standard software like windows media player etc.

PTZ Cameras shall have 64 or more pre-defined positions o be selected through suitable input alarm.

System shall have provision of WAN connectivity for remote monitoring.

CCTV System will be monitored at BMS BACnet compatible open protocol as specified in section 8965 herein.

3.0 APPLICABLE STANDARDS AND CODES

The following standards and codes shall be applicable for the material covered within the scope of the section.

IEC 801 – 2	Electrostatic discharge
IEC 801 – 3	Radiated Electro magnetic interference
IEC 801 – 4	Voltage transients

Install all the signal transmission components in accordance with the relevant standard ANSI Locate all surge protection within are metre of building entrance:

-	Dust and rain resistance	IP66 for outdoor cameras.
-	Salt mist cameras)	According to IEC 68-2-11 (for outdoor
-	Vibration	According to IEC 68-2-6
-	Bump test	According to IEC 68-3

4.0 EQUIPMENT

4.1 IP Fixed Colour Dome Day / Night Camera Varifocal

Image Device	1/3" CCD Sensor
Number of Pixels Minimum	2 Megapixel or as specified in BoQ
Scanning System	PAL
Resolution	540 TV Lines or better
Min Illumination	0.5 Lux at F1.2
S/N Ratio	> = 50 dB
Electronic Shutter	AUTO
Lens	Built-in Varifocal lens. Auto Iris, lens F=4-9 mm (approx.)
Backlight compensation	Required
POE	Compliant

4.2 IP Colour Video Dome Camera with PTZ

Colour video dome camera with PTZ shall have following technical:

Image Device	Interline transfer ¼" or better format CCD Sensor
Focal length	4.7 mm to 72 mm or better
Optical zoom (for indoor camera)	18 x or better
Optical zoom (for outdoor camera)	20 x or better
Digital zoom	12 x or better
Number of Pixels	1920x1080
Scanning System	PAL
Resolution	540 TVL or better
Illumination (for indoor camera)	1.0 Lux (Color), 0.1 Lux (B/W) or better
Illumination (for outdoor camera)	Day / Night
Pan Travel	360^0 Continuous
Tilt Travel	$0 – 90^0$
Manual Tilt Speed	0.5^0/SEC to 90^0/SEC
Manual Pan Speed	0.5^0/SEC to 90^0/SEC
Preset Tilt Speed	0.5^0/SEC to 90^0/SEC
Preset Pan Speed	0.5^0/SEC to 300^0/SEC
Preset positions	Min. 64
Iris Control	Auto
Focus	Auto
Back Light technology compensation	Required with black masking or other suitable
White balance	Auto
Electronic shutter	Auto

S/N ratio	>=48 dB
POE	Compliant.

4.3 **Network Attached Storage (NAS) / Raid Backup Device**

NAS Box/RAID backup device shall be used to record video streams based on the configuration assigned by administrator. Workstations & Servers within the LAN should be able to access the recorded video streams. The NAS/RAID backup device should support simultaneous play back and recording at full duplex operation.

It shall provide a high quality recording storage and play back of images. It should support integration with LAN to provide Centralized Management and shall operate on Windows/Linux OS. Support of user management for security level control and authentication required. These NAS boxes/RAID backup device should have the following features and specifications:

Onboard CPU	Latest Generation Processor
Onboard Memory	8 GB RAM
HD Drive	As per system requirement
Host Interface	Dual Gigabit Ethernet
RAID Support	RAID levels 0, 1 and 5
Network Transport Protocols	TCP/IP
Network File Protocols	CIFS, NFS, HTTP/HTTPS, FTP, NTP, SNMP, SMTP, DHCP and DNS
Drive Status / Space Monitoring	Supported
Operating System (OS)	MS Windows OS (Latest Version) or Linux
Power Supply	Hot pluggable Redundant Power Supply

4.4 **Workstation**

Latest industrial standard workstation with all required accessories for operation of CCTV system as specified shall be provided with wireless keyboards, mouse, video card, sound card, 10/100/1000 Base T Ethernet Port , latest operating system including antivirus software.

4.5 **Network Video Recorder / Database Servers**

Network Video Recorder and data base server in accordance with manufacture's recommendation for operation of CCTV system as specified herein or in BoQ and shown on drawing.

4.6 Camera Housing & Mount

The camera mount should be:

i) Of the same make as that of camera and suitable for the model number offered as specified by the manufacturer and should be an integrated unit.

ii) Should be compact and indoor/outdoor types as required.

iii) Should support the weight of Camera and accessories such as housing, pan & tilt head in any vertical or horizontal position etc.

4.7 Speed Dome Controller / PTZ Controller

Speed dome controller should have variable speed joystick, LCD display for programming and it should be able to control the speed dome for PAN/TILT/ZOOM.

4.8 LCD Display

42" Color LED display shall have following minimum technical specification.

Resolution	500 TVL: 1280x1024 pixels
Display Mode	VGA/SVGA/XGA
Luminance	250 cd/square meter
Power Source	230 VAC/50 Hz

5.0 VIDEO SURVEILLANCE APPLICATION SOFTWARE

The software shall operate on open architecture for integration with perimeter safety, access control, PA and fire / safety systems based on open standards.

Digital video surveillance control software should be capable to display and manage the entire surveillance system. It should be capable of supporting variety of device such as IP cameras, PTZ controller, NVR, NAS boxes/Raid backup device etc.

The software should support flexible 1/2/4 windows split screen display mode or scroll mode on the PC monitor or on preview displays as per site requirement. The software should be able to control all cameras i.e. PTZ control, Iris control, auto/manual focus and color balance of camera, selection of presets, video tour selection etc.

The software is required to generate reports of stored device configuration. The control software is required to provide alarm and alarm log. The log shall be able to be achieved, printed and displayed using a device filter, a device group filter and/or a time window.

The software should have user authority configurable on per device or per device group basis. The user shall have the facility to request the access of any camera and can control the camera for a reservation period. Control of camera is released after the reservation period.

The system shall provide user activity log (audit trail) with user d, time stamp and action performed etc.

The administrator should be able to add, edit & delete users with rights. It shall be possible to view ability/rights of each user or the cameras which can be viewed & controlled as per the permission assigned by he administrator.

The users should be on a hierarchical basis as assigned by the administrator. The higher priority person can take control of cameras, which are already being controlled by a lower priority user. There should be minimum 3 hierarchical levels of security for providing user level log in.

It should have recording modes viz. continuous, manual or programmed modes on date, time and camera-wise. All modes should be disabled and enabled using schedule configuration. It should be possible to search and replay the recorded images on date, time and camera-wise. It should provide on screen controls for remote operation of PTZ cameras. It should have the facility for schedule recording. Different recording speeds (fps) and resolution for each recording mode for each camera should be possible.

It should provide programmable motion detection and recording, to be defined area-wise. System must be able o support video motion detection algorithms to detect and track objects, learn the scene, adapt to a changing outdoor environment, ignore environmental changes including rain, hail, wind, swaying trees and gradual light changes.

The settings shall be individually configurable for each alarm and each camera pre-record duration. This shall allow the camera server to capture video prior to the alarm/event shall be selectable from a list o values ranging between 0 seconds and 5 minutes. The software for clients should also be working on a browser based system for remote users.

Retrieval: The CCTV application should allow retrieval of data instantaneously or any data/time interval chosen through search functionality of the application software. Incase data is older than 3 days and available, the retrieval should be possible. The system should be allow for backup of specific data on any drives or any other device in a format which can be replayed through a standard PC based software. Log of any such activity should be maintained by the system which can be audited at a later date.

Storage: Data storage should be at a central location. The capacity of the storage should be equal to 30 days of recording of all cameras at 25 fps/4 CIF. Submit calculation for CCTV Indoor / Outdoor cameras.

6.0 INSTALLATION

Installation of CCTV System shall be done in strict accordance with the manufacturer's recommendations.

7.0 TRAINING

A training session shall be presented by a fully qualified, trained representative of the equipment manufacturer/supplier who is thoroughly knowledgeable of the specific installation. The training shall be given to personnel responsible for operation and maintenance of the system.

8.0 MEASUREMENT AND PAYMENT

8.1 General

The Contractor bid amount, against each Bill of Quantities item as given below, shall include design, supply, installation, testing, commissioning and completion for all work specified herein and / or as shown on the Tender Drawings related to the item.

8.2 Fixed Colour Dome Camera Varifocal / Colour Video Dome Camera with PTZ

8.2.1 **Measurement:** Measurement shall be made for the total number of Fixed Colour Dome Camera Varifocal / Colour Video Dome Camera with PTZ with accessories acceptably supplied and installed by the Contractor as a complete unit.

8.2.2 **Payment:** Payment shall be made for the number of units measured as provided above at the Contractor unit price and shall constitute full compensation for supplying, installing connecting, testing and commissioning of the Fixed Colour Dome Camera Varifocal / Colour Video Dome Camera with PTZ including all mounting arrangement/racks, etc. and all accessories.

8.3 Workstation

8.3.1 **Measurement:** Measurement shall be made for the workstation acceptably supplied and installed by the Contractor as complete unit.

8.3.2 **Payment :** Payment shall be made for the total unit measured as provided above at the contract unit price and shall constitute full compensation for supplying, installing, testing and commissioning of workstation including all accessories related to the items.

8.4 Network Attached Storage (NAS) / Raid Backup Device

8.4.1 **Measurement :** Measurement shall be made for the Network Attached Storage (NAS) / Raid Backup Device acceptably supplied and installed by the Contractor as a complete job.

8.4.2 **Payment:** Payment shall be made for the number of job measured as provided above at the contract unit price and shall

constitute full compensation for supplying, installing and completion of the Network Attached Storage (NAS) / Raid Backup Device including all control equipment for operation and control of system, mounting racks and interconnections etc.

8.5 **Network Video Recorder / Database Servers**

8.5.1 **Measurement :** Measurement shall be made for the Network Video Recorder / Database Servers including chair acceptably supplied and installed by the Contractor as a complete unit / job.

8.5.2 **Payment :** Payment shall be made for the complete unit / job measured as provided above at the contract unit price and shall constitute full compensation for supplying and installing Network Video Recorder / Database Servers Console and all accessories.

8.6 **Camera Housing & Mount**

8.6.1 **Measurement :** Measurement shall be made for the Camera Housing & Mount including chair acceptably supplied and installed by the Contractor as a complete unit

8.6.2 **Payment :** Payment shall be made for the complete unitmeasured as provided above at the contract unit price and shall constitute full compensation for supplying and installing of Camera Housing & Mount and all accessories.

8.7 **Network Keyboard Controller / LED Display**

8.7.1 **Measurement :** Measurement shall be made for the Network Keyboard Controller / LED Display including chair acceptably supplied and installed by the Contractor as a complete unit.

8.7.2 **Payment:** Payment shall be made for the complete unit measured as provided above at the contract unit price and shall constitute full compensation for supplying and installing of Network Keyboard Controller / LED Display and all accessories.

8.8 **VIDEO SURVEILLANCE APPLICATION SOFTWARE**

8.8.1 **Measurement :** Measurement shall be made for the Video Surveillance Application Software acceptably supplied and installed by the Contractor as a complete job.

8.8.2 **Payment :** Payment shall be made for the complete job measured as provided above at the contract unit price and shall constitute full compensation for supplying and installing of Video Surveillance Application Software and all accessories.

8.9 OPERATOR CONSOLE

8.8.1 **Measurement:** Measurement shall be made for the Operation Console including chair acceptably supplied and installed by the Contractor as a complete job.

8.9.2 **Payment :** Payment shall be made for the complete job measured as provided above at the contract unit price and shall constitute full compensation for supplying and installing of Operation Console and all accessories.

*** End of Section 8335 ***

SECTION – 8337

PERIMETER INTRUSION DETECTION SYSTEM (PIDS)

01 SCOPE OF WORK

The scope under this section consists of site survey, detail engineering design, supply, installation, configuration, programming, integration, testing, commissioning and training of all materials and services of the complete Perimeter Intrusion Detection System (PIDS) as specified herein, shown in the Drawings and stated in the Schedule of Prices.

The Perimeter Intrusion Detection System (PIDS) with accessories shall also comply with General Technical Requirements for Security Monitoring & Control System and with other relevant provisions of the Contract Documents.

02 GENERAL

PIDS shall be able to detect intrusion at multiple locations simultaneously and provide exact location on perimeter.

Fixed and long-range PTZ CCTV cameras installed all along perimeter boundary and shall interface with the perimeter intrusion detection system.

Video analytic CCTV cameras shall interface with the PIDS. CCTV cameras shall capture real time video of intruder movement and give alarm in the Command & Control Room.

Perimeter intrusion detection system shall integrate with video management software of CCTV system.

03 ELECTRIC BASED PIDS:

- This security layer covers perimeter with electric fence installed on top of boundary wall of 3 feet or as available at site with alarm control equipment including but not limited to dual zone energizer with built in UPS, maintenance free battery, keypad controller, shielded insulators, tensioners hooks, stainless steel poles, stainless steel support pipes, strands wires, wiring sign plats, indication flash light, siren, earth spikes, cables as required as per manufacturer, 1.2/1.6mm stainless steel wire, weather proof type NEMA 4X IP67 rates enclosure suitable for corrosive environment including all interconnection equipment complete in all respect as per the recommendation of the proposed manufacturer.

- The LCD display on the dual energizer shall provide information on the status and performance of the energizer. It maximizes the power on the fence and minimizes false alarms.
- Dual energizer shall have following minimum requirements:
    - Two independently monitored and controlled zones.
    - Each zone shall be set independently to be on/off or in high/low voltage modes.
    - Shall be programmed in to alarm sensor mode
    - Built-in alarm monitoring tampering or faults on the high voltage and earth fence wires.

- Lighting and power surge protection
- Intelligent power saving to extend battery life.
- Shall be powered by 220V mains and include a built-in battery for back-up powers.

- To ensure absolute security, controller shall continuously monitors the Electro-Fence for different types of attack and generates an alarm when pre-programmed conditions are met.
- Electro-Fence System shall interface with security equipment such as IP CCTV etc.
- Electro fence controllers shall be available in single, dual or multi zone type which shall be fence mountable.
- Electric fence shall have minimum but not limited to following features:
  - Visual & physical intruder deterrent
  - Shock, voltage & short circuit monitoring
  - Cut & climb monitoring
  - Controller continuous monitoring
  - Interfaces with standard security equipment

Technical Material Data:

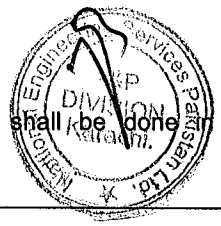
Electric PIDS shall include but not limited to the following:

- Dual zone energizer
- Maintenance free battery
- Keypad controller
- Shielded insulators
- Tensioners hooks
- Stainless steel poles
- Stainless steel support pipes
- Indication flash light
- Siren
- Earth rod
- Cables as per manufacturer
- 1.2/1.6mm stainless steel wire
- Weather proof NEMA 4X, IP 67 rated enclosure
- all interconnection equipment
- PC & Software

- Electro-Fence System shall be monitored and controlled via LCD keypads or it shall be controlled from a PC installed in control room (s) using the security management system software.
- Alarms shall be shown on maps of the site and all zones shall be controlled from the PC from control rooms. The voltage on each section of the fence shall be displayed on PC in real time.

05 **INSTALLATION**

Installation of Perimeter Intrusion Detection System (PIDS) shall be done in strict accordance with the manufacturer's recommendations.



06 **TRAINING**

A training session shall be presented by a fully qualified, trained representative of the equipment manufacturer/supplier who is thoroughly knowledgeable of the specific installation. The training shall be given to personnel responsible for operation and maintenance of the system.

*** End of Section 8337 ***

SECTION – 8341

PUBLIC ADDRESS/VOICE EVACUATION SYSTEM

1.0 SCOPE OF WORK

The work under this section consists of supply, installation, connecting, configuring, programming, testing, commissioning and training of all equipment, material, accessories and services for Public Address and Voice Evacuation System shall be complete in all respect as described in these specifications, drawings, B.O.Q and in accordance with International Organization for Standardization (ISO).

The Contractor will discuss the Public Address and Voice Evacuation System layout with the Engineer and coordinate at site with other services for exact route, location and position of electrical / telecommunication lines and equipment.

The Public Address and Voice Evacuation System with accessories shall also comply with the General specifications for Electrical Works, General Technical Requirements for Communication Works and with other relevant provisions of the Contract Document.

2.0 GENERAL

Public Address & Voice Evacuation System shall be provided as shown on drawings.

Public Address & Voice Evacuation system shall interface with the Fire Alarm System in accordance with NFPA 72 and British Standard BS5839-8: 2013 or latest version of the same.

All the active items of the Public Address & Voice Evacuation System shall be listed as a product of a single manufacturer.

The system shall make use of modular design to enable future enhancements.

Contractor shall submit Sound Pressure Level (SPL) calculation of speakers for review.

Contractor shall consider 75-80 dB as background noise level for calculation of Sound Pressure Level (SPL) of speakers.

A feedback circuit arrangement shall be provided to keep sound pressure levels at least 10 db above background noise.

A supervisory system shall monitor loudspeaker loop for open circuits, short circuit and earth leakage conditions.

Announcement facility shall be provided at Command & Control Room of Main Building. Also, Provision for announcement shall be provided at following locations:

- Evidence Block
- Reception Block.

Configuration of the system for microphone control and priority setting shall be as follows:

- The highest priority input shall be used for emergence addressing from P.A. announcer console installed in Command & Control Room.

- The second priority shall be provided to microphone installed at Evidence Block/ Reception Block.

Power amplifier outputs shall be of the 100 V type. The equipment rack shall be connected to the UPS.

It shall be possible to combine the zones of within floor and each floor into a group for simultaneous broad casting.

All equipment, cables and wires shall be numbered in accordance with the standardization procedures laid down in IEC 750.

Contractor shall point by point confirm in writing their compliance with the items of this specifications in the form of a qualified statement of compliance.

Materials furnished under this specification shall be standard product of manufacturers, regularly engaged in the production of such equipment. Manufacturer shall also have authorized representative in Pakistan for maintenance of the equipment.

All junction boxes, glands (if required) shall be provided and price shall be deemed included in respective BOQ Item.

3.0 APPLICABLE STANDARDS AND CODES

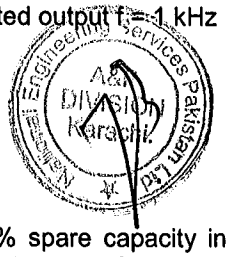
EN54, CE, DIN EN 60268-5 and DIN 45589 shall be applicable for the material covered within the scope of this section.

4.0 MATERIAL

4.01 System Manager / Network Controller with Software:

The System Manager with input and output as shown on the drawing and required as per manufacturer's recommendation shall be provided. Required Matrix Zones Bus shall be modular and shall have the following minimum characteristics:

- Indication	Available
- LAN	Available
- Control Input	8 inputs minimum
- Control Output	5 output minimum
- Audio Input	2 input
- Standby Amplifier Input	1 x input, 1 x output
- Distortion:	Less than 1% (at rated output f = 1 kHz Sine wave)
- Emergency Power Supply	Available



System Manager component shall have a provision of 25% spare capacity in main console including emergency power supply in order to cater future PA equipment requirement.

4.02 Amplifier (Compatible to System Manager)

Contractor shall provide dedicated duty amplifier for each zone as specified in load calculation chart in public address & voice evacuation schematic diagram as per their proposed manufacturer.

1 Nos. of auto standby amplifier of highest wattage shall also be provided and cost of all duty and spare amplifiers shall be deemed included in respective BOQ item.

The power amplifier shall have the following characteristics:

- Rated Output Power: As per zone load calculation given in PA schematic diagram.
- Output Voltage 100 V
- Inputs and Outputs: Available

4.03 **Mixer Amplifier for Mosque**

The mixer amplifier shall have the following characteristics:

- Rated Output Power: As per design requirement
- Inputs and Outputs: Available
- Feedback Suppressor Available

4.04 **Horn Loudspeaker**

Weather Proof Horn Loudspeaker suitable for mounting on wall brackets shall be used wherever required. Speakers shall be installed with junction box, ceiling rose, driver unit, glands, integrated 100 V-matching transformers and wall mount bracket for which price shall be deemed included in their respective BOQ item.

Horn Loudspeaker shall have following minimum technical specification.

- Rated output power: 15 watt
- Frequency Response: 120 Hz – 15 kHz
- Sensitivity / SPL: 97 dB (1 W, 1 m)
- Rated Voltage: 100 volts.
- IP Rating: IP67 Rated

4.05 **Horn Loudspeaker**

Weather Proof Horn Loudspeaker suitable for mounting on wall brackets shall be used wherever required. Speakers shall be installed with junction box, ceiling rose, driver unit, glands, integrated 100 V-matching transformers and wall mount bracket for which price shall be deemed included in their respective BOQ item.

Horn Loudspeaker shall have following minimum technical specification.

- Rated output power: 15 watt
- Frequency Response: 120 Hz – 15 kHz
- Sensitivity / SPL: 97 dB (1 W, 1 m)
- Rated Voltage: 100 volts.
- IP Rating: IP65 Rated

4.06 **Ceiling Loudspeaker for General Areas**

Ceiling Loudspeaker shall be provided as per requirement. Speakers shall be installed with fire dome, junction box, ceiling rose, driver unit, glands, integrated 100 V-matching transformers and other required accessories for which price shall be deemed included in their respective BOQ item.

Ceiling Loudspeaker shall have following minimum technical specification.

- Rated Power 6 watt
- Rated Voltage 100 volts.
- Frequency Range 160 Hz – 13 kHz
- Sound Pressure Level (SPL) 90 dB (1 W, 1 m)

4.07 **Ceiling Loudspeaker for Mosque**

Ceiling Loudspeaker shall be provided as per requirement. Speakers shall be installed with junction box, ceiling rose, driver unit, glands, integrated 100 V-matching transformers and other required accessories for which price shall be deemed included in their respective BOQ item.

Ceiling Loudspeaker shall have following minimum technical specification.

- Rated Power 6 watt
- Rated Voltage 100 volts.
- Frequency Range 45 Hz – 20 kHz
- Sound Pressure Level (SPL) 96 dB (1 W, 1 m)

4.08 **Remote Microphone**

The remote microphone shall have the following characteristics:

- Distortion: Less than 1%
- Frequency Response: 100 Hz – 20 kHz
- Signal to Noise Ratio (S/N) ≥ 60 dB

4.09 **Headgear Microphone for Mosque**

The headgear microphone shall have the following characteristics:

- Directivity — Unidirectional
- Frequency Response: — 50 Hz – 12 kHz

4.10 **Unidirectional Dynamic Microphone for Mosque**

The dynamic microphone shall have the following characteristics:

- Directivity — Unidirectional
- Frequency Response: — 70 Hz – 15 kHz
- Floor Stand — Included in respective BOQ item

4.11 **Loudspeaker Cable**

Wiring and cabling of loudspeaker cable shall be carried out in PVC/G.I conduits as required. 2 x 1.5 mm^2 fire resistant enhanced cable with LSZH outer sheath / manufacturer's recommended cable shall be provided for the wiring of loudspeaker cable for Public Address System / Voice Evacuation System. The cable shall be able to work for 120 minutes in fire condition.

All wires and cables shall be checked for open, short or ground faults. All wiring shall be made on terminal blocks of proper size and type for the services involved. Cable joints shall only be allowed on the speaker junction boxes. Appropriate size nos of cable glands and junction boxes shall be provided for speakers.

4.12 **Paging Microphone Cable**

Wiring of microphone cable shall be carried out in PVC/G.I conduits as required. Manufacturer's recommended cable shall be provided for the wiring of microphone of Public Address and Voice Evacuation System.

4.13 **Remote Microphone Cable**

Wiring of microphone cable shall be carried out in PVC/G.I conduits as required. Cat 6 STP LSZH cable / manufacturer's recommended cable shall be provided for the wiring of remote microphone of Public Address and Voice Evacuation System.

4.14 **Public Address and Voice Evacuation Rack**

Cabinet shall be 19 inch, with tie and retainers for cabling system and 600mm x 600mm, 800mm x 600mm and 1000mm x 800mm cabinet shall be suitable to install:

- Colour of rack: Black.
- Plexi glass door.
- Frame thickness 2mm, mounting rail thickness 2mm, roof thickness 1.63mm, rear door thickness 1.63mm and side panels thickness 1.2mm.
- At least two cooling fan.
- Cable entries from both top and bottom panel.
- Cabling guide system in each internal side of cabinet for front and back side.
- Earthing / grounding point.
- Door lock with key locking capacities.
- Right or left opening of door of rack shall be provided as per requirement of room.

- A cabling guide system in each internal side of the cabinet for the front side;
- A cabling guide system in each internal side of the cabinet for the backside;
- An earthing point, multi-socket strip for supply power to the active equipment;
- Metallic door shall be provided with key locking capabilities.

Power distribution unit (PDU) must have following specification:

- At least two extra sockets as per requirement of active equipment installed inside rack.
- PDU with sockets compatible with active equipment
- Industrial male plug / compatible with power socket.
- Two PDUs in each rack for active equipments that have dual power supply.

5.0 TRAINING

A training session shall be presented by a fully qualified, trained representative of the equipment manufacturer/supplier who is thoroughly knowledgeable of the specific installation. The training shall be given to personnel responsible for operation and maintenance of the system.

6.0 INSTALLATION

6.1 Voice Evacuation System Equipment

The installation of Voice Evacuation System Equipment shall be in strict accordance with the manufacturer's instructions/recommendations and these specifications.

The testing of Voice Evacuation System equipment shall be in compliance with the relevant standards and regulations. During testing of equipment, emphasis shall be laid on the following:

- Zone wise and group wise microphone live broadcast routing
- Microphone priority testing

6.2 Wiring and Cabling

Wiring and cabling of Voice Evacuation System shall be carried out as per instructions given in Section 8212 'Low Tension Cables' of these specifications.

6.3 Conduits and Accessories

Conduits and accessories for Voice Evacuation System shall be installed as per instructions given in section 'Conduits and Pipes', of contact specifications.

7.0 MEASUREMENT AND PAYMENT

7.1 General

The Contractor's bid amount against each Bill of quantities item as given below shall include supply, installation, testing, commissioning and completion of all work specified herein and/or as shown on the Contract Drawing related to the item.

7.2 System Manager with required Matrix Bus with Software etc.

7.21 **Measurement:** Measurement shall be made for System Manager with required Matrix bus with 25% spare capacity having microprocessor modular matrix, input card, output card, LAN connectivity, dedicated duty amplifier for each zone as mentioned in load calculation sheet in schematic diagram, auto standby amplifier of highest wattage, automatic switchover, line fault detection system, manufacturer's recommended emergency power supply backup with DC power output, trickle charging, with suitable manufacturer's recommended backup batteries as required, PA software, SPL calculations, interfacing with fire alarm system including any other essential interconnecting equipment and cabling as required with all installation and mounting accessories for satisfactory operation of the entire public address & voice evacuation system acceptably supplied and installed by the Contractor as a complete job.

7.2.2 **Payment:** Payment shall be made for the complete job measured as provided above at the contract unit price and shall constitute full compensation for supplying, installing, connecting, configuring, programming, testing, commissioning and completion of System Manager with required Matrix bus with 25% spare capacity having microprocessor modular matrix, input card, output card, LAN connectivity, dedicated duty amplifier for each zone as mentioned in load calculation sheet in schematic diagram, auto standby amplifier of highest wattage, automatic switchover, line fault detection system, manufacturer's recommended emergency power supply backup with DC power output, trickle charging, with suitable manufacturer's recommended backup batteries as required, PA software, SPL calculations, interfacing with fire alarm system including any other essential interconnecting equipment and cabling as required with all installation and mounting accessories for satisfactory operation of the entire public address & voice evacuation system.

8.1 Horn Loudspeaker / Ceiling Loudspeaker with Matching Transformer

8.01 **Measurement:** Measurement shall be made for the total number of each type of Horn Loudspeaker/Ceiling Loudspeaker acceptably supplied and installed by the Contractor as complete unit.

8.02 **Payment:** Payment shall be made for the complete unit as provided above at the Contract unit price each and shall constitute full compensation for supplying, installing, connecting, testing, commissioning and completion of each type of Horn Loudspeaker / Ceiling Loudspeaker complete with driver unit, integrated matching transformer, fire dome and wall mount and ceiling mount brackets as specified in BOQ and specification including all mounting and installation accessories as required complete in all respect.

8.2 Remote / Headgear / Unidirectional / Dynamic Microphone

8.21 **Measurement:** Measurement shall be made for the total number of each type of Remote / Headgear / Unidirectional / Dynamic Microphone acceptably supplied and installed by the Contractor as complete unit.

8.22 **Payment:** Payment shall be made for the complete unit as provided above at the Contract unit price each and shall constitute full compensation for supplying, installing, connecting, testing, commissioning and completion of each type of Remote / Headgear /

Unidirectional / Dynamic Microphone as specified in BOQ including all mounting and installation accessories.

8.3 **Public Address Rack**

8.31 **Measurement**: Measurement shall be made for the total number of each type of Public Address Rack for installation of system manager, power amplifier, and accessories of public address system and terminal strips for speaker circuits and microphone, earthing point, multi-socket strip for supply power to the amplifier, Plexi glass door with key locking capabilities acceptably supplied and installed by the Contractor as a complete unit.

8.32 **Payment**: Payment shall be made for the complete unit as provided above at the Contract unit Price each and shall constitute full compensation for supplying, installing, connecting testing, commissioning and completion of each type of Public Address Rack for installation of system manager, power amplifier, and accessories of public address system and terminal strips for speaker circuits and microphone, earthing point, multi-socket strip for supply power to the amplifier, Plexi glass door with key locking capabilities acceptably supplied and installed by the Contractor as a complete unit.

8.4 **Public Address System for Mosque**

8.4.1 **Measurement**: Measurement shall be made for the complete job of Public Address system for installation of mixer amplifier, ceiling speaker, microphone socket outlets, each type of microphone, microphone stand including any essential interconnecting equipment and cabling as required with all installation and mounting accessories for satisfactory operation of the entire PA system.

8.4.2 **Payment**: Payment shall be made for the complete job as provided above at the Contract unit Price each and shall constitute full compensation for detail engineering design, supplying, installing, connecting, programming, testing, commissioning and completion of each type of Public Address system for installation of mixer amplifier, ceiling speaker, microphone socket outlets, each type of microphone, microphone stand including any essential interconnecting equipment and cabling as required with all installation and mounting accessories for satisfactory operation of the entire PA system.

8.5 **Wiring of P.A & V.A System- Loudspeaker / Microphone Cable**

8.5.1 **Measurement**: Measurement shall be made for the total running feet of wiring of Loudspeaker / Microphone of P.A & V.A System acceptably supplied and installed by the Contractor.

8.5.2 **Payment**: Payment shall be made for the total running feet as provided above at the Contract unit Price each and shall constitute full compensation for supplying, installing, connecting, laying, testing and commissioning of Loudspeaker / Microphone of P.A & V.A System acceptably supplied and installed by the Contractor including all installation accessories.

*** End of Section 8341 ***

HVAC WORKS

SPECIAL PROVISIONS

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SPECIAL PROVISIONS

SP-01 GENERAL

SP-01.1 Location of Project

The HVAC system shall be installed in the following buildings;

- Main building of Forensic Science Laboratory
- Evidence Block

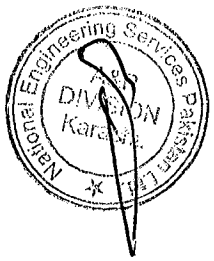
SP-01.2 Building for the Project

The building is under construction. The Contractor shall be responsible to intimate to Engineer any omission during civil construction with respect to provisions of space, openings in walls, floors, roof slabs, false ceilings, drain points and electrical requirements for HVAC Works. All civil work mentioned in Bidding document and relevant electrical work is in scope of contractor.

SP-01.3 Use of Building

The building consists of forensic science laboratory and evidence buildings. The building consists of five floors including basement, ground and upper three (03) floors. Namely, following forensic laboratories and services are housed in the building;

- Administration Offices
- DNA Forensic Unit
- Crime Scene Forensic Unit
- Firearms and tool marks Forensic Unit
- Latent Fingerprints Forensic Unit
- Narcotics Forensic Unit
- Trace Chemistry Forensic Unit
- Pathology Forensic Unit
- Audio Visual Forensic Unit
- Computer Forensic Unit
- Photography Forensic Unit
- Quality Assurance Forensic Unit
- Question Documents Forensic Unit
- Toxicology Forensic Unit
- Storage areas
- Toilets



In addition to general labs, DNA, Narcotics, Pathology and Toxicology Forensic Units consist of Biosafety Level-III Labs (BSL-III).

The Contractor is advised to study the architectural, structural, electrical

and plumbing System to familiarize himself with the Building Plans/Layout. The contractor is also suggested to visit the site for realistic bid especially with reference to civil work.

SP-01.4 HVAC System Concept

a) Type of System:

Four Pipe Central HVAC System has been adopted for the building. The components of the system are as follows;

- Water Cooled Centrifugal Chiller,
- Hot Water Generator (HWG),
- Cooling Towers,
- Air Handling Units,
- Energy Recovery Ventilators
- Fan Coil Units and
- Pumps

The critical areas such as BSL-III are provided with the additional DX-Coil in Air Handling Units with matching Condensing Units for redundancy and unitary operation when required.

Further, building has been provided with Energy Recovery Ventilator to achieve energy efficiency.

b) Summer

During the summer season, two (02) chillers with two (02) chilled water pumps, one HWG with one (01) hot water pumps, two (02) condenser water pumps and two (02) cooling towers will satisfy total cooling load of the building.

Chillers will also operate on part load if some of AHUs are switched-off. A chiller, coiling tower, chilled and hot water pump, oil pump and condenser water pump are included as standby in case of failure/maintenance of any equipment.

c) Winter

During most of the heating season, one (01) HWG with one (01) hot water pump will satisfy the total heating demand of the building.

d) Plant Operation during Power Failures

As the cooling/heating will be required continuously during power break down or load shedding so all HVAC equipment shall be connected to emergency power.

SP-01.5 Service Conditions for Auxiliaries

a) Power Supply

Electrical Circuit Voltages:

Nominal, 3-Phase:	415 volts
1-Phase:	240 volts
For equipment ratings, 3-Package:	400 volts
1-Phase:	230 volts

Fluctuation in voltage applied (+/-) 10% to equipment rated voltage.

Frequency: 50 HZ.

b) Water Supply will be available near Cooling Towers located at outside of the building, all air handling unit rooms and central plant room located in basement.

c) Water Disposal:

Floor drains will be connected to sewerage system of the Building.

SP-01.6 Units

The units used in these specifications are as under:

Unit System:	SI/British/FPS
Gauge:	US Gauges as per ASTM
TR:	Ton of refrigeration equivalent to 12000 BTU/H (12 MBH) or 3516 W

SP-02 WORK BY THE CONTRACTOR

SP-02.1 Scope of Work

a) The work under this Contract comprises of all HVAC works including supply, installation, balancing, testing, commissioning and operations & maintenance during defect liability period.

b) The Contractor shall furnish all labour, materials, equipment tools, appurtenances, services, temporary work and storage necessary to completely supply, install, test, commission, and maintain the heating, ventilating and air-conditioning (HVAC) system, all in the perfect operating conditions in accordance with these Specifications and Drawings. The Contractor shall also adjust, balance, re-adjust all the air and water systems as specified and shown. The Contractor shall commission, operate and maintain all

the systems for a period specified in Clause SP-22 under Defect Liability Period.

c) The complete civil work as mentioned in schedule of price and any relevant civil work require to complete the job is included in contractor scope of work.

d) The contractor shall plan and coordinate his activities and schedules so as not to interfere with the work of other contractors.

The contractor shall inform for the schedule of any construction activity well in advance.

If any part of the work is damaged or has to dismantle or redone due to negligence/omission/incorrect position of the embedment etc. as part of the contractor, all such loses/expenses shall be borne by the Contractor.

e) The Specifications are only general guidelines and by no means cover details of each equipment. These only spell out the intent of the requirement. The details have to be provided by the Contractor along with details of performance, construction and technical literature with the Bid. The specifications are to be read in conjunction with the Drawings.

All equipments and materials shall be brand new bearing stamped ratings as required by Equipment Schedules and must be approved by the Engineer prior to their use. Any doubts about the practicability and implementation of Specifications and details shown in the Drawings must be expressed along with submission of Bid. Inability of the Contractor to implement these specifications after the acceptance of the Contract shall be considered breach of Contract.

SP-02.2 Services by the Contractor

a) Erection Supervisor

The Contractor shall provide competent Erection Supervisor to direct and be responsible for the erection, starting and operation of the Equipment supplied by the Contractor until issue of Substantial Completion Certificate. Further details concerning Erection Supervisors are covered in Clause SP-17, "Erection Supervisors and Operating Staff". In addition, the Contractor shall also provide services of Factory Engineer authorized by manufactured to direct and supervise the installation, testing & commissioning.

b) Operation during Defect Liability Period.

The Contractor shall operate service and maintain HVAC system

for a period mentioned in and as per requirements of Clause SP-22, "Defect Liability Period". The Contractor shall provide all personnel for operation and maintenance including one Supervisor. Qualifications, experience and number of all these personnel shall be subject to the Engineer's approval.

c) Training of Employer's Operative Personnel.

The Contractor shall arrange for free of cost on-site training of operative personnel, nominated by the Employer, in the operations and maintenance of all HVAC equipment and system. The period of training shall not be less than fifteen (15) days.

The group of operative personnel will comprise of Engineers/Supervisors and Technicians. The training shall be imparted by a qualified Engineer having at least ten (10) years experience in the operation and maintenance of similar HVAC systems.

The Trainer shall fully orient the group with the actual system and impart thorough training in the operation and maintenance of the system and equipment with the help of drawings, charts, hand-outs, diagrams, video aids, lectures, etc. Details and time of training shall be approved by the Employer/Engineer before training is commenced.

SP-02.3 Erection Plant

Under this clause the Contractor shall provide erection plant and tools for his own use during erection period only; he would take back these tools on completion.

Tools for maintenance after completion are to be provided under Clause TP-10-05.

The Contractor shall furnish special erection plant and tools in accordance with the requirements of Clause SP-15, "Fabrication, Erection Testing and Maintenance Tools Plant and Instruments.

SP-02.4 Related Works

The Contractor shall provide all works related to HVAC system, whether specifically mentioned or not, except those specifically stated in exclusion Clause SP-03, "Work Not Included". These related works shall include, but not be limited to:

a) Power supply and earthing shall be provided by the Contractor and incoming power feeders and earth continuity conductors shall be terminated at locations as shown on the Drawings and/or as stated in the Technical Provisions, Section 7, Electrical Equipment and

Controls. All electrical works from these points onward shall be the responsibility of the Contractor.

b) Water supply shall be provided by others from overhead tank or city water main, in the main plant room, each AHU room and near cooling tower at ground level. Plumbing works from the points indicated on the drawing to make-up water point shall be the responsibility of the Contractor.

c) All works related to water and cooling coil condensate disposal from HVAC system up to nearest floor drains shall be the responsibility of the Contractor.

d) Cutting, patching and repairing in accordance with Section 1.0 of the Technical Provisions.

e) Providing written information regarding location and sizes of door louvers, where required, to the persons responsible for door louvers, through the Engineer. This information shall be provided within thirty (30) days of issue of the Engineer's Order to Commence Work.

f) All wood-work required for satisfactory completion of the project as specified except decorative wood work provided to conceal HVAC equipment.

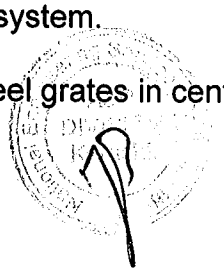
g) Providing shop drawings at scale (1:50) and other written information regarding Concrete Pads and foundations for HVAC equipment to the Civil Contractor through the Engineer. Catalogue cuts showing foundation details will not be accepted.

h) Providing steel frames for inertia pads and cork sheet/neoprene sheet for other pad.

i) All foundations for HVAC equipment including concrete foundations, housekeeping pads and concreting for inertia pads (where required) shall be provided by the HVAC Contractor.

k) Coordinating HVAC installation with other trades work, by way of study of other trades drawings and pointing out the areas of conflict to the Engineer before installing items of HVAC system.

l) Concrete flooring & finishing, drain channel & steel grates in central plant room.



SP-03 WORK NOT INCLUDED (NOT USED)

SP-04 DESIGN CONDITIONS

HVAC System has been designed with conditions listed hereunder.

SP-04.1 Outside Design Conditions

a) Maximum Summer Dry Bulb Temperature: 108 °F

b) Design Dry Bulb Temperature: 104.3 °F
(ASHRAE 0.4%)

c) Coincident Wet Bulb Temperature: 78.4 °F

d) Maximum Daily Range: 11.2 °F

e) Wind Velocity:

- Summer 24 KPH
- Winter24 KPH

f) Climate: Tropical, Dust Storms (April – June)
Torrential Rains (July – August)

i) Latitude: 25 Degrees North
ii) Longitude 67 Degrees East
iii) Elevation 13 Feet

SP-04.2 Inside Design Conditions

Category	Inside Design Temperature (°F)		Sound Levels (dB)	Relative Humidity (%)	
	Summer	Winter			
Offices	74 - 78	70 - 74	30 - 45	50 - 60 (Summer)	20 - 30 (Winter)
Class Rooms/Training Areas	74 - 78	70 - 74	25 - 30	50 - 60	
Laboratories	70 - 72		25 - 30	30 - 50	

SP-04.3 Air Filtration

Air filtration based on ANSI/ASHRAE Filter Test Standards 52.2-2017, " Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size " or latest version. Filter efficiencies are stated in AHU Equipment Schedules.

SP-05 DRAWINGS, EQUIPMENT SUBMITTALS, INFORMATION MANUALS, SAMPLES & CONTRACTOR'S OTHER SUBMISSIONS

SP-05.1 General

All drawings, other information and samples must be supplied to the Engineer as laid down in these Specifications and as and when agreed during site meetings, in the Progress Chart or as instructed by the Engineer.

The Contractor shall submit, for approval, detailed submittals as specified and no material or equipment may be delivered to the job site or installed until the Contractor has in his possession with the approved Data Sheet, Catalogue cuts or samples of particular material. Approval rendered on submittals shall not be considered as a guarantee of measurements or building conditions.

Where submittals are approved, said approval does not in any way relieve the Contractor from his responsibility for necessity of furnishing material or performing work as required by the Drawings and Specifications.

Failure of the Contractor in providing submittals in ample time for checking shall not entitle him to an extension of the Contract time and no claim for extension by reason of such default will be allowed.

SP-05.2 Omitted Particulars

All works and matters omitted from the Contract but which may reasonably be implied or inferred from them and in the opinion of the Engineer obviously are necessary for the efficiency, stability, completion and maintenance of the works and which are ordered by the Engineer to be carried out shall be executed by the Contractor accordingly as if they had been expressly described in or shown on the Contract documents and the costs thereof shall be deemed to be included in and covered by the Contract Price.

SP-05.3 Drawings

The Drawings listed in Volume - III of the Bidding Document show the Scope of Work to be performed by the Contractor. These Drawings shall not be used as a basis for fabrication, construction or installation but shall be used for estimation for bidding purpose only. These drawings are not

to be considered defining the design of HVAC equipment to be furnished or defining the exact details of the installation under this Contract, but are only illustrative of the Specifications and HVAC System and show the general layout of the equipment forming part of HVAC System and schematic diagrams explaining the system flow, controls and sequence of operation. These drawings are not to be scaled.

These Drawings do not show every offset, bend or elbow which may be required in the piping or ductwork for installation in the space provided. The routes and sizes (if shown) of ductwork, piping, air inlets and outlets shown on these Drawings are subject to change depending upon the make of major HVAC equipment to be provided by the Contractor. These design parameters shall be adjusted at the shop drawing stage.

Work shown on the HVAC Drawings and not mentioned in the Specifications, or described in the Specifications without being shown on the HVAC Drawings, shall nevertheless be held to be included in the contract in the same manner as if they had been specifically shown upon the Drawings and described in the Specifications.

SP-05.4 Drawings Supplied by Engineer

The Engineer may supply to the Contractor after signing the contract working drawings/detail drawings and instructions as may be necessary for preparing shop drawings and for the guidance of the Contractor in the construction, completion and maintenance of the works, and the Contractor shall execute, obey and be bound by the same.

The Contractor shall not be entitled to any payment in addition to the Contract Price in respect of any work shown or directed to be done by such working/detail drawings or instructions unless the Engineer shall have given and approved a variation order for the same.

Any additional drawings found necessary or desirable by the Contractor to show different combinations of drawings supplied by the Engineer shall be prepared by the Contractor at his own expense. The Contractor shall carefully check all drawings and advise the Engineer of any errors or omissions discovered. The Contractor shall be furnished with one copy of all detail drawings and graphic instructions prepared by the Engineer. Additional copies, within reasonable quantity, will be furnished to the Contractor, upon request, at cost.

The Contractor shall be furnished with one copy of all textual instructions as may be issued by the Engineer.

SP-05.5 Shop Drawings

The Contractor shall make detailed analysis of the requirements of the works. Based upon such analysis and working drawings supplied by the Engineer, he shall revise and amplify the Drawings and shall prepare

detailed Shop Drawings at his own cost for complete HVAC System and Equipment. Initially he shall submit 3 preliminary copies each of all such Shop Drawings to the Engineer for obtaining approval. Once basic agreement is reached with the Engineer regarding the details then the Contractor shall submit 3 copies each of all such Shop Drawings and one epia to the Engineer for obtaining approval of the Engineer. After obtaining approval and after having in possession these approved Shop Drawings, the Contractor shall use these Shop Drawings for fabrication, construction and installation.

The work described on any shop drawing submitted shall carefully be checked by the Contractor for all clearances, field conditions, maintenance of architectural conditions and proper coordination with all trades on the job. To this end, the Contractor during the shop drawing stage, shall ensure that he receives drawings of all other trades that might interfere with the proper installation of his work. No payment shall be made for any variations or alterations on site due to lack of knowledge of other trades. Any unresolved conflict between trades shall be referred to the Engineer for decision.

Equipment layout is to be detailed on shop drawings, showing the exact method of installing and clearly illustrating components to be used in making all connections.

The Contractor shall submit shop drawings of all sheet metal work for approval, before work is fabricated and installed. Ductwork drawings must show clearances between ductwork and masonry. All dampers, splitter dampers, fresh air inlets, exhaust outlets, connections to equipment and methods of support and any other details necessary for the satisfactory installation of the system must be indicated. Each type of grille, register, diffuser and louver is to be referenced in a schedule and the type and size clearly indicated at each location. Taper and flat sides of ductwork at all transitions must be indicated, and all equipment piping and ductwork must be located exactly by showing exact dimensions with column lines or other reference lines.

Duct bottom and piping centre-line height from finished floor level shall be marked with every change in level

Position of hangers and supports with type and method of installation of each hanger shall be given, detailing the type of hanger fixing with a reference number for each type

Piping drawings must be fully detailed, showing all piping in double line and indicating the precise size of fittings, valves and equipment. Positions of hangers and supports with reference numbers must be given showing the type and method of installation of each hanger detailing the type of hanger fixings with a reference number for each type.

All general layout drawings shall be drawn to 1:50 (1':1/4") scale. Details

of hangers, methods of fixing of pipes and ducts, detailed cross section of pipe, ducts and risers, details of control and piping hook-ups to equipment shall be drawn to 1:10 (1':1") scale.

The Contractor shall prepare Drawings and Schedules showing precise details of holes in concrete, masonry, etc. and necessary sleeves required for passage of ducts and pipes and fitting of grills, registers, diffusers, louvers, plant, plant supports etc. Drawings and Schedules, approved by the Engineer must be available before any structural work requiring holes or other modifications, is constructed.

Signed and approved drawings shall not be departed from unless a signed variation order or site instruction is issued in writing by the Engineer. Drawings returned to the Contractor for alteration or amendments are to be resubmitted for approval.

Amended or altered drawings shall show the nature of the amendment or alteration in a revision block on the drawing, together with revision number or letter and the date of the revision.

The Contractor shall be responsible for any discrepancies, errors or omissions in the drawings and other particulars supplied by him whether such drawings and particulars have been approved by the Engineer or not, provided that such discrepancies, errors, or omissions are not due to inaccurate information or particulars furnished in writing to the Contractor by the Engineer.

SP-05.6 As-Built Drawings

The Contractor shall supply to the Engineer a set of "As-Built" drawings showing the Contract works as installed, together with any other information necessary for operation and maintenance. Six copies of each drawing (scale as per shop drawing) and other information shall be supplied, along with a reproducible and a soft copy.

SP-05.7 Manufacturer's Data

Manufacturer's performance data, certified factory drawings and/or curves of apparatus giving full information as to capacity, performance at different operating and ambient conditions, dimensions, materials, electrical data and all information pertinent to the adequacy of the submitted equipment shall be submitted for approval. One original and 2 copies of catalogues and other information shall be submitted.

Manufacturer's names, sizes, catalogue numbers and/or samples of all materials shall also be submitted for approval.

Orders for equipment submitted for approval must be accompanied by relevant drawings, curves, technical data, catalogues and samples. Where data, certified drawings or other required information is not

available until after orders have been placed, the Engineer shall give provisional approval until all requested drawings and information have been supplied to the Engineer and approved by him. It is the Contractor's responsibility to ensure that all necessary information is supplied to the Engineer in accordance with the progress of works.

Should the Engineer give provisional approval only for an order due to lack of complete information and should the missing information not eventually meet with the approval, the Engineer shall not be held responsible for any delay incurred. For equipment where information from the manufacturers is likely to be delayed, it is essential that the Contractor places provisionally approved orders at the earliest possible date so as to ensure approval of orders in complete conformity with the progress of the works.

Submittals and shop drawings should, as far as possible, be complementary so that drawings and submittals can be cross-checked.

SP-05.8 Samples

Contractor shall provide at his cost, samples of materials, instruments, gauges and electrical items, for approval by the Engineer before order is placed for the same. Engineer may waive this requirement, if detailed published catalogues submitted by the Contractor provide sufficient information for approval. These samples shall include, but not limited to:

i) G.I. sheet, each gauge to be used
ii) Pipes and fittings
iii) Valves (all types), strainers, air vents, pressure gauges and thermometers
iv) Duct insulation, liner and covering
v) Pipe insulation and covering
vi) Insulation adhesive and tapes
vii) Diffusers, grilles and registers
viii) OA/EA louvers
ix) All types of dampers
x) Power and control cables
xi) Electrical items; push buttons, HOA & toggle switches, pilot lamp, contactor, relays, circuit breakers and isolating switches
xii) Vibration isolating springs, pipe hangers and rollers
xiii) Flexible duct connections
xiv) Pipe flexible connection/expansion joints (when specified local)
xv) Air filters
xvi) Electrical conduits and fittings
xvii) Paints
xviii) Anchor bolts, studs, etc. for hanging arrangements
xix) Round insulation flexible duct
xx) Any other item required by the Engineer

SP-05.9 Copies of Drawings and Specifications

One set of Bidding Documents and one (01) sets of Drawings will be issued by the Employer to the Contractor free of cost after award of Contract. Additional sets will be provided at cost upon written request to the Engineer by the Contractor.

SP-05.10 Sound Absorption Data

The Contractor shall provide data for sound absorption from HVAC machinery, air terminals, etc. to ensure NC ratings as specified in SP-04 and TP-1.12.

SP-05.11 Photographs and Progress Reports

The Contractor shall arrange, at his cost, color photographs of Works in progress at Site. At least six photographs per month shall be taken from approved locations, commencing with the first month up to the completion of the Works. A professional camera shall be used. The Contractor shall submit, not later than seventh of each month, a negative and six prints of 10x8 inch of each photograph taken during the previous month, with a brief report indicating progress of Works to date.

SP-06 APPROVAL OF MATERIALS AND EQUIPMENT

As soon as practicable after the award of Contract, the Contractor shall submit for the approval of the Engineer specifications, drawings, catalogue - cuts, diagrams and other descriptive data for all materials, components and equipment which the Contractor proposes for use under this Contract. For certain materials and equipment, data may be required to be submitted in accordance with a detailed form furnished by the Engineer. Items submitted shall be properly labeled to indicate the Contract number, project, manufacturer, source of supply, Contract Item number, and other data required by the Specifications. All items shall be submitted in sufficient time to permit proper consideration and action thereon without delaying the construction schedule. These data shall include original copies of proforma invoices for placing orders, a type written specification sheet of each SOP item, and technical literature (complete bound published catalogue) with relevant portions highlighted by a marker. Accessories to be included shall clearly be marked in catalogue and indicated in specification sheet.

SP-07 TIME FOR DELIVERY

All equipment plant and machinery shall be delivered at Site on such dates so as to ensure adherence to scheduled dates stated in Programs of works submitted by the Contractor and approved by the Engineer subsequent to the award of contract. The Contractor shall keep the Engineer informed of the progress of the shipment and notify them approximately 3 weeks in advance, in writing, as to when the equipment

will be ready for inspection at Site by the Engineer and shall supply lists covering each consignment in sufficient detail to enable Engineer to check the contents of the packages, if he so desires.

SP-08 STANDARDS AND CODE REQUIREMENT

SP-08.1 All equipment and materials under HVAC Scope of Works shall be furnished in conformity with the latest edition of Applicable Standards of ASME, ASHRAE, ARI, SMACNA, TIMA, AMCA and applicable Government and Local Codes governing the same. In case of conflict, the strict requirements shown/specified shall govern. All equipment shall be rated and tested as per standards listed in ASHRAE Handbook (latest Edition).

SP-08.2 Abbreviations for Codes and Standards referred in the Contract are as under:

1) ASME - American Society of Mechanical Engineers
2) ASTM - American Society for Testing & Materials
3) ASHRAE - American Society of Heating, Refrigerating and Air-conditioning Engineers
4) NFPA - National Fire Protection Association, USA
5) ARI - Air-conditioning and Refrigeration Institute, USA
6) SMACNA - Sheet Metal and Air-conditioning Contractors National Association, USA
7) CTI – Cooling Tower Institute
8) EUROVENT – European Committee of Ventilating Equipment Manufacturers
9) GOVERNMENT - Government of Pakistan
10) LOCAL - Local authorities of the city where the Project is located
11) I.E.E. - Institute of Electrical Engineers, London
12) NEMA - National Electrical Manufacturers Association, USA
13) AMCA - Air Moving and Control Association Inc., USA
14) P.S. - Pakistan Standards.
15) B.S. - British Standards.
16) TIMA - Thermal Insulation Manufacturer's Association, US

SP-09 STANDARDS OTHER THAN THOSE SPECIFIED

Where the specifications provide requirements for material or equipment by specifying a standard such as for example, one of the American Society of Heating, Refrigerating and Air conditioning Engineers which has its origin in one country, it is not the intention to restrict the requirements solely to that standard and that country. Other standards, including standards of other countries, will be accepted provided the requirements thereof, in the sole opinion of the Engineer are atleast equal to the requirements of the standards specified. The Contractor may propose to the Engineer an equivalent standard other than that specified, in which case he shall submit the proposed standards and all other information to demonstrate and prove his proposed standard is equivalent

in all significant respects to the standard specified. All submissions must be made in the English language.

SP-10 PERMIT

The Contractor shall secure and pay for any necessary approvals, permits and inspections from Government or other controlling agencies where applicable as required by law, before commencing any work so as to avoid all delays during erection and turn over the official records of granting of permits to the Engineer. No reimbursements shall be made for such payments.

SP-11 SHOP INSPECTION, DAMAGES AND MATERIAL ORDER

SP-11.1 Inspection

SP-11.1.1 Inspection at Factory Premises

All major equipment to be supplied under this Contract which has been manufactured or shop-assembled in or outside Pakistan shall be subject to inspection (if the Employer so desires) by Employer or its authorized representative at its point of original manufacture or final shop assembly before its dispatch to SITE. The Contractor shall make necessary arrangements and provide all the facilities required for such inspection. The cost of travel, boarding and lodging of Employer, his authorized representative or the Engineer shall be the responsibility of the Contractor.

The following equipment shall be inspected and tested at the manufacturer's facility:

1) Chillers (Imported)
2) Air Handling Units (Imported)
3) Fan Coil Units (Imported)
3) Centrifugal Pumps (Manufacturer's Premises for Local or Manufacturer's Authorized Representative's Premises for Imported)
4) Electrical & Control Panels (Local)

For local items inspection, Contractor will pay Rs. 2000/Day (Daily Allowance) in addition to cost of traveling, boarding or lodging for one Employers representative and one Engineer's representative for the subject inspection.

For imported equipment, the detail requirements are mentioned below:

a) The Contractor shall import the equipment, preferably on Invoice issued by the local distributor. Trans-shipment will not be allowed. The Contractor may import the equipment without involvement of local distributor provided he fulfills following conditions:

A certificate from the manufacturer, on original stationery be furnished along with equipment submittal for approval, certifying that the manufacturer will be responsible to provide after-sale service through his authorized local representative. The certificate should carry the name and location of the project as well as the name and address of the authorized local distributor.

b) The Contractor shall arrange at his own cost factory visit(s) for pre-shipment inspection separately for Chillers, air handling units/fan coil units. One Engineer's representative and one Employer's representative accompany with Contractor's representative will visit manufacturer's premises. Club Class Air-fare to and from inspector's home town, boarding and lodging, and transport for two persons shall be Contractor's responsibility. The Contractor shall arrange visa for the inspectors and all formalities and costs in this respect shall also be the Contractor's responsibilities.

In addition, the Contractor shall provide (for two persons) daily allowance in US$ for out of pocket expenses at 150 US $/day/person. The number of days shall be actual days spent in travel calculated from the dates of travel from and to the home town of the concerned inspector, but not less than five (5) days. The US$ in cash shall be provided before start of travel from hometown.

c) Technical submittal furnished in accordance with Contract provisions shall include:

Manufacturer's computer selection sheet, in original on Manufacturer's stationery stating, besides other information project name and location, make, country of origin and source of supply, as per Contract Clause SP-06, and as stipulated in Equipment Schedule for all equipment.

Manufacturer's Warrantee Statement on Manufacturer's stationery in original shall be submitted.

Manufacturer's confirmation on his stationery in original, acknowledging the condition that no trans-shipment would be allowed, Warrantee Statement will be part of shipping documents, and shipment will be subject to pre-shipment inspection and witnessing of performance test by One Engineer's representative and one Employer's representative at Manufacturer's factory. The Acceptance Certificate by Engineer's Representative will be part of shipping documents.

After approval of Technical Submittal for all equipment, following documentation shall be furnished.

- Attested copy of Letter of Credit (price portion may be

blanked off).

- Manufacturer's confirmation on his original stationery, that the order has been entered for production. Project name, location and expected shipment date be stated.

d) In case of absence of pre-shipment inspection for any valid reason which is not in control, Engineer may advise 3rd party inspection/testing or will deduct suitable amount of pre-shipment inspection or direct the Contractor to change the make/country of origin of the equipment if so required.

e) The Contractor is required to fill the rates of pre shipment inspection of AHUs/FCUs and pre shipment & performance testing of Chillers in the respective item of BOQ.

SP-11.1.2 Inspection at Karachi Port

All major imported equipment (Chillers, Air Handling Units, Fan Coil Units and Cooling Towers, Pumps) will be inspected at Karachi port. The Contractor shall make necessary arrangements and provide all the facilities required for such inspection. The cost of travel, boarding and lodging of Employer, his authorized representative or the Engineer shall be the responsibility of the Contractor. In case of unavailability of such inspection, Engineer reserves the right to deduct suitable amount from Contractor's payment and subsequent inspection at dry port will be additional responsibility of the Contractor up to Engineer's satisfaction.

SP-11.2 Material Orders

Triplicate copies of material or equipment orders required in this Contract shall be furnished to the Engineer. All orders shall state the specification designation under which the material is to be furnished and shall bear reference to the drawing number, if any, pertinent thereto. Orders shall also state that material is subject to inspection and testing and shall show the required date of delivery of the material to destination.

SP-11.3 Acceptance of Materials

The acceptance of any material or equipment prior to shipment shall in no way relieve the Contractor of any of his responsibilities for meeting all of the requirements of the specifications and shall not prevent subsequent rejection if such material or equipment is later found to be defective.

SP-11.4 Damages, During Transportation, Storage and Installation

The Contractor shall be responsible for any damage of the Equipment/ material during transportation to site, storage and until satisfactory handling over the works. The Contractor shall replace any damaged

equipment/ materials at his own cost.

SP-12 NAMEPLATES

The Contractor shall provide and attach to each major piece of equipment, a metal name and rating plate to be approved by the Engineer, giving the name and address of the manufacturer, the date and rating data. All ratings shall be in the British system. Large lettering on any of the parts will not be permitted. All ratings shall be in the unit system adopted for the project, unless otherwise authorized by the Engineer.

SP-13 DIRECTED AND REQUIRED ETC.

Unless otherwise stated, wherever in the Specifications or upon the Drawings the words, "directed", "required", "permitted", "ordered", "designated", "prescribed" or words of like import are used, it shall be understood that the direction, requirement, permission, order, designation, or prescription of the Engineer is intended, and similarly the words "approved", "accepted", "satisfactory", or words of like import shall mean approved by, or acceptable or satisfactory to the Engineer unless otherwise indicated.

SP-14 SEQUENCE OF ERECTION

The sequence of erection of the Equipment shall conform to the requirements of the civil construction and of the Erection Instructions. Such information will be furnished to the Contractor by the Engineer upon request.

SP-15 FABRICATION, ERECTION, TESTING AND MAINTENANCE TOOLS PLANT & INSTRUMENTS

SP-15.1 The Contractor shall furnish special plant and tools for the complete and proper fabrication erection and maintenance tools, plant and instruments of the HVAC Equipment. Tools shall include the type of tools not normally available in the market as standard tools and is generally manufactured especially for use with the HVAC Equipment. All lifting devices shall be accurately machined to fit the parts to be handled. The wrenches and tools for maintenance, insofar as practicable, shall be mounted on a suitable hardwood or steel board arranged for wall mounting and provided with means for ready identification. The Contractor shall also provide refrigerant charging Plant if and when required. No separate payment shall be made for providing Plant and Tools and the Contractor may withdraw the Plant and Tools after its use.

SP-15.2 The Contractor shall furnish and install sign board showing information about the project, name of Employer, Engineer and the Contractor, as directed by the Engineer.

SP-16 MATERIALS AND EQUIPMENT TO BE IMPORTED

Imported materials and equipment, whether procured from local market or imported especially for this project by the Contractor shall include, but not limited to the items listed hereunder. The Engineer may however issue a Variation later for use of locally fabricated item, if he is satisfied that specified requirements will be met.

a. Water Cooled Chiller
b. Hot Water Generator (HWG)
c. Cooling Tower
d. Air Handling Units
e. Condensing Units
f. Fan Coil Units
g. Energy Recovery Ventilators
h. Pumps
i. Plume Fans for Bio-safety cabinets
j. Exhaust and Supply Fans
k. MS Seamless Pipes (Schedules 40) Fittings & Specialties
l. Valves & Specialties
m. Automatic Controls
n. Instruments & Gauges
o. Piping Expansion Joints & Flexible Connectors
p. Vibration Isolators for split air conditioning units, fans, chillers, pumps etc. when specified.
q. Insulation, Sound Liners, Tapes, Sealants and Adhesives for Ducts, and Pipes
r. Electrical Circuit Breakers, Contactors, Relays, Indications and Measuring Instruments for Electrical Panels
s. Testing & Balancing Instruments
t. Chemical Feeders & Chemicals

SP-17 ERECTION SUPERVISORS AND OPERATING STAFF

SP-17.1 General

The Contractor shall provide the services of Erection Supervisors and Operating Staff in accordance with the requirements of the Conditions of Contract, of sub-clause SP-02.2 Services by the Contractor, and as specified herein

SP-17.2 Work by Erection Supervisor

a) The Erection Supervisor shall direct the activities of Contractor's employees as they concern the installation, commissioning balancing and testing of the Equipment furnished under this Contract. The Contractor through his Erection Supervisor shall cooperate with other Contractors to whatever extent is necessary to produce an installation satisfactory to the Engineer in accordance with the requirements of the time schedule, the Drawings and the

Specifications.

b) Erection Supervisor shall be present from the Commencement of Work and remain on Site until the substantial completion.

c) Should a disagreement arise between other Contractors and the Erection Supervisor, the matter shall be submitted without delay to the Engineer for his decision. Upon such decision, the Erection Supervisor shall proceed with the work in accordance therewith, immediately.

d) Erection Supervisor shall be a graduate HVAC or mechanical engineer, registered with Pakistan Engineering Council, having at least 5-6 years experience in HVAC installation works of similar nature.

e) If the Contractor fails to fulfill his obligations under clause SP-02.2(a) and also fails to provide the Services of the Erection Supervisor having the minimum qualifications as stated in sub-clause (d) of this Clause then the Contractor would be obligated to pay to the Employer an amount of Rs.1500 per day for the number of days when the services of such Erection Supervisor are not provided. The Employer would be entitled to deduct the amount due from the Contractor in this regard from his running Bill/any payable sums.

f) Provision of (e) above shall not apply when the Erection Supervisor is on authorized legal leave (casual), sick leave and official holidays only. His absence up to a period of ten (10) days will also be allowed when the contractor intends to replace the Erection Supervisor with the consent of the Engineer.

SP-17.3 Operating Staff

The Contractor shall provide staff to operate the HVAC system continuously for twenty four (24) hours a day during the one year Defect Liability Period and whenever the HVAC facilities required. Operating supervisor shall be a graduate HVAC or mechanical engineer, registered with Pakistan Engineering Council having at least five (05) years experience in HVAC operation of similar plant or a three (03) year diploma holder from Government College of Technology in HVAC Technology having at least ten (10) years experience of similar plants with DDC controls. The Contractor shall also arrange to provide proper training to Employer's staff to operate the HVAC system to the entire satisfaction of the Employer. All costs incidental to providing operating staff including staff salaries shall be deemed to be included in relevant item of Schedule of Prices. No separate payment shall be made to the Contractor for fulfillment of his obligations under this clause.

SP-18 RIGHT TO OPERATE PLANT

The Employer reserves the right to operate any and all Equipment after it has been Commissioned and prior to substantial completion of whole Works. All repairs or alterations found to be necessary during such operation, and required of the Contractor, shall be made by the Contractor at such time as directed by the Engineer. The repairs or alterations shall be made in such a manner and at such a time as will cause the minimum interruption in the use of the Equipment by the Employer.

SP-19 ERECTION INSTRUCTIONS

Erection Instructions in form of published installation manual, as furnished by the manufacturer regarding all applicable HVAC equipment listed here under shall be provided by the Contractor.

1. Centrifugal Type Water Cooled Chiller
2. Air Handling Units
3. Condensing Units
4. Fan Coil Units
5. Energy Recovery Ventilators
6. Pumps
7. Fans
8. Plume Fans
9. Expansion Tank
10. Air Separator
11. Automatic Controls System
12. Chemical Feeder
13. Cooling Tower
14. Fan Coil Units
15. Major Components of Electrical Panels
16. Instruments & Gauges

These instructions shall include full and detailed instructions for the guidance of the Erection Supervisor as to all procedures and precautions to be observed in erecting, assembling and adjusting the Equipment and as to the use of the Erection Plant. It shall include or be accompanied by drawings, clearly showing erection marking and particularly any matchmaking and shall embody in particular a full statement as to erection tolerances to be observed.

These shall also include full instructions for the maintenance of the Equipment not only during the period of Contractor's liability but more particularly during its operating life. The directions shall be set out simply, clearly and systematically. In particular this section shall include a full list of all routine checks and their timing, directions as to fault finding, detail of all routine attentions (such as greasing), in the form of check sheets for daily, weekly, monthly, quarterly, half-yearly, yearly and any other periodic checks recommended by the manufacturer. This section should also

provide detailed and complete instructions for trouble shooting, maintenance and all necessary adjustments to the Equipment Technical leaflets and brochures in respect of all equipment supplied under the Contract including all relays, instruments, switches, controllers, regulators etc., should be supplied with the erection instruction. This should also include complete catalogue of spare parts with exploded views of the equipment and relevant part numbers to facilitate identification and ordering of spares throughout the operating life of the Equipment.

The Contractor shall submit 3 copies to the Engineer for approval.

SP-20 WATER, POWER AND GAS DURING ERECTION AND TESTING

Water and power supply for Erection and Preliminary Tests shall be the responsibility of the Contractor. Water, power and gas supply for Balancing & Commissioning Performance Tests and Reliability Trial Tests and operation during Defects Liability Period will be provided by the Employer.

SP-21 SPARE PARTS

The Contractor shall furnish spare parts as per list given in the sub-clauses of Technical Provisions of relevant equipment. The Contractor shall also furnish recommended spare parts with the recommendation of manufacturer of equipment. The spare parts listed shall serve all Equipment furnished.

The Contractor shall also furnish recommended spare parts selected by the Employer at the applicable unit rates, from the lists provided by the Bidders. Payment for recommended spare parts will be made from the amount set out in Schedule of Prices against respective items. The spare parts listed shall serve all Equipment furnished.

These spare parts shall not be used during Defects Liability Period, or earlier.

The Contractor shall supply, at his own cost any spare parts required during the Defects Liability Period.

SP-22 DEFECTS LIABILITY PERIOD

The Contractor shall operate service and maintain complete HVAC System for a period of three hundred and sixty five (365) days after date of issuance of Certificate of Substantial Completion. The plant shall be operated in accordance with provisions of Clause SP-02.2(b), SP-17.3 and as specified herein, and shall include supply of operating staff, consumables, all necessary adjustments, greasing, oiling and cleaning and the furnishing of necessary tools, instruments supplies and parts to keep the system in perfect operation, except such parts made necessary by misuse or neglect not caused by the Contractor.

The cost of operating the plant during Defects Liability Period shall be paid by the Employer to the Contractor under Schedule of prices item named "HVAC System Operation during Defects Liability Period As specified".

SP-23 APPROVAL FROM GOVERNMENT

The Contractor shall arrange and be responsible for all tests, test reports and approvals regarding electrical works under this contract, any other works under this Contract requiring tests/Government approvals. All the requirements to be completed for this purpose, whether specified or not shall be at the cost of the Contractor. The Contractor shall handover all test results and approval certificates to the Engineer within one week of obtaining such approval.

SP-24 PERFORMANCE GUARANTEE

The Contractor shall be required to furnish a Performance Guarantee in accordance with Conditions of Contract.

SP-25 SITE FACILITIES

Except for the Site facilities specifically stated in Conditions of Contract and/or Special Provisions, no other site facility shall be provided by the Employer to the Contractor.

SP-26 SUFFICIENCY OF RATES AND CURRENCY FOR PAYMENT

All rates and amounts filled in the SOP by the Contractor for equipment/material whether locally procured or imported shall be deemed to include, but not limited to, the cost of items, custom duties, sales tax and surcharges, freight, marine insurance, local duties, sales tax and surcharges, clearance charges, inland transport and insurance, octroi, L/C opening charges, bank charges, etc. Payments to the Contractor shall be made in local currency.

SP-27 IMPORT LICENSE

The Contractor will arrange the import licenses if required for all the imported Equipment, Plant, Tools and Machinery to be incorporated in permanent works. All the costs and charges for arranging import licenses will be paid by the Contractor. The Contractor shall be responsible to arrange foreign exchange for import of all equipment and materials.

SP-28 GUARANTEES AND WARRANTIES

SP-28.1 Performance Guarantee

The contractor shall guarantee the performance of the complete HVAC system, viz.-a viz. his workmanship for the work executed at site, and

quality of material, as specified. He shall replace the material/workmanship, whenever found not meeting the specified requirements, at his own cost.

SP-28.2 Manufacturer's Warranties

The contractor shall obtain manufacturer's standard warranties for all equipment extended for a period up to completion of Defects Liability Period at his own cost. In case the completion of Defects Liability Period is delayed, the contractor should obtain further extension of warranties. The contractor shall be responsible for cost of such extension, if the delay is due to his fault, otherwise the cost of such extension shall be reimbursed to him on production of acceptable documentary evidence of such costs.

SP-29 PACKING OF EQUIPMENT AND MATERIALS

All equipment and material shall be adequately packed at the manufacturer's works to protect them against damage, scratching, corrosion, dust, rain and moisture during handling, transportation and storage. The packaging shall be rigid enough to withstand normal service incidental to shipping and handling. Wherever necessary, crates/boxes shall be provided with lifting hooks attached by means of vertical rods or plates to strong bottom supports to enable rigging.

The following information shall appear inside all packages:

a) Stock or Identification Number
b) Description of Contents & Packing List
c) Quantity of Each Item
d) Invoice Number
e) Year of Manufacture

SP-30 INSPECTIONS AND TESTS

SP-30.1 Inspection by Engineer at Site

The Engineer shall inspect the works in progress at site as and when considered necessary by the Engineer and the Contractor shall provide full access and assistance to the Engineer for carrying out inspection to verify the conformity of works to general lay-out of HVAC System as designed and as shown on Drawings and as specified. Such inspection if made shall not relieve the Contractor from any obligations under the Contract.

SP-30.2 Tests

A) General

i) All Tests as specified shall be carried out unless otherwise

specified. The Engineer shall witness the tests.

ii) The Contractor shall give the Engineer at least seven days notice in writing of the date on which any equipment will be ready for inspection and/or testing as provided in the Specifications and unless the Engineer shall attend within seven days of the date which the Contractor has stated in his notice the Contractor may proceed with the tests in the Engineers absence and shall forthwith forward to the Engineer five duly certified copies of test readings, on the forms prescribed by the Engineer. The Engineer shall give twenty four hours notice in writing of his intention to attend any test.

iii) The Contractor shall provide all labour, materials, electricity, fuel, stores, apparatus machines and instruments as may be necessary to carry out tests, unless otherwise specified.

iv) The cost of all tests carried out by the contractor under this Clause shall be borne by the Contractor if such tests are clearly intended by or provided for in the Specifications or Schedule of Prices.

v) As and when any equipment or HVAC System or part thereof shall have passed any inspection/test the Engineer shall furnish to the Contractor a certificate in writing to that effect.

vi) The Engineer may reject any part or parts of Equipment, and HVAC System which he shall after inspection/ testing decide is not in accordance with the Specifications and Drawings and he shall give to the Contractor within fourteen (14) days of such inspection/ testing notice in writing of such rejection stating therein the grounds upon which his decision is based.

vii) The test results shall be filled out by the Contractor in the forms proposed by the Contractor and approved by the Engineer. Six copies of filled out forms shall be submitted to the Engineer for review and approval.

B) Once the inspection/test certificate has been obtained by the contractor, as stated in A (v) above, the contractor shall test and balance the system in accordance with NEBB (National Environmental Balancing Bureau), USA, code of practices. The Contractor shall be responsible for all remedial measures if any, required. The Contractor shall be responsible for the following.

Supply and fixing of any test hole covers, paint, gauges, gadgets, testing and balancing instruments, or any such thing which is

necessary to carry out this work.

To provide all supervision, labour and materials required to carry out these balancing works.

C) Preliminary Inspection & Tests

Preliminary Inspection/Tests as specified in Technical Specifications shall be carried out on all or any major HVAC equipment and such other equipment as the Engineer may require, on completion of installation of that equipment or at such time which the Engineer may require.

D) Balancing & Commissioning

Balancing and Commissioning shall be carried out on all or any major equipment, as Specified in Technical Specifications, when such is ready for operation. The Engineer must witness the Balancing and Commissioning procedures and Contractor shall proceed further after Engineer's written satisfactory approval.

E) Performance Tests

These tests as specified in Technical Provisions shall be carried out on each equipment of HVAC system after successful completion of Commissioning of that equipment, during appropriate season, on the dates proposed by the Contractor and approved by the Engineer. The Engineer keeping in view the weather conditions may fix the test date on any equipment of HVAC system within 6 months of Completion of Commissioning of that equipment.

F) Reliability Trial Tests

i) During the Defects Liability Period the Contractor shall inform the Engineer in writing of his readiness to commence the Reliability Trial Test of HVAC System or part thereof. Cooling or Heating Tests shall be carried in appropriate season and the Engineer shall, within fourteen (14) days of receipt of such information shall forward his consent for commencement of Reliability Trial Test as specified in Technical Specifications, after having satisfied that all the requirements for such Tests have been completed.

ii) If any Reliability Trial Test be not fulfilled to the satisfaction of the Engineer, such test shall be repeated at such time as the Engineer.

TECHNICAL PROVISIONS

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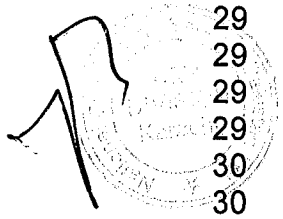

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SECIFICATIONS

TECHNICAL PROVISIONS

SECTION 1 - GENERAL REQUIREMENTS

1-01 MATERIAL

All materials shall be of the highest grade, free from defects and imperfections, of recent manufacture and unused, and of the classification and grades designated, conforming to the requirements of the latest issue of the appropriate specifications cited herein. All materials, supplies, and articles forming part of major equipment and not fabricated by the manufacturer of the equipment shall be the products of the recognized reputable manufacturers.

1-02 WORKMANSHIP

Workmanship and general finish shall be of the highest grade, in accordance with the requirements specified herein, and the best modern standard practice.

1-03 EQUIPMENT

a) For ratings and characteristics of manufactured equipment, Equipment Schedule as appended to Technical Provisions shall be followed.

b) All equipment shall be manufactured by companies, which have had at least ten years previous experience in the design and manufacture of equipment of comparable type, capacity and operating conditions. Unless otherwise approved by the Engineer.

c) Where the requirement of this Clause make any equipment proprietary or non-obtainable, the Engineer reserves the right to waive any portion or portions of it as required to obtain the intent of the technical specifications (s).

d) When a manufacturer's product is specified by name, or equivalent, it shall be in the sole judgment of the Engineer as to acceptability of any product, which is offered as equal to that specified.

e) Where two or more units of the same class of equipment are furnished, product of the same manufacturers shall be used: component parts of entire system need not be product of same manufacturer.

1-04 CHASSES AND OPENINGS

The Contractor shall provide shop drawings, templates or details for chases and openings to be left in concrete walls, concrete partitions, and floor or roof slabs to accommodate work under HVAC scope of works.

1-05 PROTECTION

The Contractor shall keep pipe, duct and other openings closed to prevent entry of foreign matter. All fixtures, equipment and apparatus shall be covered and protected against dirt, water, chemical or mechanical damage, before and during

the construction period. All fixtures, apparatus, or equipment damaged including damaged shop coats of paint shall be restored to original conditions prior to Commissioning and also again prior to Final Acceptance. All bright finished shafts bearing housings and similar items shall be protected until in service: no rust will be permitted.

1-06 CUTTING, PATCHING AND REPAIRING

Required for proper installation and completion of HVAC works, including masonry work, concrete work, carpentry work, painting and re-painting shall be performed by skilled craftsmen in respective trades, at expense of the Contractor. Construction shall be cut only after obtaining written permission from the Engineer.

1-07 LINES, LEVELS AND SPACES

The Contractor shall check dimensions at the building site and establish lines and levels for work specified in Specifications. The Contractor shall check with work of other trades to ensure proper clearance of piping, ductwork, conduit and other items. Any deviations observed between drawings and actual construction shall be brought to the notice of the Engineer. The erection supervisor shall regularly inspect, during progress of civil works, the areas allocated for installation of HVAC equipment and any conflict observed shall immediately be reported to the Engineer.

1-08 MACHINERY GUARDS

All moving parts of machinery are to be protected by strong guards to adequately protect all personnel working on or in the vicinity of equipment.

Wherever possible, moving parts should be protected by guards supplied by the equipment manufacturer. All guards must be strongly attached to equipment and should be designed for easy removal for access, servicing, adjustment and maintenance.

1-09 TOOLS

The Contractor shall supply in a toolbox, full sets of tools suitable for maintenance of all components of the plant furnished by him including the electrical equipment, for use by the Employer after completion of Maintenance Period. List of Tools shall be subject to approval by the Engineer.

1-10 OIL AND GREASES

The oils and greases shall be supplied in sealed containers. These shall be of suitable quality sufficient for the initial charge plus hundred percent (100%) extra. The quantity, grade of oil and greases and their manufacturer shall be approved by the Engineer the extra oils and greases shall be reserved for use by the Employer after completion of Defects Liability Period.

1-11 SPARE PARTS

The spare parts for HVAC System shall be duplicates of the original parts with same country of origin furnished and interchangeable therewith.

1-12 ACOUSTIC TREATMENT

The noise criteria for different areas stated in Special Provisions is to be obtained.

Sound measurements will be made at approximately five (5) feet above floor level in the occupied area served and not more than five (5) feet from the grills, diffusers or other air devices being tested. Instruments for sound measurement shall be provided by the Contractor.

Provision is to be made to minimize noise and vibration. However, different manufacturers equipment have varying sound and vibration characteristics and it is, therefore, the responsibility of the Contractor to ensure that the requirements in these specifications are fully met by the equipment he is offering. If the Contractor has any requirements for additional vibration or sound isolation, these must be incorporated into the price quoted.

All equipment installed should not be audible inside the occupied areas and the Contractor must ensure that all equipment he is offering is quiet and have satisfactory sound levels. Where silencers are required, these must be incorporated into the price quoted.

1-13 ACCESS PANELS

The Contractor shall mark locations of, and give sizes of, access panels required in false ceiling and wall paneling for adjustment and maintenance of HVAC Equipment, such as Dampers, Fire Dampers, valves, ceiling-hung equipment, etc. This information shall be provided to the Engineer before commencement of false ceiling work by the concerned persons.

1-14 SEALING OF OPENINGS

The contractor shall seal all openings in external walls and roof where HVAC ducts/pipes penetrate in external membrane. The sealing shall be air tight to prevent penetration of outside air and water into building. The method and materials for sealing shall be subject to Engineer's approval.

SECTION 2 – EQUIPMENT

2-01 GENERAL

All equipment shall be of such overall dimensions, operating weights, service area requirements and configuration that it can be located where shown on the plans without any adverse effect on its performance and clearance requirements. Any change in other trades work, anticipated by offering alternate equipment, shall be estimated by the Contractor and its cost shall be included in the quoted price for HVAC Works.

Provision for clearance and service spaces shall be made around all mechanical equipment as recommended by equipment manufacturers.

All equipment supplied under this section shall be brand-new, factory manufactured and factory assembled (unless otherwise specified) and complete in all respects. The type, characteristics, capacity ratings, component sections of all equipment shall be as Scheduled.

All equipment furnished by the Contractor shall include vibration isolation mounting pads, anchor bolts, frames or any other mounting or supporting accessories.

All power driven equipment shall include drives, motors and adjustable motor foundation bases and accessories including machinery guards where applicable.

All equipment shall be completed with all accessories necessary to serve the intended purpose, whether specified or not.

All equipment installed on roof or intermediate floors shall include suitable vibration isolators to prevent any vibration traveling to building structure.

2-02 WATER COOLED CENTRIFUGAL CHILLER (EUROVENT/AHRI CERTIFIED)

2-02.1 General

Each unit shall be completely factory-packaged including evaporator, unit mounted VFD, harmonic filter, condenser, sub-cooler, compressor, open or Semi-hermetic motor, lubrication system, microprocessor control center and all interconnecting unit piping and wiring. The chiller will be painted prior to shipment. Each machine shall be suitable for installation in the spaces provided and spring vibration isolators supplied by the manufacturer of chiller shall be included.

Performance will be certified in accordance with ARI Standard 550/590 Latest Standards. Only chillers that are listed in the ARI/EUROVENT Certification Program for Centrifugal Water Chillers are acceptable.

The Chillers should be of high Energy Efficiency model of latest series not less than 0.585 KW/TR on full load. The Chillers should be factory charged with Ecological Refrigerant. The Chiller shall be equipped with harmonic filter and should be of low noise type and shall have acoustic optional items.

The initial charge of refrigerant and oil will be supplied, shipped in containers and cylinders for field installation or factory charged in the chiller.

2-02.2 Compressor

The compressor will be a single/dual -stage centrifugal type powered by an open-drive or semi- hermetic type electric motor. The housing will be fully accessible with vertical circular joints, with the complete operating assembly removable from the compressor and scroll housing. The rotor assembly will consist of a heat-treated alloy steel drive shaft and impeller shaft with cast aluminum. The impeller will be designed for balanced thrust, dynamically balanced and over speed tested for smooth, vibration-free operation. Insert-type journal and thrust bearings shall be used which conforms to AGMA Standards.

Capacity control will be achieved by use of pre-rotation vanes to provide fully modulating control from maximum to minimum load. The unit will be capable of operating with lower temperature cooling tower water during part-load operation in accordance with ARI Standard 550/590.

2.02.3 Lubrication System

Lubrication oil shall be force-fed to all compressor bearings, gears, and rotating surfaces by an external variable speed oil pump. The oil pump shall vary oil flow to the compressor based on operating and stand-by conditions, ensuring adequate lubrication at all times. Compressor shall have an auxiliary reservoir to provide lubrication during coast down in the event of a power failure.

Oil shall be filtered by an externally mounted ½ micron replaceable cartridge oil filter equipped with service valves. Oil cooling shall be done via a refrigerant cooled oil cooler, with all piping factory installed. Oil side of the oil cooler shall be provided with service valves. An automatic oil return system to recover any oil that may have migrated to the evaporator shall be provided. Oil piping shall be completely factory installed and tested.

2.02.4 Motor Driveline

The compressor motor will be an open drip-proof or semi-hermetic design, squirrel cage, induction type operating at 2975 RPM.

The open motor shall be provided with a D-flange, bolted to a cast iron adapter mounted on the compressor to allow the motor to be rigidly coupled to the compressor to provide factory alignment of motor and compressor shafts.

Motor drive shaft will be directly connected to the compressor shaft with a flexible disc coupling. Coupling will have all metal construction with no wearing parts to assure long life, and no lubrication requirements to provide low maintenance. Semi – hermetic motor shall be suitable for operation in a refrigerant cooled atmosphere cooled by atomized refrigerant in contact with motor winding.

Starter shall be unit mounted type for units utilizing remote electro-mechanical starters, a large steel terminal box with gasketed front access cover will be provided for field connected conduit. Overload/overcurrent transformers will be furnished with all units.

2-02.5 Evaporator

The evaporator shall be of flooded shell and tube type with refrigerant in shell and water in tube. The water tubes shall be replaceable type. Construction shall conform to the applicable ASME Code for unfired pressure vessels; it shall be made of carbon steel with inner rifled copper pipes, with water differential pressure switch, air bleed valve, water discharge cock, Victaulic type water connections and insulation of closed cell expanded polyurethane rubber with anti U.V. protection layer. The seamless tubes shall be of copper. The evaporator shall be provided with at-least 1 inch thick of closed cell foam insulation and 20 gauge steel jacket.

The assembled coils shall be pressure tested at 10.5 bar.

2-02.6 Condenser

Coils shall be water cooled and chiller shall be of flooded shell and tube with refrigerant in shell and water in tube. The water tube shall be replaceable fabricated of copper pipes. The condenser shall have a safety valve for protection against refrigerant access pressure. The tubes shall be cleaned, dehydrated and sealed. The assembled condenser tubes shall be pressure tested at 10.5 bar.

Tubes shall be individually replaceable from either end of the heat exchanger without affecting the strength and durability of the tube sheet and without causing leakage in adjacent tubes.

2.02.7 Refrigerant Flow Control

Refrigerant flow to the evaporator will be controlled by a variable orifice or float type metering valve to maintain proper liquid refrigerant level in evaporator and for improving unloading capabilities.

2.02.8 Compressor Motor Starter

A variable speed drive will be factory installed on the chiller. It will vary the compressor motor speed by controlling the frequency and voltage of the electrical power to the motor. The adaptive capacity control logic shall automatically adjust motor speed and compressor pre-rotation vane position independently for maximum part-load efficiency by analyzing information fed to it by sensors located throughout the chiller.

Drive will be PWM type utilizing IGBT's with a power factor of 0.95 or better at all loads and speeds.

The variable speed drive will be unit mounted in a NEMA 1 enclosure with all power and control wiring between the drive and chiller factory installed, including power to the chiller oil pump. Field power wiring shall be a single point connection and electrical lugs for incoming power wiring will be provided. The entire chiller package will be UL listed.

VSD shall have a short circuit interrupt and withstand rating of at least 100,000 amps.

The following features will be provided:

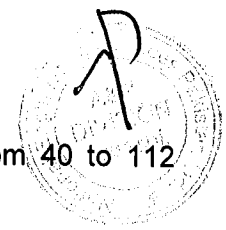
- Door interlocked circuit breaker capable of being padlocked.
- UL listed ground fault protection.
- Over voltage and under voltage protection.
- 3-phase sensing motor over current protection.
- Single phase protection.
- Insensitive to phase rotation.
- Over temperature protection.
- Digital readout at the chiller unit control panel of output frequency, output voltage, 3-phase output current, input Kilowatts and Kilowatt-hours, self-diagnostic service parameters. Separate meters for this information will not be acceptable.
- KW Meter - The unit's input power consumption will be measured and displayed digitally via the unit's control panel. The KW meter accuracy is typically +/- 3% of reading. KW meter scale is 0 - 788 KW .
- KWh Meter – The unit's cumulative input power consumption is measured and displayed digitally via the unit's control panel. The KWh meter is resetable and it's accuracy is typically +/- 3% of reading. KWh meter scale is 0 – 999,999 kWh.
- Ammeter – Simultaneous three-phase true RMS digital readout via the unit control panel. Three current transformers provide isolated sensing. The ammeter accuracy is typically +/- 3% of readming. Ammeter scale is 0 - 545 A RMS .
- Voltmeter – Simultaneous three-phase true RMS digital readout via the unit control panel. The voltmeter accuracy is typically +/- 3% of reading. Voltmeter scale is 0 – 670 VAC.
- Elapsed Time Meter – Digital readout of the unit's elapsed running time (0 – 876,600 hours, resetable) is displayed via the unit control panel.

2-02.9 Refrigerant Monitor

Provide calibrated, refrigerant monitor for specific refrigerant used, capable of detecting concentrations of 10 ppm for low level detection. Provide monitor with audible and visual alarms that activate at a valve corresponding to the TL V of the refrigerants in use. The alarm system shall annunciate visual and audible alarms inside the machinery room and outside each entrance to the room. Monitor shall have the capability of detecting, alarming and controlling from 0-50 ppm. Digital display accuracy shall be within one (1) ppm.

Monitor shall require only minimum maintenance.

a) Recalibrate no more than once every five (5) years.
b) Re-zeroing no more than once every week.



Monitor shall be capable of operation in ambient temperatures from 40 to 112 degrees F.

2-02.10 Pump Out System

Units shall be provided with a separate pump-out system for each machine.

Pump-out systems shall be complete with transfer pump, condensing unit, and tank constructed in accordance with ASME Code for Unfired Pressure Vessels bearing the National Board stamp. Pump-out systems shall be supplied and warranted by the chiller manufacturer.

2-02.11 Microprocessor Controller

General:

The chiller shall be controlled by a stand-alone microprocessor based control center. The chiller control panel shall provide control of chiller operation and monitoring of chiller sensors, actuators, relays and switches.

Control panel:

The control panel shall include a diagonal color liquid crystal display (LCD) surrounded by "soft " keys which are redefined based on the screen displayed at that time. This shall be mounted in the middle of a keypad interface and installed in a locked enclosure. The screen shall detail all operations and parameters, using a graphical representation of the chiller and its major components. Panel verbiage shall be available in other languages as an option with English always available. Data shall be displayed in either English or Metric units. Smart Freeze Point Protection shall run the chiller at 36.00 °F leaving chilled water temperature, and not have nuisance trips on low water temperature. The sophisticated program and sensor shall monitor the chiller water temperature to prevent freeze up. The panel shall display countdown timer messages so the operator knows when functions are starting and stopping. Every programmable point shall have a pop-up screen with the allowable ranges, so that the chiller cannot be programmed to operate outside of its design limits.

The chiller control panel shall also provide:

1. System operating information including:

   - return and leaving chilled water temperature
   - return and leaving condenser water temperature
   - evaporator and condenser saturation temperature
   - differential oil pressure
   - percent motor current
   - evaporator and condenser saturation temperature
   - compressor discharge temperature
   - oil reservoir temperature
   - compressor thrust bearing positioning and oil temperature
   - operating hours
   - number of compressor starts

2. Digital programming of set points through the universal keypad including:

   - leaving chilled water temperature
   - percent current limit
   - pull-down demand limiting
   - six-week schedule for starting and stopping the chiller, pumps and tower
   - remote reset temperature range

3. Status messages indicating:

   - system ready to start

- system running
- system coastdown
- system safety shutdown-manual restart
- system cycling shutdown-auto restart
- system prelube
- start inhibit

4. The text displayed within the system status and system details field shall be displayed as a color coded message to indicate severity: red for safety fault, orange for cycling faults, yellow for warnings, and green for normal messages.

5. Safety shutdowns enunciated through the display and the status bar, and consist of system status, system details, day, time, cause of shutdown, and type of restart required. Safety shutdowns with a fixed speed drive shall include:

- evaporator – low pressure
- evaporator – transducer or leaving liquid probe
- evaporator – transducer or temperature sensor
- condenser – high pressure contacts open
- condenser – high pressure
- condenser – pressure transducer out of range
- auxiliary safety – contacts closed
- discharge – high temperature
- discharge – low temperature
- oil – high temperature
- oil – low differential pressure
- oil – high differential pressure
- oil – sump pressure transducer out of range
- oil – differential pressure calibration
- oil – variable speed pump – pressure setpoint not achieved
- control panel – power failure
- motor or starter – current imbalance
- thrust bearing – proximity probe clearance
- thrust bearing - proximity probe out – of – range
- thrust bearing – high oil temperature
- thrust bearing – oil temperature sensor
- watchdog – software reboot

5.1 Safety shutdowns with a VSD Shall include:

- VSD shutdown – requesting fault data
- VSD – stop contacts open
- VSD – 105% motor current overload
- VSD – high phase A, B,C inverter heatsink temp.
- VSD – high converter heatsink temperature

6. Cycling shutdowns enunciated through the display and the status bar, and consists of system status, system details, day, time, cause of shutdown, and type of restart required. Cycling shutdowns with a fixed speed drive shall include:

- multiunit cycling – contacts open
- system cycling - contacts open
- oil – low temperature differential
- oil – low temperature
- control panel - power failure
- leaving chilled liquid - low temperature
- leaving chilled liquid - flow switch open
- motor controller – contacts open
- motor controller – loss of current
- power fault
- control panel - schedule
- starter – low supply line voltage
- starter – high supply line voltage
- proximity probe – low supply voltage
- oil - variable speed pump - drive contacts open

6.1 Cycling shutdowns with a VSD shall include:

- VSD shutdown – requesting fault data
- VSD – stop contacts open
- VSD initialization failed
- VSD - high phase A,B,C instantaneous current
- VSD – phase A,B,C gate driver
- VSD – single phase input power
- VSD – high DC bus voltage
- VSD – pre charge DC bus voltage imbalance
- VSD – high internal ambient temperature
- VSD – invalid current scale selection
- VSD – low phase A, B, C inverter heatsink temp.
- VSD – low converter heatsink temperature
- VSD – pre-charge - low DC bus voltage
- VSD – logic board processor
- VSD – run signal
- VSD – serial communications

7. Security access to prevent unauthorized change of setpoints, to allow local or remote control of the chiller, and to allow manual operation of the prerotation vanes and oil pump. Access shall be through ID and password recognition, which is defined by three different levels of user competence: view, operator, and service.

8. Trending data with the ability to customize points of once every second to once every hour. The panel shall trend up to 6 different parameters from a list of over 140, without the need of an external monitoring system.

9. The operating program stored in non-volatile memory (EPROM) to eliminate reprogramming the chiller due to AC power failure or battery discharge. Programmed setpoints shall be retained in lithium battery-backed RTC memory for a minimum of 11 years with power removed from the system.

10. A fused connection through a transformer in the compressor motor starter to provide individual over-current protected power for all controls.

11. A numbered terminal strip for all required field interlock wiring.

12. An RS-232 port to output all system operating data, shutdown / cycling message, and a record of the last 10 cycling or safety shutdowns to a field-supplied printer. Data logs to a printer at a set programmable interval. This data can be preprogrammed to print from 1minute to 1day.

13. The capability to interface with a BMS to provide:

- remote chiller start and stop
- remote leaving chiller liquid temperature adjust
- remote current limit setpoint adjust
- remote ready to start contacts
- safety shutdown contacts
- cycling shutdown contacts
- run contacts

The controller shall be integrated with BMS on open protocols, preferably BACnet over IP, thorough local area network (LAN). For this purpose, LAN port (RJ-45) shall be available in controller.

14. Safeties

a. Unit shall be equipped with thermistors and/or potentiometers and all necessary components in conjunction with the control system to provide the unit with the following protections:

1. Loss of refrigerant charge protection.
2. Low water flow detection.
3. Low chilled water temperature protection.
4. Low and high superheat protection.
5. Low control voltage (to unit) protection.
6. Visual alarm signal (alarm light)
7. High-pressure switch
8. Low oil protection for each compressor circuit.
9. Ground current compressor protection.

b. Compressors shall be equipped with the following manual- reset type protections:

1. Pressure overload.
2. Electrical overload through the use of definite-purpose contactors and calibrated, ambient compensated, magnetic trip circuit breakers. Circuit breakers shall open all 3 phases in the event of an overload in any one phase (single-phasing condition).

c. Fan motors shall have inherent overcurrent protection.

15. Diagnostics

a. Diagnostic display module shall be capable of indicating the safety lockout condition by displaying a code for which an explanation may be scrolled at the display. Display module shall be capable of indicating the

tripping of protections through display of 2-digit code, for which a legend shall be provided in control panel. Information included for display shall be:

1. Compressor lockout.
2. Loss of charge.
3. Low water flow.
4. Low oil pressure
5. Cooler freeze protection
6. High or low suction superheat
7. Thermistor, transducer, or potentiometer malfunction.
8. Entering-and leaving-water temperature.
9. Evaporator and condenser pressure.
10. Electronic expansion valve positions.
11. All set points
12. Time of day

b. Module in conjunction with the microprocessor must also be capable of displaying the output (results) of a run test to verify operation of every switch, thermistor, potentiometer, fan, and compressor before chiller is started.

c. Provide serial output port.

2.02.12 Motors

Compressor motors shall be cooled by suction gas passing around motor windings.

Condenser-fan motors shall be 3-phase type with permanently lubricated bearings and Class F insulation.

2.02.13 Electrical Requirements

Unit primary electrical power supply (3 Phase) shall be connected to a single power source location.

Unit control power (1 Phase) shall be connected to a separate entry point.

Unit shall be shipped with factory control and power wiring installed.

2-02.14 Special Features

a. Shell-and-tube type, direct expansion.
b. Tubes shall be internally enhanced seamless-copper type rolled into tube sheets.
c. Shell shall be insulated with 1" (25.40 mm) PVC foam (closed-cell) with a maximum K factor of 0.28.
d. Cooler shall be rested and stamped in accordance with ASME Code for a refrigerant working side pressure of 220 psig (1517 kPa). Cooler shall have a maximum water-side pressure of 300 psig (2068 kPa).
e. Cooler shall be provided with a factory-installed flow switch.
f. Water/humidity proof casing for chiller export
g. Separate storage tank (ASME certified) and pump out units to be included
h. Voltage/current, above/under load protection

i. Unit mounted single point power connection with circuit breaker.
j. Factory mounted transformer for control unit supply.
k. Power factor correction.
l. Units with magneto thermic switches for protecting compressors
m. Units shall be with intercept valve on the compressor inlet
n. Power factor correction capacitors
o. RS 485 serial interface for communication with building automation, centralized systems and supervision networks
p. Harmonic Filter

2-02.15 Essential Spares for Chillers

Sr. No.	Spare Parts	Qty.
1	Electronic Expansion Valve	1 No.
2	Solenoid Valve	3 No.
3	Filter Drier Core	3 No.
4	Electronic Expansion Valve Control Board	1 No.
5	Electronic Expansion Valve Cable	1 No.
6	Electronic Expansion Valve Display Board	1 No.
7	Vision Controller Board	1 No.
8	Vision Controller Cable	1 No.
9	Pressure Transmitter	2 No.
10	Temperature Sensor	3 No.
11	Timer	2 No.

2-03 HOT WATER GENERATORS

2-03.1 General

The hot water generator shall be dual fuel (Natural Gas & Diesel) fire forced draft type, with capacity as shown in Equipment Schedule and Drawings. The hot water generator shall be constructed of welded steel upper and lower headers connected with a high capacity down flow legs. Flexible water tubes or fire tubes having 12 gauge thickness formed in 4 pass serpentine design shall be push fitted to the headers. All tubes can be replaceable without any welding and rolling involved through the front access panel. The entire tube area can also be easily accessible for cleaning through front access panel. HWG shall be certified by latest ASME boiler and pressure vessel code.

2-03.2 Trim

The H.W.G. term shall consist of, but not be limited to, the following items:

- Low water cutoff.
- ASME rated relief valve.
- Automatic gas valve.
- Shut off controls in case of failure of ignition.
- Water temperature controls to regulate burner operation.

2-03.3 Heating Surface

H.W.G. shall be rated not less than 5 Square feet of heating surface per rated

H.W.G. horsepower. H.W.G. shall be complete package ready for field installation.

2-03.4 Burner & Accessories

1 burner complete with control box
1 Electronic ignition controller
1 Ignition electrode
1 Ignition transformer
1 Pressure switch
1 Working regulation gas valve
1 Safety valve
1 Pressure regulator with filter
1 Diesel pump
1 Hot water generator Operating and Maintenance Manual

2-03.5 Fuel Supply System and Safety Arrangement

Fuel valve shall be motorized remote controlled, spring loaded to close automatically in the event of power failure. The train shall include manual shut-off valve, pressure regulator, and manifold pressure gauge.

2-03.6 Controls

H.W.G. controls shall be suitable for intermittent start-stop operation of H.W.G. as the H.W.G. will not be operating 24 hours a day.

The HWG shall have an interface for integration with BMS on open protocols like BACNET, LONWORKS and MODBUS etc. The interface shall be used for monitoring and control of HWG through BMS. All the status/alarm conditions and parameters available through built-in control/HMI shall also be available for remote monitoring/Control through BMS.

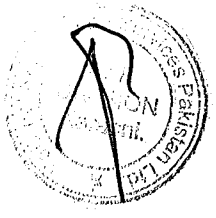
2-03.7 Flue Collar

H.W.G. shall have flue collar for connection to Bracing with structural angle flange and bolts.

2-03.8 Control Panel

The control panel shall be factory fabricated supplied by the manufacturer of H.W.G., mounted on the H.W.G. panel shall include, but not be limited to:

- 240v control circuits
- Hot water generator on/off Switch
- Power ON indication light
- Burner Control Programmer
- Regulation thermostat 55-85°C
- Safety thermostat 100°C
- Water thermometer 0-120°C
- Flue gas thermometer 50-350°C
- Feed Water Pump Switch
- Panel Indicator Lights
- Provision of control interface for integration with BMS



2-03.9 Breaching Flue Stack

The Contractor shall provide welded steel breaching/ stack for size and configuration as required and as per recommendations of the manufacturer. Fabrication shall be by welding using no less than 6mm thick plate conforming to ASTM A36 or A283. Structural angle flanges for breaching and H.W.G. connection shall be provided. Stack shall be terminated as shown on the Drawings.

2-03.10 Spare Parts for Hot Water Generator

Following spare parts shall be provided as a minimum along with the spares recommended by the Manufacturer.

No.	Spare Parts	Quantity
1.	Pressure Gauge	2 No.
2.	Draft diverter	1 No.
3.	100% shut-off pilot controls	1 Set
4.	Secondary Automatic safety valve quick closing	1 No.
5.	Pressure regulator	1 No.
6.	ASME rated hot water relief valve	1 No.
7.	Low water alarm bell with mute switch	1 No.
8.	Operating thermostat	1 No.
9.	High limit thermostat with manual reset	1 No.
10.	Automatic fuel valve	1 No.
11.	Electronic low water cut-off	1 No.
12.	Temperature indicator	1 No.
13.	Burners spare parts as recommended by the manufacturer	1 Lot
14.	Gaskets	1 Lot
15.	Control transformers	1 No.

2-04 CHEMICAL FEEDER AND CHEMICALS

2-04.1 Chilled/Hot Water Chemical Feeder

The Contractor shall provide chemical feeder for chilled/hot water system. Gravity Bypass Feeders shall be installed at the pumps as shown on Drawings. Gravity Bypass Feeder shall be complete with necessary valves. Make of Feeder shall be subject to Engineer's Approval.

2-04.2 Condenser Water Chemical Feeder

The Contractor shall provide chemical feeding system comprising of electrically operated pump with manual start/stop button and suitable piping system with necessary number of drums to feed various types of chemicals required for the treatment of condenser water system. The make of chemicals and its feeding system shall be subject to Engineer's approval.

2.04.3 Chemicals

Sufficient chemicals for Preliminary Tests, Balancing Commissioning and Reliability Trial Tests and Operation during Maintenance Period shall be included.

In addition to the above, sufficient quantities of chemical for further one year operation shall be handed over to the Employer at the expiry of Maintenance Period.

2.04.3.1 Chemicals for Chilled/Hot Water

The quantities of chemicals shall be based on system volume stated in Expansion Tank schedule and 104 weeks with 24 hours & 7 days a week operation. Over and above chemicals for initial and passive doze of 2 weeks shall also be supplied.

2.04.3.2 Chemicals for Condenser Water

The quantities of chemicals shall be based on system volume with 6 days a week & 12 hours operation for 58 weeks. Make-up quantity shall be calculated on 80% average load. Over and above chemicals for initial and passive doze of 2 weeks shall also be supplied. Sufficient chemicals, as described in Clause 2-03.3.1 shall be furnished.

2-05 EXPANSION TANK

Expansion tanks shall be horizontal diaphragm type for ceiling suspension, designed, fabricated, tested, inspected and stamped as per ASME Code for Unfired Pressure Vessels, (Design pressure rating shall be 150 PSIG maximum). The expansion tank shall be selected for maximum operating temperature for various applications. Tank shall be fitted with refrigeration type sight glass, sight glass valves, air release fitting in bottom of tank incorporating air tube, hose and bottom drain.

2-06 AIR SEPARATORS

The Contractor shall supply and install centrifugal air separators for chilled water and hot water piping as shown on drawings. Air separator shall be of cylindrical design, vertical, with inlet, outlet, drain and expansion tank connection. It shall be designed fabricated, tested, inspected for 150 PSIG maximum water operating pressure, for required system flow rates.

2-07 PUMPS

2.07.1 General

Before placing order for pumps the Contractor shall check the total required dynamic head for the System with equipment actually proposed by the Contractor and approved by the Engineer. The dynamic head may be different than Scheduled value due to Contractors proposed equipment. The contractor shall submit the total head calculation for actual pipe circuit and equipment selection for Engineer's approval. No compensation will be paid to the Contractor, if actual head requirements are above the schedule values.

Pumps shall be of type as specified in Equipment Schedule with casings designed for working pressure at least one and a half times the total pressure on the casing. Flange connections shall correspond to casing working pressure.

Certified test curves of pump performance shall be furnished for approval showing horsepower, total dynamic head and efficiency versus water flow.

Each pump shall be driven by a variable speed motor with VFD through a flexible coupling. Motor horsepower shall be selected in a way that the motor shall not be overloaded at any point on the characteristic curve when operating at design speed.

Each pump shall be guaranteed to circulate not less than the quantity of water against the required circulating head when operating continuously, without overheating the motor or bearings, etc. Pumps shall not transmit vibration to the building and shall operate without producing noise, audible anywhere in the building, outside the space in which the pumps are installed. Flexible connections shall be provided at pump suction and discharge.

Pumps shall have stainless steel shaft and mechanical seals.

Pumps and motor shall be mounted on common base frame and shall have been factory aligned. Specifications for electric motors shall be as given under Section – 7 "Electrical Equipment and Controls".

The motor make, country of origin and model no. shall be identified during technical submission and shall be from manufacture's best ranking make, most efficient and shall be included in manufacturer's scope of standard. For further details on motors refer Clause # 7-04 of Technical Provisions.

2-07.2 Essential Spares for Pumps

No.	Spare Parts	Quantity
1.	Bearings	02 for each type of pump
2.	Mechanical Seal	04 for each type of pump

2-08 MEDICAL GRADE AIR HANDLING UNITS (EUROVENT/AHRI CERTIFIED FOR MECHANICAL STRENGTH & PERFORMANCE)

2-08.1 General

The characteristics and capacities of air handling units shall be as scheduled. The configuration of component sections shall be as scheduled and as shown on Drawings. All AHUs shall complete with drives, motors, and belts. These shall include mixing box with dampers, filters and humidifiers when scheduled. Filter specifications are given separately in this section.

AHUs shall be of imported origin as mentioned in equipment schedule or list of approved equipment/material or approved by the Engineer.

For purpose of calculation of motor BHP, specified external SP and AHU manufacturer's internal SP should be added. Filter pressure drop shall be part of internal SP, which shall be calculated on average of clean (initial) and filter manufacture-recommended dirty (final) pressure drop. Published recommendation of filter manufacturer shall be furnished along with technical submittal. In case published recommendation is not available, a recommendation on the printed stationery of filter manufacturer shall be acceptable provided the manufacturer certified that no such published data is available. Motor HP shall be at least 120% of calculated BHP.

The EUROVENT certified air handling units shall meet the requirements of ARI 430-86 and ASHRAE 51-85 standards and shall be factory tested according to the requirements of these standards. The minimum mechanical strength standards for AHUs as per Eurovent certification are as follows;

1- Casing Mechanical Strength (D1)
2- Casing Leakage (L1/L2)
3- Thermal Transmittance (T2)
4- Thermal Bridge Factor (TB2)
5- Bag Filter Leakage Pass (F9)

The (EFF3, TEFC, CLASS F Insulated, VFD Compatible) motors make, country of origin and model no. shall be identified during technical submission and shall be from manufacture's best ranking make, most efficient and shall be included in manufacturer's scope of standard.

Cleaning methodology, general arrangement and dimension of the AHU including location of doors and/or hatches shall be including in the Installation and Operation Manual of the product.

2-08.2 Construction

These shall be factory assembled draw-through packaged air handling unit of capacities and characteristics as scheduled. Air handling units shall be horizontal or vertical with component and configuration as scheduled and shown on the drawings.

Large AHUs may be shipped in sections e.g. Fan Coil Section, filter section, mixing box section for ease of transportation and rigging.

AHRI Certified (AHRI 410-91) Coils shall be of copper construction with mechanically bonded smooth aluminum fins, suitable for chilled water and hot water applications.

Fan shall be high efficiency (Airfoil/ Backward Curved) mounted on a common shaft. Fan impeller shall be statically and dynamically balanced and shall have permanently lubricated bearings. Fan shall be belt driven with adjustable sheaves. Fan shall have spring isolation from the casing. All fans shall be in accordance with AMCA 210 Standard for performance.

Casing shall be made of sheet steel and finished with baked enamel. (Or approved by the Engineer) The casing shall be double skin with minimum 1-1/2 inch thermal insulation between the skins and removable panel type. AHU shall be equipped with factory fabricated filters and filter boxes with side access door.

The medical grade AHUs shall have inner surfaces of stainless steel. Before coating with the stainless steel, an antibacterial silicon sealant is applied to the unit to prevent water leakage to the bottom part. The unit shall be coated with antimicrobial powder.

All coil bases and sledges shall be made of Cr-Ni stainless steel.

All AHUs shall be supplied with factory built in VFD and compatible motor.

A condensate drain pan, with double wall construction and insulation in between,

shall be provided as per ASHRAE 62.1-2010. Inner pan shall be finished with a factory applied coating of corrosion resistant material. Insulation, adhesive and inner coatings shall comply with NFPA-90A Standard.

Flat filters installed in Air Handling Units, shall be permanent, impingement, dry type, washable, all metal, panel type, at least 2 inch thick unless otherwise scheduled. Media shall be aluminum screen, arranged in alternate layers of flat and herringbone-crimp, 4 layers of each per one inch reinforced and enclosed in a frame of 16 gauge galvanized steel with flush mitered corners. Initial pressure drop at 500 FPM shall not exceed 0.1 inch WG. Holding frame shall be factory-built of 16 gauge steel; with felt air seal. Filters shall have at least 35% efficiency on 0-5 microns range when tested in accordance with ASHRAE Standard 52-76.

Bag filter in AHUs shall be extended surface dry type non-supported pocket, cartridge filter. Average efficiency shall not be less than 90% when tested as per ASHRAE standard 52. Initial resistance at 500 FPM shall not exceed ½ inch.

Steam humidifiers of capacity as per equipment schedule shall be of self-contained, electronically controlled design suitable for installation in AHUs. Humidifier shall generate steam from ordinary tap water. It shall have full modulating control to provide 0 to 100% capacity. Drain cycle will be self-regulating for automatic control of mineral (conductivity) build-up. Humidifier shall have programmed diagnostics to confirm that input and output circuits are functioning. The humidifier steam generator shall be of cleanable type which can be taken apart for inspection. The electronic circuit shall provide automatic protection from excessive electrode current. The humidifier fill water line shall have an air gap to prevent backflow. Humidifier shall have interface for BMS integration and control. It shall be supplied with stainless steel steam dispersion tube and with condensate connections.

2-08.3 Cross Flow Plate Type Heat Exchanger for Air Handling Units

2-08.3.1 General

Air handling units shall be provided with Plate Heat Exchanger/ Pipe type heat recovery section to conserve the energy. The heat recovery section shall have sufficient size to accommodate the proper heat exchange in between exhaust air and outside air.

Air-to-Air Energy Recovery Heat Pipes to be supplied by Plate Heat Type to exchange heat/cooling between two air streams for heat or cooling recovery. The heat pipes shall be inside and integral to the equipment cabinet. Drain pans are required and to be provided by equipment manufacturer. Heat Pipe circuits comprise multiple tubes connected in series, end-to-end. The heat pipe circuits shall be suitable to attain greater recovery in cooling mode with appreciable recovery in heating mode.

Energy recovery heat pipes shall be tested and certified by AHRI or EUROVENT certification.

2-08.3.2 Heat Pipe Coils

The tubes shall be 3/8" or 5/8" OD copper, of specific design for Heat Pipe application, permanently expanded onto the fin collar to form a firm, rigid, and complete pressure contact at all operating conditions. Aluminum tubes will not be

allowed.

The fin surface shall be continuous plate type aluminum fins of specific design to produce maximum heat transfer effectiveness for heat pipe applications. Air side pressure loss shall be as scheduled. Fin density and the number of rows of tubes shall be selected to comply the scheduled parameters.

Heat transfer fluid shall be classified as Safety Group A1 in ASHRAE Standard 34-2013.

Heat pipe capacities, entering and leaving dry and wet bulb temperatures, and face velocity shall be as specified in schedule.

The frames and mounting structure shall be of minimum 16 gauge galvanized. The supply and exhaust air streams shall be isolated from each other by a double separating partition. Cross contamination between the air streams is not acceptable.

Heat pipe circuitry shall be as specified by Heat Plate Type design. Each circuit shall be individually processed, charged and hermetically sealed.

Scheduled effectiveness or heat recovery shall be met at a minimum and total pressure drop shall not be exceeded. The resulting Recovery Efficiency Ratio (RER), shall therefore be met at a minimum.

2-08.4 Spare Parts for Air Handling Units

Following spare parts shall be provided as a minimum along with the spares recommended by the Manufacturer.

No.	Spare Parts	Quantity
1.	Fan Belts	01 set for each AHU type
2.	Mechanical Seal	01 set for each AHU type
3.	Motors	01 for each AHU type
4.	Contactor	01 No. for each AHU type
5.	Contactor Thermal Overload	01 No. for each AHU type

2-09 AIR COOLED CONDENSING UNITS FOR AIR HANDLING UNITS

The condensing unit shall be of the vertical/horizontal discharge, air cooled type, suitable for outdoor installation and sized to deliver the required capacity matched to relevant DX-type indoor AHUs at specified ambient temperature. The condensing unit shall be of reversible type and shall be suitable for operation at 46°C ambient temperature conditions.

The unit casing shall be constructed from galvanized sheet steel, coated with zinc phosphate and with a stove enamel finish. All access panels and the unit casing shall be provided with thermal and acoustic insulation. All moving components such as compressors and condenser fan motors shall be anti-vibration mounted to minimize the transmission of vibration and noise.

Condenser coils shall be made of seamless copper tubes mechanically expanded into aluminum fins.

Epoxy coated coils used in corrosive and or salt range environments which handle fresh air. The Fins should be hydrophilic blue fin which can pass 500 hrs Salt spray test.

Condenser fans shall be of direct drive, statically and dynamically balanced propeller type. Weatherproof fan motors suitable for outdoor use, permanently lubricated and provided with built-in thermal overload protection shall be used. Fans shall be mounted on rubber vibration dampers. All condensing units shall be weatherproof and capable of operating satisfactorily at high and low outdoor temperatures at full load.

Hermetically sealed scroll compressors shall be fitted with internal and external shock absorbers to minimize vibration and noise transmission. The compressor shall be fitted with a discharge line silencer and charged with the required quantity of oil for adequate lubrication circulated by means of an internal oil pump.

Internal overload protection located in the motor windings shall be provided.

The units shall be complete with ASTM B280 refrigerant piping & insulation and all necessary valves and filter drier from the unit to the air cooler. Suction and discharge pipes shall be equipped with pipe vibration dampers. Condensing units shall be factory pressure tested, evacuated and dehydrated.

The units shall be installed on steel brackets of adequate strength fixed to the walls with expansion bolts or on concrete foundation on roof as shown on the drawings.

A condenser unit which is capable to interface with BMS.

2-09.1 Spare Parts for Air Cooled Condensing Units

Following spare parts shall be provided as a minimum along with the spares recommended by the Manufacturer.

No.	Spare Parts	Quantity
1.	Fan Motor	01 No.
2.	Propeller Fan	01 No.

2-10 COOLING TOWERS (CTI/JCI CERTIFIED)

The cooling tower(s) shall be of type, characteristics and capacity as scheduled in Equipment Schedules. It shall be double or single flow as scheduled. Packaged type, induced draft cross flow, low noise (maximum 72 DB at 5 feet from fan discharge) square vertical discharge cooling tower with PVC internal piping and shipped in knocked down condition for field assembly.

All the material used for the cooling tower shall be suitable for use in coastal areas outside installations.

The tower shall be heavy duty type designed to provide more wetted surface for uniform water distribution and higher heat transfer rate.

The casing shall be of fiberglass (FRP) construction suitable for salty/corrosive environments with all frame members bolts, nuts, washers and steel shall be

galvanized. Louvers may be integral with fill.

Hot water distribution basin shall have non-ferrous diffusing type metering orifices.

The PVC louvers, fill and eliminators shall be self extinguishing for fire resistance and shall be impervious to rot, decay, fungus or biological attack. Eliminators shall ensure entrainment of moisture in air and drift loss of less than 0.1% of the total water circulated. Stainless steel positioning rods shall be provided for holding & keeping the fill in correct position.

Fans shall have die cast aluminum blades with fine finish and anti corrosive parts as suitable. Blades shall be adjustable and individually attached to the hub. Fans shall be belt driven. Fan motors and drive shall be heavy duty type suitable for cooling tower applications at salty/corrosive environments. Temperature sensor shall be provided in the cold water basin to set the motor to low or high speed.

Float operated make-up valve and sump complete with suction screen and anti-cavitations device shall be provided.

The Cooling Tower shall be supplied complete with galvanized steel access ladder for safe access to fan deck and access door for access to inside of tower. Galvanized steel handrails, knee rails, toe board and heavy gauge galvanized wire mesh fan guard shall be provided around tower perimeter. The anti vibration spring isolators shall be included in cooling tower manufacturers scope of supply. The cooling tower controls shall be compatible with HVAC Controls.

The motor make, country of origin and model no. shall be identified during technical submission and shall be from manufacture's best ranking make, most efficient and shall be included in manufacturer's scope of standard. The motor shall be capable of operating at minimum ambient temperature of 46°C. The efficiency class of motor shall be minimum IE3 type. For further details on motors refer Clause # 7-04 of Technical Provisions.

2.10.1 Spare Parts for Cooling Towers

Following spare parts shall be provided as a minimum along with the spares recommended by the Manufacturer.

No.	Spare Parts	Quantity
1.	Fan Assembly (Complete)	01 No. for each size
2.	Fan Motor	01 No. for each size
3.	Driver Belts	04 Nos. for each Size
4.	Showering Nozzles (if applicable)	20 Nos.

2-11 FAN COIL UNITS

Fan coil units shall be of capacity and characteristics as scheduled and shown on the drawings. All FCUs shall be of make and country of manufacture similar to AHUs unless otherwise approved by the Engineer.

Unit shall be of blow-through design and shall be wall mounted/ceiling-hung type/concealed type/cassette type as scheduled complete with combination hot/chilled water coil, motor(s), fan(s) and drain pan. The unit shall have one or more quiet operating centrifugal fans directly connected to extend motor shafts.

Motor fan assembly shall be easily detachable from coil section. The coil and drain pan shall be readily reversible. The coil shall be supplied with drains and vent cocks so located as to permit drain and vent of coil regardless of position. The fan and motor assembly shall be readily removable and shall be provided with a quick disconnect on the motor chord.

Unit motor shall be of capacitor run type with at least three speeds of operation. Motors shall be equipped with oil cups for lubrication with the oil cups located for easy accessibility.

Fan coil rating shall be such that after considering room effect, the sound level shall not exceed NC rating specified in special provision in second through 8th octave band. Calculation of sound pressure level shall be submitted by the Contractor to the Engineer for his approval.

Filters installed in FCU (if scheduled) shall be permanent impingement dry type, washable all metal, penal type at least ½ inch thick. Media shall be aluminum clean arranged in alternate layers of flat and herring bone- crimp, reinforced and enclosed in a 16 gauge G.I. Frame with flush mitered corners. Initial pressure drop at 500 FPS shall not exceed 0.05 inch WG. FCU thermostat shall be digital type with LCD display of room temperature. FCU controls shall be preferably supplied by the manufacturer. In case Contractor recommend controller in Control System refer to Chapter # 8. The FCU controller shall be LCD wired type install at wall of the room.

2-11.1 Spare Parts for Fan Coil Units

Following spare parts shall be provided as a minimum along with the spares recommended by the Manufacturer.

No.	Spare Parts	Quantity
1.	Room Thermostats	02 Nos. for each FCU type
2.	Fans	01 No. for each FCU type
3.	Motors	01 No. for each FCU type

2-12 FILTERS OTHER THAN INSTALLED IN FILTER BOXES OF AHUs

Filters shall be permanent, impingement, dry type, washable, all metal, panel type, at least 2 inch thick, unless otherwise scheduled. Media shall be aluminum screen, arranged in alternate layers of flat and herringbone- crimp, 4 layers of each per 1 inch reinforced and enclosed in a frame of 16 gauge galvanized steel with flush mitered corners. Pressure drop at 500 FPM shall not exceed 0.12 inch WG Holding frames shall be factory- built of 16 gauge steel; with felt air seal. Filters to be installed with return air grilles shall be ½ inch thick.

Filters shall have at least 25% efficiency (85% arrestance) on 0.5 microns range when tested in accordance with ASHRAE Standard 52-76.

2-13 FANS

2-13.1 General

These specifications are for all fans other than fitted inside AHUs and/or FCUs. The characteristics and capacity of all fans be as schedule.

All fans shall have been rated and certified as per AMCA standards or ASHRAE standard 51-75 or equivalent. Wheels shall be heavily rigidly constructed and accurately balanced both statically and dynamically, and be free from objectionable vibration or noises. Actual brake horsepower of fan and drive shall not exceed nameplate rating of motor driving fan. Motor shall be included.

All fans shall be such suitable for outdoor use in salty and corrosive environment.

2-13.2 Propeller Fans

Propeller fans shall be direct driven type complete with motor, angle iron frame, back draft dampers and mounting accessories. Blades shall be of steel and factory adjusted for pitch. Blades of back draft damper shall have a link rod and the design shall be such that damper remains in full open position without rattling when the fan is operating.

In case no false ceiling is available at site, plastic body fans are provided.

2-13.3 Tube Axial Fans

These shall be axial flow, duct mounted, circular in shape of characteristics and capacities as scheduled. Fans shall be direct or belt driven as scheduled. Fan motors above 1/2 HP shall be 3-phase induction type and 1/2 HP or smaller shall be single phase split-capacitor. Motors for direct drive fans shall be mounted within fan casing and impeller attached to the motor shaft end. The fan casing shall have flanges with holes for connection to duct work. Fans shall be complete with mounting frames, bolts and accessories, as required.

2-13.4 Centrifugal Fans

These shall be forward curve or back-wardly curved air-foil fan as scheduled, complete with housing, motors, drive equipment, supports, vibration isolators and inertia bases of slide rails as required and as scheduled. Shaft shall be cold drawn, hot rolled or forged steel ground to close tolerances for perfect bearing fit and shall be provided with keys and keyways for impeller hubs and fan pulleys.

Housing shall be heavy gauge steel suitably braced to provide stiffness to housing and rigid supports for bearings. Fan blades shall be continuously welded to back plate.

All bearing shall be cast pillow block, ball or roller bearings, self-aligning type. Bearings shall be selected for 60,000 hours minimum life based on continuous operation at operating fan RPM.

Fan outlet shall be equipped with removable angles and bolts for attaching canvas or other flexible connections. Fan housing shall be provided with access panels and drain plugs.

Centrifugal fans shall be designed to have weatherproof construction and should be suitable for exposed installation.

For the stair case pressurization roof supply type fans shall be employed as specified in the equipment schedule and drawings. Motors of such fans shall be of

Class H type. For fans used as stair case pressurization the motor shall be class H type with VFD.

2-13.5 In Line Centrifugal Fans

These shall be centrifugal in line type, of characteristics and capacities as Scheduled. Fans shall be belt driven as Scheduled. Fan motors above 1/2 HP shall be 3-phase induction type and 1/2 HP or smaller shall be single phase split capacitor. Motors for direct drive fans shall be mounted within fan casing and centrifugal impeller attached to the motor shaft end. Motors for belt driven fans shall be mounted on fan casing. Motor base shall be adjustable type with pivot at one end for easy and accurate belt adjustment. The fan inlet shall have an aerodynamic design to ensure turbulence free airflow at discharge. Centrifugal impeller blades shall be backward inclined or aerofoil type. Fan casing and impeller shall be made of heavy gauge steel. Impeller shall be dynamically balanced and shall have cast iron hub. The fan bearings shall be self-aligning ball bearing type. Fan shall have an inner cylinder and belt duct to protect bearings and drive from the air system. Fan motor and drive shall have weatherproof cover. A bolted access shall be provided in the fan casing for cleaning and inspection. The fan casing shall have flanges with holes for connection to ductwork. Fans shall be complete with mounting frames, brackets for ceiling suspension, bolts and accessories, including belt guard and spring vibration isolators as required.

2-14 HIGH PLUME FANS FOR BIOSAFETY LABORATORIES

All materials shall meet or exceed all applicable referenced standards and conform to codes. Base fan performance at standard conditions (density 0.075 Lb/ft3). Fans shall be capable of accommodating static pressure and flow variations of +/- 15 percent of scheduled values. The completely assembled fan shall be tested to meet the vibration limits as published in AMCA 204. Equip each fan with fan inlet isolation damper to prevent the fan from turning in reverse rotation when the fan is off. Equip fans with stainless steel lifting lugs for corrosion resistance.

When a powder coating process is used on fan and plenum, the coating shall be minimum thickness of 3 mils. Finish color shall be light gray.

Fasteners exposed to corrosive exhaust shall be Type 304 or Type 316 stainless steel. I. Fan assembly shall be designed for a minimum of 125-mph side wind loading, without the use of guide wires.

2-14.1 Centrifugal High Plume Exhaust Fans

Fans shall be configured as belt driven or direct drive. Fans mounted on top of exhaust air plenums or are not accessible from the roof shall be equipped with jib cranes (complete with removal hoist), for motor maintenance and removal.

Fan, plenum and dampers shall be coated with a minimum of 3 mils of Plastifer epoxy ES90- AS81, or Hi-Pro Polyester resin coatings. Finish color shall be light gray.

Fan assemblies that use flexible connectors that can fail and cause loss of laboratory containment are not acceptable. Inlet elbow/plenum shall be attached to the fan inlet by a high strength, corrosion resistant flexible connector, or vibration isolation pad or gasket, provided by the fan manufacturer.

2-14.2 Mixed Flow High Plume Exhaust Fans

Mixed flow steel case fans shall be direct driven or belt driven. Fans systems shall be equipped with jib crane (complete with removal hoist), for motor maintenance and removal.

Fan, plenum and dampers shall be coated with a minimum of 4-6 mils of Plastifer epoxy ES90- AS81, Hi-Pro Polyester resin or Amercoat 90HS Epoxy-phenolic coatings. Finish color shall be light gray.

2-14.3 Fan Housings and Outlet

Fan housings shall be aerodynamically designed with high-efficiency inlet, engineered to reduce incoming air turbulence.

Steel fan housings shall be centrifugal involute scroll, allowing all drive components including the motor to be serviced without contact of the contaminated air stream, and manufactured of welded steel coated with a minimum of 3 mils of Hi-Pro Polyester resin, electrostatically applied and baked. Finish color shall be gray. No uncoated metal fan parts exposed to the exhaust will be acceptable.

Fiberglass reinforced plastic (FRP) fan housings shall be manufactured in specifically formulated resins, for maximum corrosion resistance, UV inhibited and reinforced with fiberglass for structural strength. Fastening bolts holding the casing to the support plate are to be encapsulated in FRP. Finish color shall be light gray.

Fan to be supplied with a graphite liner and grounding strap to remove static electricity, as well as a flame retarding capacity of 25 or less, if required. Fiberglass reinforced plastic fan housings that are fabricated shall have mechanical strength and toughness properties equivalent to steel housings, interior surfaces shall be smooth to assure corrosive or hazardous compounds cannot collect, and / or chalk and structurally degrade. Having smooth interior surfaces will also reduce collection of biological contaminants.

Centrifugal fans shall be equipped with access doors shaped to conform to the housing scroll with quick opening latches and gaskets.

A steel or fiberglass reinforced plastic discharge nozzle shall be supplied by the fan manufacturer, and shall be designed to efficiently handle an outlet velocity of up to 7000 FPM. The discharge nozzle shall include either bifurcated section or a discharge section surrounded with a wind band to induce ambient air.

A drain shall be designed as an integral part of the centrifugal fan housing to drain rainwater when the fan is de-energized.

Supply a bolted and gasketed access door for impeller inspection and service.

2-14.4 Fan Impellers

2-14.4.1 Centrifugal Type

Fan impeller for centrifugal fans shall use backward inclined or airfoil blade design wheel with non-stall characteristics. The impeller for either wheel design shall be electronically balanced, both statically and dynamically meeting or exceeding

Grade 6.3 per AMCA Standards.

Fan impeller shall be manufactured of welded and coated steel with a minimum of 3 mils of Hi-Pro Polyester resin, or 4-6 mils of Plastifer epoxy ES90-AS81 with a finish color of light gray.

2-14.4.2 Mixed Flow Type

Fan impeller for vertical inline fan shall use a combination axial / backward curve blade design wheel with non-stall characteristics. Stationary discharge guide vanes located above the impeller shall be provided to increase fan efficiencies. The impeller for either wheel design shall be electronically balanced, both statically and dynamically meeting or exceeding as per AMCA Standards.

Fan impeller shall be manufactured of welded and coated steel with a minimum of 3 mils of baked Hi-Pro Polyester resin or 4 mils Epoxy-phenolic coatings. Finish color shall be light gray.

2-14.5 Exhaust Air Plenum Curbs

For a constant volume exhaust system, the fan/nozzle assembly shall be connected directly to roof or roof curb and exhaust duct without need for a bypass air plenum.

For a variable volume exhaust system, a bypass air plenum shall be provided as shown on Drawings. The plenum shall be provided with stainless steel modulating opposed blade bypass air damper(s) for introducing outside air at roof level upstream of the fan, complete with bypass air rain hood and bird screen. The actuator(s) to operate the bypass damper are to be supplied by the building automation system (BAS) Provider.

A parallel blade fan tight shutoff isolation damper, two position actuated, fabricated of stainless steel, shall be provided as shown on the Project documents. Isolation damper shall include a factory mounted and wired actuator; complete with a mounted and wired step down transformer, wired to the fan disconnect. Transformer shall be mounted in a NEMA 3R panel, minimum, or as shown on the Drawings. The isolation damper precludes reverse rotation of the fan wheel when the fan is not energized.

The plenum shall be constructed of welded cold rolled steel, and coated with minimum 3 mils of Hi-Pro Polyester resin or Epoxy-phenolic coatings.

Plenums that are fabricated of plastics or resin that are combustible and have mechanical properties less than steel shall not be acceptable.

The bypass air plenum shall be mounted on factory fabricated roof curb provided by the fan manufacturer, as shown on the Drawings

Fan designs that use inlet flexible connectors that can leak causing loss of lab exhaust shall not be permitted.

Blower / Plenum vibration isolation shall be limited to neoprene/cork vibration pads

Exhaust system manufacturer shall supply a structural support curb for the plenum, of specified height, as shown on the Drawings.

Curb shall be fabricated of a minimum of 12 gage corrosion resistant coated steel and structurally reinforced.

Vertical exhaust inlet plenums shall have curbs that are insulated. Horizontal exhaust inlet plenums shall have un-insulated plenums.

The plenum shall have integral drain connections to drain water that may condense on the inner wall of the plenum.

When properly anchored to the roof structure, the standard curb / plenum / blower assembly shall withstand wind loads of up to 125 mph without additional structural support.

2-14.6 Fan Motors and Drives

Motors shall be premium efficiency, standard NEMA frame, TEFC, and compatible with variable frequency drives as scheduled. Provide a factory mounted NEMA 3R disconnect switch, mounted and wired, for each fan.

Direct drive arrangement, utilizing a direct mount coupling connecting the motor shaft and fan impeller shaft.

Exhaust fan systems with direct drive where the fan wheel is connected directly to the shaft of the motor, will require a tight shut-off isolation damper at the fan inlet to allow the fan to be removed for motor replacement. Fan shaft shall be Type 316 stainless steel.

Belt drive arrangement, Drive belts and sheaves shall be sized for 200 percent of the fan operating brake horsepower, and shall be readily and easily accessible for service. Fan shaft shall be 316 stainless steel or ANSI C-1045 steel and be protected with TECTYL protective coating. If the fan is not scheduled to be operating in conjunction with a variable frequency drive, then include an additional set of drives for each fan to be used for final adjustments. After correct speed has been determined with variable sheave, provide fixed sheaves.

Belt Guard: All belt drives shall be furnished with belt guards. Fabricate to SMACNA Low Pressure Duct Construction Standards; of 12 gage 3/4-inch diamond mesh wire screen welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short circuiting vibration isolation, with provision for adjustment of belt tension, lubrication, and use of tachometer with guard in place.

Fan shaft bearing(s) shall have a key-way, and shall be milled and machine polished, Type 316 stainless steel.

Mechanical shaft seals are to be either neoprene or Teflon (but only when required).

Fan shaft bearings shall be ball or roller pillow block type and be sized for a requirement of L-10 life of no less than 200,000 hours. Bearing(s) shall have extended lube injection lines Zerk grease fittings and lube relief lines with caps.

Motor, coupling, and bearing shall all be outside the contaminated exhaust air pathway.

2-15 FUEL OIL SYSTEM

2-15.1 General

Fuel oil system shall include the following:

a. 2 Nos. (01 Working & 01 Standby) Oil Lift Pumps (Fuel Oil Pumps) for lifting oil from underground main oil storage tank towards day storage tank located in Plant Room.
b. 2 Nos. Oil Feed Circulating Pumps.
c. Complete valves as shown on drawings.
d. Complete accessories as shown on drawings.
e. Oil piping.
f. Main Storage Tank(s) (underground) and Day Tank(s).

The oil piping schematic including accessories as shown on drawings are indicative only. The supply & installation of all oil pipe work including oil pumps & accessories shall be carried out as per schematic diagram provided by the manufacturer of chiller-heater.

2-15.2 Main Oil Storage and Day Tank

Oil Storage and Day tanks of welded steel construction, including but not limited to:

a. Main storage tank(s)
b. Day tank(s)
c. Tank foundation
d. Tank accessories
e. Any other work for the proper functioning of the works.

2-15.3 Applicable Codes and Standards

ASME SECTION VIII Boiler and Pressure Vessel

ANSI-B.16.5 Steel Pipe Flanges and Flanged Fittings.

API 650 Welded Steel Tanks for Oil Storage

ACI 318 Building Code Requirements for Reinforced Concrete.

AWS D1.1 Structural Welding Code.

AISC Specifications for the Design, Fabrication and Erection of Structural Steel for Buildings.

ASTM-A36 Structural Steel

ASTM-A53 Pipe, Steel, Black and Hot-dipped, Zinc Coated, Welded and Seamless.

ASTM-A240 Heat Resisting Chromium and Chromium - Nickel Stainless Steel Plates.

ASTM-A297 Corrosion resistant Iron Chromium, Iron Chromium Nickel, and Nickel-base Alloy castings for General Application.

ASTM-A522 Fittings, Valves and Parts for Low Temperature Service.

ASTM-A573 Structural Carbon Steel Plates of Improved Toughness

2-15.4 Performance and Design Criteria

The tank shall be designed in accordance with the requirements of ASME SECTION VIII and Standard 650 of American Petroleum Institute (API) or equivalent as approved by the Engineer. A corrosion allowance of 0.8 mm (1/32 inch) shall be made in the designed thickness of all components of the tank.

2-15.5 Materials of Fabrication

The tank shall be fabricated from steel plates conforming to ASTM Standard for specified capacities. The structural sections shall also conform to ASTM. The stresses in the steel plates and sections under normal operating conditions shall not exceed as permissible in API 650 & AISC, respectively.

Internal pipes, ladders, bolts, etc. shall conform to ASTM A511. The weld joint efficiency shall be taken as 90 percent.

2-15.6 Tank Foundation

The tanks shell shall be supported on a reinforced concrete designed in accordance with the applicable provisions of ACI Code.

2-15.7 Pipe Work

All pipelines, valves, insulation pieces, fittings and appurtenances including the following:

- The filling inlet main connection flange with valves, drives, fittings, etc.

- The suction outlet main, complete with valves, fittings etc

- The return main complete with valves, fittings etc

- The drain pipes and vent system complete with valves and fittings etc.

- The fuel oil gauge connection pipe etc.

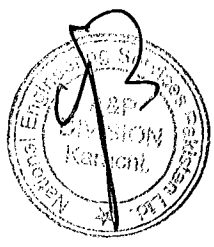
- The required insulation, gaskets and sleeves.

2-15.8 Tank Accessories (each)

- One (1) inlet connection nozzle with internals.

-One (1) spare inlet connection nozzle with blind flange.(Use in DT)

- One (1) outlet connection nozzle with internals



- One (1) spare outlet connection nozzle with blind flange. (Use in DT)

- One (1) shell manholes, complete with all accessories. (Only MST)

- One (1) drain connection, complete with all accessories.

- One (1) vent, complete with filters and differential pressure gauge as well as all other accessories.

- One (1) sounding hatch

2-15.9 Common Equipment

- All necessary anchor bolts, dowels, and bolts, nuts, washers, alignment pieces etc. required for anchoring and/or connection of delivered components.

- All necessary local instrumentation and monitoring equipment with a scope at least conforming to the technical schedules plus further instrumentation needed for adaptation to special versions of apparatus and equipment.

- All necessary safety measures

- Final fire proof painting of all equipment according to the relevant specifications.

- All standard equipment and accessories which are normally included in the supply schedule, but which are not separately listed.

2-15.10 Construction Requirements

The requirements specified under the relevant sections of the General Specifications are to apply and, where applicable, further regulations from the other sections of these specifications.

The tanks shall be designed in accordance with the requirements of ASME SECTION VIII, API Standard 650 or an approved equivalent standard. In case that the specifications requirements are beyond the scope of the aforementioned standard, the requirements of the specifications shall be followed.

The maximum storage temperature for the tanks shall be considered with the highest one-day mean ambient temperature plus 20°K. The tank's shell temperature caused by solar radiation shall be considered.

All connection nozzles shall be provided with flanges inside and outside of the tank. Two inlet and two outlet nozzles shall be provided for each tank. One of the inlet and outlet nozzles shall serve as standby connections and shall, therefore, be equipped with blind flanges outside the tank.

Welded joints shall be produced as follows:

Side joints one sided lap weld

Side Plate to Side joint	two sided fillet weld

All tank internals (pipes, etc.) bolts & nuts shall be made of stainless steel type AISI 304 or approved equivalent materials.

One (01) manhole (24 inch dia) shall be provided in the tank.

Each tank shall be provided with vent located on the top of the tank. Each vent shall be designed for 100% capacity to pass air so that at the maximum possible flow rate of the oil, either entering or leaving the tank, excessive positive or negative pressure will not be developed. To prevent any ingress of sand, dust, insects, etc. the vents shall be equipped with filters containing exchangeable filter elements with a mesh width of not more than 0.5 mm. Each clear filter area shall be at least 200% of the vent nozzle area. A differential pressure gauge shall be provided for each filter and shall be equipped with sensor to trigger an alarm when the filter is blocked by 30% of its clear area.

The manholes equipped with hinges (davits) and safety devices which prevent unintentional closure of the covers.

The Contractor shall guarantee that the tanks are designed, constructed and painted in such a manner that outside and inside corrosion and especially contamination of the stored product by rust and/or by other matters shall be prevented. To prevent any damage to the oil storage tanks by storms, they shall be reliably stiffened.

2-15.11 Materials

All materials shall be new and of specified quality.

For all plates, mill certificates shall be obtained by the manufacturer from the steel maker and upon request, such certificates shall be made available to the Engineer. The mill certificates for all plates with a specified minimum yield strength exceeding 240 MPa shall be authenticated by an approved authority.

In the absence of mill certificates, the manufacturer shall provide a report from an authorized laboratory which certifies the quality and grade of materials.

Manhole covers, reinforcing plates and nozzles shall be made of the same material as that of main part of the tank, or in forged materials of approved quality.

All steel plates and pipes, forged components and bolts used for flanged assemblies shall be accompanied by test certificates, indicating the chemical composition, the mechanical properties, the cast batch test number and the identification symbols.

2-15.12 Final Testing

When assembly is completed the dimensions of the tank shall be controlled in presence of the Engineer. The dimensions measured must be within the tolerances as specified in the API 650 code, section 5.4.

The tank shall be given a hydrostatic test in compliance with the API 650 code. For all tanks, test pressure shall be at least equal to the design pressure. Pressure shall be maintained for at least 24 hours. While testing the outside of the tank

shall be dry at the beginning of tests and has to remain dry throughout the whole test.

Each reinforcing plate shall be subjected to pneumatic test with compressed air at minimum pressure of 1 bar applied between the plate and the tank.

The tests shall be carried out in the presence of the Engineer.

Tests shall be judged satisfactory under the following conditions:

- No pressure drops on the test pump pressure gauge.
- No indication of permanent deformation after decompression of the tank, the girth of the side walls must return to its initial dimension.

In the event of leaks being spotted and duly repaired, a new hydraulic test shall be made at the Contractor's expense, after radiographic inspection of the concerned welds.

Unless otherwise stated, the Contractor shall provide all equipment and pipes required for tests. The Contractor shall also be responsible for emptying the tank.

The inside of the tank shall be cleaned and dried after hydrostatic testing.

The Contractor shall submit a hydrostatic test certificate to the Engineer.

2-15.13 Oil Lift Pumps

All pumps for high speed diesel shall be rating 50% (minimum) above the maximum requirement of chiller-heater. The pump shall be direct driven gear type, with integral relief valve. The pumps shall incorporate mechanical seals. A cast iron strainer shall be located at oil inlet. Factory fitted electrical motor of suitable horse power (HP) shall be provided with the pump. A stainless steel needle valve shall be provided to permit reduction in oil flow rate below the pump maximum capacity. The capacity of the oil pumps feeding the burner shall be as recommended by the chiller-heater generator manufacturer of oil lift pumps.

2-16 ANTI CONTAMINATION CONTAINER WITH HEPA FILTER

The HEPA Filter mounted in duct shall be placed in the housing consisting of the anti contamination chamber and place for HEPA filter placement designed for biohazard applications.

2-16.1 Construction

The housing shall have anti contamination chamber and filter installation chamber. Continuously welded housing and continuously welded gasket frame, smooth surfaces and easy to clean. Sealants are not allowed.

Housing shall be Made of powder coated GI sheet, 140µm surface treatment, applied in a separate double layer (epoxy powder and polyester powder) with anti-fungal/anti-bacterial paint.

The galvanized steel clamps for filter clamping is required. Provide U-clamps for

the filter installation.

The housing shall have the removable frontal door with perimetral gasket, door locking by fold down tie rods with wheel clamps. Constructed such that it is impossible to clamp the filter unless it is fitted correctly. Provide flanges for connection with duct system. The container shall be provided with the transition pieces for connection with duct system.

The container shall be provided with BIBO bag in/bag out thermo sealable PVC change-out bag (made of 200µm thick transparent PVC) which shall include O-ring (stretched around the housing collar) and sleeve port for safe filter handling.

The container shall be provided with butterfly damper of body ductile iron with epoxy coating and damper disc shall be of stainless steel.

The container shall be provided with the injection module.

Negative or positive pressure up to 6000 Pa, and fulfill:

Class C: According to EUROVENT 2/2.
Class L1: According to EN1886:2008
Class 3: According to ISO 10648-2:1994
OEL Test: OEB 4

2-16.2 Filters

Filters shall have low pressure drops and a uniformity of the flow with velocity +5% of the average value. The filter class shall be H14 (efficiency ≥ 99.995%).

Filter media shall be Glass fiber paper folded with constantly calibrated spacing using thermoplastic threads. The pleats of filters shall be uniform and closely packed. Filter frame shall be stainless steel/galvanized steel with powder coating and epoxy paint.

A polyurethane resin sealing is required to insure the seal between the filter pack and the frame. Single piece of cold expanded elastomeric semi-circular gasket shall be applied to guarantee a perfect seal.

2-17 DX - SPLIT AIR-CONDITIONING UNITS

All unit(s) shall be inverter reversible (Heat Pump) type. Unit(s) shall have split type indoor, remote air cooled condensing unit, factory assembled, tested, single unit connected to outdoor unit as specified and shown. Unit shall include:

i) Air Cooled Condensing Units (CU)

The condensing unit shall be of the vertical/horizontal discharge, air cooled type, suitable for outdoor installation and sized to deliver the required capacity matched to relevant DX-type indoor unit at specified ambient temperature. The condensing unit shall be of same manufacturer as the Indoor AC Unit and shall be suitable for operation at 50 °C ambient temperature conditions.

The unit casing shall be constructed from galvanized sheet steel, zinc phosphate and with a stoved enamel finish. All access panels and the unit casing shall be provided with thermal and acoustic insulation. All moving components such as

compressors and condenser fan motors shall be anti-vibration mounted to minimize the transmission of vibration and noise. The Condensing unit shall be of same manufacturer as the Indoor AC unit.

Condenser coils shall be made of seamless copper tubes mechanically expanded into aluminum fins.

For Coils used in corrosive environments and handling untreated fresh air the Fins should be Hydrophilic blue fin which can pass 500 hrs Salt spray test.

Condenser fans shall be of direct drive, statically and dynamically balanced propeller type. Weatherproof fan motors suitable for outdoor use, permanently lubricated and provided with built-in thermal overload protection shall be used. Fans shall be mounted on rubber vibration dampers. All condensing units shall be weatherproof and capable of operating satisfactorily at high and low outdoor temperatures at full load.

Hermetically sealed reciprocating/rotary compressors shall be fitted with internal and external shock absorbers to minimize vibration and noise transmission. The compressor shall be fitted with a discharge line silencer and charged with the required quantity of oil for adequate lubrication circulated by means of an internal oil pump.

Internal overload protection located in the motor windings shall be provided.

The units shall be complete with K-Type refrigerant piping & insulation and all necessary valves and filter drier from the unit to the air cooler. Suction and discharge pipes shall be equipped with pipe vibration dampers. Condensing units shall be factory pressure tested, evacuated and dehydrated.

The units shall be installed on steel brackets of adequate strength fixed to the walls with expansion bolts or on a concrete foundation on the roof as shown on the drawings.

ii) Indoor Unit (SAC-Units)

The DX-type Indoor units shall be elegant, decorative types, wall mounted ceiling recessed (cassette) mounted, concealed ducted or vertical floor standing type as specified. All component parts shall be selected, manufactured and assembled by the same manufacturer as for outdoor Condensing unit.

Each unit shall be constructed so as to prevent drumming, distortion and vibration and shall enable ease of handling and replacement of sections.

The units shall include the following sections:

- Washable filters
- DX-type cooling coil
- Supply air fan and motor
- Thermostat microprocessor type with cooling & heating mode
- Automatic air swing mechanism
- Supply air plenum with adjustable grille

The casing shall comprise of galvanized sheet steel, zincphosphated, with a stoved enamel finish or as approved by the engineer and shall include supply and

Return air grilles. For cassette type, AC units, the colour of the front grille shall be approved by the Engineer.

Fan shall be statically and dynamically balanced centrifugal type with backwardly or airfoil blades to suit the pressure and operating characteristics specified.

Fan housings shall be constructed from galvanized steel sheet. The casing shall be constructed to a truly voltute form.

Shafts shall be cold finished, turned, and polished steel. Bearings shall be self-aligning, permanently lubricated ball bearings.

All parts of fans and motors liable to deterioration shall be protected by paint or grease before delivery to site.

Filters with dust arrestance of 35% as per ASHRAE standards shall be provided. The filter media shall be washable, cleanable, reusable, chemical and moisture resistant, non-perishable, and flame resistant.

Cooling coils shall be manufactured from solid drawn seamless copper tube staggered in the direction of air flow. Tube return bends shall be copper and brazed to tube ends.

Fins shall be of continuous aluminium having extended collars for spacing and bonding mechanically to the tube.

Coils shall be air pressure tested to 20.6 bar while immersing the coil in a tank of water after completion.

Tubes shall be expanded onto the fin collar by hydraulic pressure only.

No part of the coil tube ends or headers shall be external to the section. Coils shall be suitably sealed with grommets where connections pass through the unit casing.

The air-cooler shall incorporate a galvanized drain pan with integral insulation. The pan shall be fitted with galvanized drain socket connections for attachment to drain points. A manometric trap should be supplied and installed by the installing contractor.

The coil shall be easily removable from the unit for maintenance and cleaning purposes.

The coil shall include a thermostatically controlled expansion valve.

Microprocessor based thermostat with integral 3 speed fan selector shall be supplied as part of the unit.

Condensate Drain

All cooling coil condensate drain shall be uPVC class D. The fittings for the cooling coil condensate drain shall be uPVC class D.

2-18 INROW/ROW TYPE COMPUTER ROOM PRECISION AIR CONDITIONING UNITS (CRAC) UNITS (R410A REFRIGERANT)

2-18.1 General

The system shall be designed to maintain temperature and humidity conditions in the rooms containing server and electronic equipment.

The CRAC shall be of single-zone floor-mounted in row/row based type. It shall be of low noise level type and suitable for continuous/heavy duty operation.

The provision of CRAC units design/layout is in Contractor's scope of work. The Contractor shall provide layout details as per actual quantities in shop drawing prior to approval.

2-18.2 Design Requirements

The CRAC system shall maintain the computer data centre at 20°C +/-1 °C and 50%RH +/- 5%. The computer room air-conditioning system shall be of self-contained factory assembled unit with in row /row based air delivery. It shall be air cooled compressorised (DX) system. The system is designed for 46°C high ambient heavy duty operation (24 hours a day and 365 days a year).

2-18.3 Cabinet and Frame Construction

The cabinet shall be constructed from galvanized steel sheet, externally painted with epoxy-polyester powder paint and assembled using stainless steel screws and high tensile rivets.

The front and rear panels are removable double-skinned. The side access shall be fabricated from 20 gauge galvanized steel and shall be securely bolted to 14 gauge base and the top plate. The top plate front and rear panels shall be fabricated from 16 gauge galvanized steel. The cabinet shall be powdered coated with satin finish to provide durability and to protect from corrosion.

No allowance for side service access shall be required. However, removable side access panels shall be provided for additional access.

2-18.4 Filter Chamber

The filter cells shall be made of pleated synthetic fibre in a cardboard frame and are designed to minimize the air pressure drop while maintaining maximum filter efficiency. They shall be easily accessed / replaced by opening the front panel(s). The rated efficiency is G4 [F5=1/3], in compliance with EN 779 standards. The unit shall be fitted with a filter differential pressure switch, connected to the microprocessor controller to provide 'Filter Clogged' warning indication.

2-18.5 Fan Section

The fan shall be backward inclined plenum style, high efficiency, and single inlet, backward curved with electronically communicated motor (EC) motor, for maintenance free operation. The fan motor(s) shall be three-phase, 4-pole, IP54, with internal thermal protection, multi speed settings adjustable via an autotransformer.

The motor shall include integrated electronic control board and direct microprocessor control signaling for fan speed control, soft-starting capabilities

and integrated current limitations.

Each fan impeller is statically' and dynamically balanced to reduce vibration and equipped with self lubricating bearings.

2-18.6 Infrared Humidifiers

The unit shall be fitted with an electrode boiler humidifier suitable for use with water of varying degrees of hardness.

The humidifier shall complete with a water inlet valve, water outlet valve and a maximum water level sensor. Steam from the cylinder is mixed with the discharge air from the evaporating coil by means of a copper steam distributor. The unit controller monitors the condition of the steam cylinder, and generates an alarm when the cylinder needs to be changed. Cylinder replacement is to be easy and quick.

The humidifier shall complete with a self-adapting flow control system, which monitors and controls the electrical current passing through the cylinder. Output adjustment is from 30-100% via the unit controller.

Humidification control shall be of the proportional type.

2-18.7 Electric Reheat

The heating resistors shall be of a rigid design for extended operational life and are normally utilized to maintain room dry-bulb conditions during a system call for dehumidification. The low Watt-density, electrically enclosed elements are made of finned aluminum, reducing sheath temperatures and eliminating ionization.

Heating control is of the ON-OFF type. The heaters are phase balanced and are provided with a manual reset safety thermostat to disable them in the event of a high temperature.

The heating system shall also incorporate Miniature Circuit Breaker(s) which shall protect the heater(s) from short circuits, should the harness be damaged accidentally.

2-18.8 Direct Expansion Coil/Condenser Units

Refrigeration circuit(s), incorporating a high efficiency, fully hermetic compressor with crankcase heater, liquid receiver with outlet service valve, safety valve, filter drier, moisture indicating sight glass, liquid line solenoid valve and an externally equalized thermostatic expansion valve.

Each compressor shall be equipped with pre-set high and low pressure switches for protection against high condensing and low evaporating temperatures. The low pressure switch features an automatic reset (with an adjustable delay for winter start-up) whilst to avoid compressor cycling at high discharge pressures, the high pressure switch is equipped with a manual reset.

The inclined evaporator coil shall be manufactured from seamless copper tubes, mechanically bonded to hydrophilic painted aluminum fins, with a stainless steel condensate drain pan. The coil shall be designed for a maximum of 500 ft./min face velocity.

The moisture indicating sight glass, liquid line solenoid valve and thermostatic expansion valve for each circuit shall be mounted in a service compartment, isolated from the air stream, to allow checking and adjustment while the unit is in operation.

The unit shall be capable to be used in corrosive and sea environments. The Fins should be Hydrophilic blue fin which can pass 500 hrs Salt spray test.

2-18.9 Electrical Panels

The electrical panel to be located at the front of the unit in a compartment isolated from the airflow shall contain the MCB's, contactors, transformers, controller PCB, overload relays etc. Each high voltage system component shall be provided with an MCB over-current protective device. All high voltage components to be touch protected by means of a plastic cover. The electrical panel shall comply with the IEC norm 204-1.

Electrical power supply is 400V (±10%)/3Ph/50Hz +N +E to fitted with a mains isolator, mechanically interlocked with the electrical panel cover.

2-18.10 Advanced Microprocessor Control Including Graphics

The Control System shall be microprocessor based, 32 bit RISC. It can be programmed to control the function of every device within the CRAC via I/O. An external on/off switch is to fitted, incorporating a 3-colour LED, indicating the unit status - 'Power on' (Orange), 'Stand-by' (Flashing green), 'Unit on' (Green) or 'Warning/Alarm activated' (Red).

The controller shall be capable of integration with BMS over BACnet.

The controller shall allow for setting and monitoring of the following minimum room parameters via a keypad:

- Air Temperature
- Temperature set-point
- Temperature band
- Humidity
- Humidity Set Point
- Humidity band

The parameters shall be displayed using symbols and text on a back-lit, Liquid Crystal Display. Cooling and heating modes are also indicated on the LCD screen. Alarm conditions shall activate a visual indicator. Three LED's indicate the unit status - 'Power on' (Yellow), 'Unit on' (Green) and Warning/Alarm activated' (Red).

The controller shall be provided with the following functions:

- Run / stand-by rotation
- Automatic changeover and parameter sharing functions
- Sequential auto restart timer, with adjustable time delays to be applied to CRAC restart after a power loss.

The following warnings / alarms are included:

- High Return Air Temperature
- Low Return Air Temperature
- High relative humidity
- Low relative humidity
- Humidifier failure
- Fan failure
- Compressor Low Pressure trip
- Compressor High Pressure trip
- Electrical heater high temperature
- Sensor failure
- Controller errors
- Change Filters
- Loss of Air Flow
- Loss of Power

Terminals are provided for remote start/stop control plus Volt-free 'Common Alarm' and 'Unit Run' indication.

The system shall allow user review and programming of temperature and humidity set points, alarm parameters, and setup selections including choice of control type. A password shall be required to make system changes. For all user selections, the range of acceptable input (temperature, humidity, time delay) shall be displayed on the monitor screen. The system shall provide monitoring of room conditions, operational status in % of each function, component run times, date and time.

Control

The control system shall allow programming of the following room conditions:

a)	Temperature Set Point	18° - 29°C
b)	Temperature Sensitivity	+ 1 ° to +9.9° F (°C) in 0.1 °F(°C) Increments
c)	Humidity Set Point	20 - 80% R.H.
d)	Humidity Sensitivity	+1 % to +30% R.H.

All set points shall be adjustable from the individual unit front monitor panel. Temperature and Humidity Sensors shall be capable of being calibrated using the front monitor panel controls to coordinate with other temperature and humidity sensors in the room.

Predictive Humidity Control

The microprocessor shall calculate the moisture content in the room and prevent unnecessary humidification and dehumidification cycles responding to changes in dew point temperature.

System Auto-Restart

For start-up after power failure, the system shall provide automatic restart with a programmable (up to 9.9 minutes in 6-second increments) time delay.

Sequential Load Activation

During start-up. or after power failure, the microprocessor shall sequence

operational load activation to minimize inrush current. Systems allowing multiple loads to start simultaneously are unacceptable.

SECTION 3 - FOUNDATIONS AND SUPPORTS

3-01 GENERAL

All equipment, piping and duct work where used shall be mounted on or suspended from foundations and supports, all as specified, as shown and as required. All concrete foundations where required, including thickened structural slab, housekeeping pads and concrete for inertia pads will be provided by the Employer or other Contractor appointed by the Employer or HVAC Contractor as described in Special Provisions Clauses SP-02 & SP-03.

Shop drawings, other information and templates for all concrete foundations where used, shall be provided by Contractor as per recommendations of the manufacturer of the equipment. Necessary integral steel framings, concrete reinforcing rods welded to frame, required anchor bolts, spring mountings, and neoprene pads, shall be provided by the Contractor. The Contractor shall cooperate with those doing the flooring work to ensure proper installation of all these elements.

Foundations and vibration isolation mountings for various equipment, piping, and duct work where used shall be as per requirements specified. Vibration isolators where used shall be of approved make.

Springs used for vibration isolation shall be single, open coil type and laterally stable, having a ratio of loaded height to mean coil diameter not greater than 1.25. To preclude possibility of spring coils "shortening" when motor starts or slows down, the springs shall be selected so that there remains when the spring is design loaded, a reserve deflection of between 25 and 30% of maximum deflection of free spring. When fully compressed, maximum stress in steel should not exceed yield stress of spring material. Springs shall be unhoused and held well clear of any part of suspended mass. Isolated system if supported on a flat slab type base shall be held clear of supporting structure or pad by the minimum distance thought necessary for efficient housekeeping or 1 inch. Lower end of each spring shall be supported on a rigid, square steel base plate sufficiently thick to withstand a bearing pressure of 427 kPa. This plate should be complete with 3 thickness of type W neoprene waffle pad between under inside of plate and supporting structure. A 16 gauge steel shim plate bonded to pad surfaces shall separate adjacent thicknesses. Spring base plate shall also be bounded to top layer of pad. Pad area should be chosen to suit hardness of neoprene. For 40 durometer neoprene, bearing pressure on supporting structure shall be 276-352 kPa when spring is design loaded. Waffle pads may have to be cut away in the middle of pads since pads shall have same overall dimensions as spring base plate.

All pipe hangers must be insulated from the building by cork inserts between the hanger bar fixing and the connection to the structure. Details of the Contractor's method of achieving this shall be submitted to the Engineer for approval. All ceiling hung equipment having fans and motor as integral part of equipment shall have adequate vibration isolators.

All ceiling hung equipment having fans and motor as integral part of equipment shall have adequate vibration isolators.

Flexible duct connections, as specified elsewhere, shall be fitted wherever ducts cross building expansion joints, at suction and discharge end of each air handling unit and fan wherever ducts are connected to such unit, and/or wherever shown on

the drawings. Supply outlet of concealed ceiling-mounted fan coil unit shall also be connected to Fan-coil with flexible connection.

Details of all vibration isolators, flexible connections and bases shall be submitted to the Engineer for approval.

3-02 MOUNTING OF EQUIPMENT

3-02.1 Floor or Roof Mounted Equipment

All floor or roof mounted equipment shall be generally placed on at least 4 inch concrete housekeeping pads, unless otherwise indicated. The pads shall be constructed on 1 inch thick cork-sheet. Protective curbs shall be provided on all sides of the pad to protect the cork sheet edges. Special attention shall be given to the equipment at roof and intermediate floors and heavy equipment like Pumps and Chillers shall be mounted on spring isolators / inertia pads. The spring isolators shall preferably be supplied by equipment manufacturer and shall be from manufacturers specializing in manufacturing of vibration isolators. Manufacturer's recommendations for prevention of vibration and noise travel to the structure shall be adopted. The foundation details shall be subject to the approval of the Engineer.

3-02.2 Wall Mounted Equipment

All equipment installed through wall shall have 20 gauge galvanized sheet metal which shall remain in place permanently. Sleeves shall be packed with non combustible glass fiber insulation minimum of 1.5 lb/cu.ft density and sealed with sealant. Equipment installed through walls shall have supporting wall brackets.

3-02.3 Air Inlets/Outlets

All wall grilles/EA-OA louvers shall be fixed to wooden frames and not to the ceiling material/wall masonry. Metallic frames may be used with metallic frame false ceilings. Wooden wall frames shall be grouted and finished by Contractor.

3-02.4 Ceiling Suspended Equipment

All ceiling suspended equipment shall be hung from ceiling (concrete slab) and shall not rest on false ceiling.

3-02.5 Floor Mounted Equipment

All floor-mounted equipment shall be resting directly on the raised floor pad (or supported from wall when approved by the Engineer).

3-03 VIBRATION ISOLATION

Vibration isolation bases shall be provided and installed under all pumps, to prevent the transmission of vibration to the building structure, as shown on Drawings.

Where fans and motors are integral parts of factory assembled air handling units and the fans and motors are not spring isolated from the air handling unit, the entire unit shall be mounted on vibration isolators.

Inertia pads where indicated shall be reinforced cement concrete pad, at least 4 inch thick with 4 inch steel channel all around to protect concrete edges. Reinforcing rods shall be welded to channel frame.

Floor mounted Fans with belt drives shall be mounted on continuous rails with sliding base for motor adjustment and fan-rails shall be mounted on vibration isolators as specified above. When shown on Drawings, continuous rails shall be mounted on Inertia pads and pads shall be mounted on vibration isolators.

Flexible pipe connectors shall be installed in piping to prevent vibration and noise travel. Location and construction of these connectors are specified in Section on "Piping, Fittings, Valves and Specialties."

SECTION 4 - DUCTING AND SHEET METAL WORK

4-01 GENERAL

4-01.1 Ducting Material

All duct work shall be of galvanized steel sheet unless otherwise indicated on Drawings. Galvanized steel shall be of lock forming quality (LFQ) and shall have a galvanized coating of 8 oz total for both sides of one square meter of a sheet. The GI sheet shall conform to ASTM A-525 and ASTM-90.

Galvanized steel sheet shall be Cut Lengths coated by the Hot-Dip Method and manufactured per ISO Standard 3575-76 zinc coating designation Z-275.

The ducting for high plume fans shall be epoxy resin powder coated and shall be painted with anti-rustic and anti-fungal paint. When a powder coating process is used on fan and plenum, the coating shall be minimum thickness of 3 mils.

4-01.2 Structural Steel

Structural Steel shall be M.S. members rolled from Pakistan Steel billets or equivalent conforming to ASTM designation A-36 standard specifications for structural steel.

4-01.3 Canvas Cloth

Canvas Cloth shall have specified weight with flame retardant quality.

4-01.4 Painting

All steel work in connection with supports for ductwork etc. exposed to the elements is to be painted with two coats of an approved rust preventive paint.

All exposed metal surface of hangers, brackets, etc. must be painted with two under-coats and two finishing coats of enamel paint of approved color. G.I. sheet is not to be painted. However, all uninsulated pipe work and valves are to be painted as stated above.

Identification bands shall be painted on uninsulated ducting, or on insulation at frequent intervals. Lettering shall be agreed with the Engineer.

All duct hangers in concealed locations shall be given one coat of black asphalt paint before being concealed.

4-02 DUCT CONSTRUCTION

All sheet metal duct work shall be of a standard construction and erected in a first class workmanlike manner. The duct work shall be constructed as per SMACNA Low Velocity Duct Construction Standards.

Where specified, duct work shall be provided with interior insulation. Ducts shall be straight and smooth on the side, with joints neatly finished. Where ducts are lined with interior insulation, the dimensions required shall be for the net free area after

insulation is applied. Ducts shall be anchored securely to the structure in an approved manner and shall be installed so as to be completely free from vibration under all conditions of operation.

Sheet metal ducts shall be properly braced and reinforced with steel angles, or other structural members approved by the Engineer unless otherwise required, the internal ends of all slip joints shall be installed in the direction of flow.

Finished work shall show no flaking or peeling within 1/4" of a cut edge. The construction and gauge of material, size and spacing of stiffeners for duct work shall be as follows:

Larger Diameter of Duct (Inches)	Gauge (US)	Traverse Joint Type/Size (Inches)	Interim Bracing, Angle Size (Inches)	Maximum Spacing between Traverse Joint &/or Interim Reinforcement (Feet)
Thru 12	26	Drive Slip	-	-
13 thru 18	24	Drive Slip	-	-
19 thru 30	24	Pocket lock/1	1x1x1/8	5
31 thru 42	22	Pocket lock/1	1x1x1/8	5
43 thru 54	22	Pocket lock/1-1/2	1-1/2x1-1/2x1/8	5
55 thru 60	20	Pocket lock/1-1/2	1-1/2x1-1/2x1/8	5
61 thru 84	20	Angled Reinforced Standing Seam	1-1/2x1-1/2x1/8	5
85 thru 96	18	Angled Reinforced Standing Seam	1-1/2x1-1/2x1/4	2.5
Over 96	18	Angled Reinforced Standing Seam	1-1/2x1-1/2x1/4	2.5

Other types of Traverse joints allowed as per ASHRAE/ SMACNA Standards shall

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be acceptable, subject to Approval of Engineer, in places where pocket lock is not possible due to tight space.

All angles for bracing shall be painted with one coat of approved rust-inhibitive paint before fixing to duct.

All duct work in the finished areas shall be run parallel to the beams wherever possible. All outlet opening and open ends shall be kept closed with sheet metal caps during construction. Rectangular duct shall be constructed by breaking the corners and grooving the longitudinal seams. Elbows and transformation sections may be formed with Pittsburgh corner seams but complicated fittings shall be constructed with double seams. Angle bracing shall be of steel and shall be carried out on all four sides of the ducts. All bracing is to be in accordance with the current addition of the ASHRAE Hand Book/ SMACNA Standards.

4-03 ELBOWS

Ducts shall be built with curves and bends, where required, to affect an easy flow of air. Curved elbows shall have a centre line radius at least equal to 150% of the width of the duct unless otherwise indicated. All duct curves having an inside radius smaller than the width of the curve shall be equipped with approved single thickness vanes.

Vertical ducts shall have full size bends where horizontal branches are taken off unless otherwise indicated, and/or approved.

Where square elbows are used in changing directions, approved and aerodynamically correct vanes as per latest SMACNA Duct Construction Standards shall be used.

These turning vanes must be free from vibration when the system is in operation.

4-04 HANGERS

Hangers and supports shall be fastened to the structure in a manner approved by the Engineer All fastening shall be such as to ensure permanent stability and to be capable of supporting at least three times the applied load.

Galvanized sheet metal ducts less than 20" in width (larger dimension) may be suspended by means of galvanized iron straps extended along the bottom of the duct to form a trapeze, only if hanger length above the duct is not more than 12".

Hangers and support system including accessories to be installed outside of the building shall be minimum made of SS316 or equivalent material.

All other ducts shall be suspended by means of iron bars securely fastened to the angle iron bracing or angle iron placed under the duct. Bars shall be fastened to bracing only on un-insulated ducts.

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Bars shall be screwed to angles attached therein by sleeve/stud anchor screws and heavy iron washers from ceiling. Where horizontal ducting is fixed to walls, columns, supported from floor slabs, etc. angle iron frames are to be fabricated and fitted to support rectangular ductwork and associated equipment.

Vertical ducts are to be supported by steel angles bolted to at least two sides of

the duct and on the complete circumference of the ducts where the larger duct dimension is greater than 24 inch.

Angle iron extensions shall be either grouted or bolted to the structure.

Hangers spacing and sizes shall be as follows.

Larger Duct Diameter (Inch)	Strap Size (Inch)	Bar Diameter (Inch)	Bottom Angle Size (Inch)	Maximum Spacing (Feet)
Thru 12	1" x 22 Gauge	3/8	1x1x1/8	8
14 thru 18	1" x 22 Gauge	3/8	1-1/4x1-1/4x1/8	8
19 thru 30	1" x 18 Gauge	3/8	1-1/2x1-1/2x1/8	8
31 thru 42	1" x 18 Gauge	3/8	1-1/2x1-1/2x1/8	8
43 thru 54	1" x 16 Gauge	3/8	1-1/2x1-1/2x1/8	7
54 over	1" x 16 Gauge	½	2x2x1/4	6

Hanger rods shall be cross-braced whenever the length of rod above duct work is more than 3 ft. to prevent swing of ducts.

All structural steel including hanger rods and angle iron shall be painted with one coat of approved rust- inhibitive paint before installing.

4-05 QUADRANTS FOR VOLUME DAMPERS

All dampers other than dampers behind registers and diffusers shall be fitted with substantial locking quadrants, mounted outside the duct in an accessible position. On insulated ducts the quadrants shall be fastened to bearing plates flush with the outside finish of the insulation.

4-06 DAMPERS

4-06.1 Volume Dampers (V.D)

A substantially constructed manual volume damper of the butterfly or multiple blade type as per latest SMACNA Duct Construction Standards shall be fitted where shown on the Drawings and at all branch entries or exits with main ducts for balancing purposes. Dampers shall have galvanized or painted steel interlocking blades of 8" maximum blade width. Blades shall be fabricated from 16 gauge steel

with seamed edges and a maximum length of 4 ft. It should be noted that these dampers, shall be separate and independent from the dampers, hereinafter specified. Volume Dampers are not required where splitters Dampers, as specified hereinafter, are installed.

4-06.2 Splitter Dampers (S.D)

At each point of division in a supply trunk duct where a branch is taken off a trunk duct, an adjustable splitter or deflecting damper, one gauge heavier than the duct with operating rod and locking quadrant as above, shall be installed. These deflecting dampers shall be permanently set and locked in position after completion of the installation and adjustment with fans running.

Operating rods are to be full blade length extending through the duct to externally mounted bearing plates. Construction shall be as per latest SMACNA Duct Construction Standards.

4-06.3 Fire Dampers (F.D)

Fire dampers are installed as shown on the drawings. Frame shall be 4"x1"x1/8" galvanized steel channel with 16 gauge thick blades. Blades shall have an overlap of 1" and shall be fixed on self-lubricating bronze type bearings.

Dampers shall be complete with linkage rod and fusible link rated at 160 deg F. Damper construction shall meet NFPA 90-A requirements, and shall have the "hour" fire-rating not less than the fire rating of the plane where installed. Fire dampers shall be air tight when in close position.

4-07 FLEXIBLE DUCT CONNECTIONS

Flame proof flexible connections shall be furnished and installed on all suction and discharge connections of fans and air-conditioning units for prevention of transmission of vibration through the ducts to occupied spaces.

Flexible connections also be provided wherever ducts cross building expansion joints.

Flexible connections shall be factory fabricated of imported origin, made from chemically impregnated canvas or other material approved by the Engineer. Connections shall fit closely and are to be secured in an airtight fashion at connections to ductwork, fans and apparatus. The unclamped section of the flexible connection between apparatus and ductwork shall not be less than 6" in length. Flexible connections shall not be painted or insulated. Samples of the material shall be presented to the Engineer for approval before installation.

4-08 ACCESS DOORS AND PANELS

Wherever necessary, suitable access openings, doors and frames to permit inspection, operation and maintenance of all filters, controls, dampers, bearings or other apparatus shall be provided in ducting. Doors shall be of double construction, of not lighter than 20 gauge metal sheet and shall have sponge rubber gaskets around their entire perimeter. On insulated duct work the space between the inner and outer door sheets shall be insulated as specified for the ductwork. All access doors in sheet metal shall have air tight seal, shall be hung on heavy flat hinges and shall be secured in the closed position by means of wing type nuts and screws

or coin operated catches.

4-09 SLEEVES

Where ducts pass through walls, partitions, or floors, wooden sleeves shall be provided by the Contractor and these sleeves shall remain in place permanently. Sleeves shall be packed with non-combustible glass- fiber insulation, minimum of 1.5 lbs/cu.ft. Density and sealed with sealant.

4-10 TEST WELLS

The Contractor shall provide test wells for measurement of air velocity and static pressure for balancing purpose. These wells made up of a brass nipple with screwed caps are to be fixed into the duct or casing on the downstream sides of each fan, filter, AHU, FCU and branch volume damper in each branch supply duct, and on upstream side of branch volume damper in each branch return. The design of test well shall be subject to Engineer's approval.

4-11 FLEXIBLE ROUND DUCT & INSULATION

This shall be round insulated duct, factory made with 1 1/2" thick fiberglass blanket wound round a coated helix wire coil and fiberglass inner mesh liner. Thermal conductance shall not be more than 0.27 $BTU/FT^2.HR.^\circ F$ at $75^\circ F$ and shall meet the fire safety requirement of UL 181 Class 1 air duct. Flexible round duct shall be as manufactured by certain Teed (USA) or approved equal.

4-12 BREACHING FLUE STACK

The contractor shall provide welded steel breaching/stack for size and configuration as required and as per recommendations of the manufacturer. Fabrication shall be by welding using no less than 3.4 mm thick plate conforming to ASTM A36 or A283. Structural angle flanges for breaching and boiler connection shall be provided. Stack shall be terminated as shown on drawings and at least five (5) feet above cooling tower fan level and shall be provided with weather cap on top.

4-13 SOUND ATTENUATORS

Sound attenuators shall be designed as splitter type to be used in air ducts, air pipes and air chambers, comprising sound-absorbing elements and an external casing with flanges and mounting frames, including external heat and sound insulation if required.

The casing and flanges or frame as well as the frames of the sound-absorbing elements shall be made of galvanized sheet steel. The sound-absorbing elements shall be made of non corrosive, moisture resistant and non-combustible mineral wool, covered with acoustical transparent lagging against abrasion made of perforated stainless sheet steel.

The sound pressure level of the air generated noise shall be lower than the required sound pressure level for the connected room by 10 dB at minimum.

All supports, hangers, etc., shall be installed sound insulated to avoid sound

transmission conducted through solids.

SECTION 5 - PIPES, FITTINGS, VALVES & SPECIALITIES

5-01 GENERAL

5-01.1 Each part of the piping system shall be complete in all details and provided with all control valves and accessories necessary for satisfactory operation. Valves from local manufacturer shall have additional warranty of three (03) years with complete replacement of parts or whole valves.

5.01.2 The Bidding Drawings indicate generally the routes of all main piping and sizes are shown on Drawings for quotation purpose. The Engineer reserves the right to change the runs and sizing of piping to accommodate conditions during construction.

5.01.3 All piping shall comply with the requirements of the ANSI B31.1 Code for Power Piping. The other pressure vessels shall comply with ASME Boiler and Pressure Vessel Code Section VIII.

5-01.4 All piping shall be grouped wherever practicable and shall be erected to present a neat appearance. Pipes shall be parallel to each other and parallel or at right angles to structural members of the building and shall give maximum possible headroom.

5-01.5 All pipe drops shall be truly vertical. No joints shall be formed in the thickness of walls, floors or ceilings. The Contractor is responsible for ascertaining the thickness of plaster and other wall finishes, skirting heights, sill lengths and floor finishes.

5-01.6 Piping shall not pass in front of doorways or windows and shall be generally arranged so that it is at least 3" above finished floor level and at least 1" from finished wall faces. Sufficient space is to be allowed for accessibility for servicing.

5-01.7 Piping shall be pitched for proper circulation and drainage. Run outs shall be graded in such a manner as to prevent air traps being formed within them when the mains expand or contract. Automatic or manual vents are to be provided at high points. All automatic vents shall be piped to suitable drains.

5-01.8 All drain piping shall pitch down in direction of flow. All drains from items such as drip pans of air conditioners and air handlers shall be piped to spill over an open sight drain, floor drain, roof gutter or other acceptable discharge points and shall be terminated with a plain end unthreaded G.I. Pipe, 6" above the drainage. Drain piping from all air handling units except fan coils shall have 3" water seal unless indicated otherwise.

5-01.9 All low points of the system must be fitted with drain valves to permit the complete drainage of the system. Bottoms of all risers must have dirt pocket the size of the riser of at least 12" long with a drain valve fitted. All water piping to equipment and valves shall be connected with either flanges or unions for dismantling and removal. All piping shall be reamed after cutting to remove all burrs.

5-01.10 Approved pipe fittings shall be used and bending of pipes will not normally be allowed except for black steel pipe 2" diameter and under which shall be permitted where space conditions allow for a bending radius of at least 10 times the diameter of the pipe. A hydraulic pipe bender shall be used to bend all pipes. Bends

showing kinks, wrinkles, or other malformations, will not be acceptable.

5-01.11 Piping shall not be installed passing through ductwork or directly under electric light fixtures, unless indicated otherwise.

5-01.12 In placing pipes through sleeves, near walls, partitions or in chases, care must be taken to provide sufficient space for pipe fittings and covering.

5-01.13 Where pipes are held in vices, as when screwing, care shall be taken to ensure that the pipe surface is not damaged. Any pipe work so damaged shall not be fitted.

5-01.14 All pipes stored on site shall be kept clean and off the ground and where possible stored under cover. Pipes corroded beyond normal "stock-rust" condition shall not be used. Special care should be taken to prevent dirt entering into pipes. The Contractor shall note that a valve fitted to the open ends of a disconnected pipe is not considered satisfactory to prevent entry of foreign matter. Screwed iron caps or plugs or plastic covers shall be used to seal pipe ends. Wood, rag, paper or other inadequate plugs will not be permitted.

5-01.15 Before connecting up to return mains, the system of piping must be blown and flushed out. After flushing, all strainers shall be opened and baskets cleaned.

5-01.16 Liberal allowance shall be made for expansion and contraction of pipes by means of changes in direction or by the inclusion of expansion joints in the piping system. Flexible connections shall also be provided whenever piping cross building expansion joints. Not less than 2 Pipe Guides as approved by the Engineer shall be used on both sides of expansion joint/loop.

5-01.17 All steel work in connection with supports for pipes exposed to the elements is to be painted with two coats of an approved rust preventive paint.

All exposed metal surface of hangers, brackets, etc. must be painted with two under-coats and two finishing coats of enamel paint of approved color. G.I. sheet is not to be painted. However, all un-insulated pipe work and valves are to be painted as stated above.

Identification bands shall be painted on piping or on insulation at frequent intervals. Lettering shall be agreed with the Engineer.

All steel pipes when delivered at site, shall have factory manufacturing date not older than two (02) month for local pipes and three (03) months for imported pipes.

All pipe hangers in concealed locations shall be given one coat of black asphalt paint before being concealed.

5-02 PIPING, FITTINGS & ACCESSORIES

5-02.1 Pipe Schedule

No.	Service	Size	Specifications

(a)	Seamless Steel		
(i)	Chilled/Hot Water	All sizes	Schedule 40 Black Seamless Steel, ASTM A106 Grade B or equivalent
(ii)	Condenser Water	All sizes	Schedule 40 Black Seamless Steel, ASTM A106 Grade B or equivalent Additional treatment of 02 coats of epoxy resin coating, 02 coats of rust & fungus preventive paint shall also be applied to outdoor pipes.
(iii)	Chemical Feed, Natural Gas & High Speed Diesel Oil	All sizes	Schedule 40 Black Seamless Steel, ASTM A106 Grade B or equivalent
(b)	PPRC		
(i)	Cooling Coil Condensate Drain	All sizes	PPRC PN 20
(ii)	Make Up Water & Drain Pipe for Cooling Tower	All sizes	PPRC PN 20
(c)	Pipes – Automatic Air Vents Discharge	1/4"	Copper (Type K)

5-02.2 FITTINGS

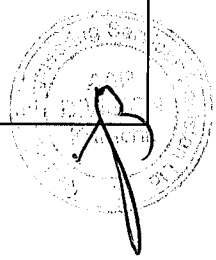
5-02.2.1 General

Fittings shall conform to following Schedule; in piping 6" and larger, "stub-in" type connections will be permitted when branch line is at least four pipe sizes smaller than main run.

5-02.2.2 Fittings Schedule

No.	Service	Size	Specifications

(a)	Seamless Steel Piping		
(i)	Chilled/Hot Water	2.5" & smaller	150 lb black steel threaded fittings, ANSI B 16.11, ASTM A105.
(ii)	Condenser Water	2.5" & smaller	150 lb black steel threaded fittings, ANSI B 16.11, ASTM A105. Additional treatment of 02 coats of epoxy resin coating, 02 coats of rust & fungus preventive paint shall also be applied to outdoor pipes.
(iii)	Chilled/Hot Water	3" & larger	Schedule 40 black welded steel, welding fittings to ANSI B 16.9
(iv)	Condenser Water	3" & larger	Schedule 40 black welded steel, welding fittings to ANSI B 16.9 Additional treatment of 02 coats of epoxy resin coating, 02 coats of rust & fungus preventive paint shall also be applied to outdoor pipes.
(v)	Chemical feed, natural gas, and diesel oil	All sizes	150 lb black cast iron screwed fittings to ANSI B 16.4
(b)	PPRC Piping		
(i)	Cooling coil condensate drain	All sizes	PPRC PN 20
(ii)	Make-up water/drain pipe for Cooling Tower	All sizes	PPRC PN 20



5-02.3 UNIONS AND FLANGES

5-02.3.1 General

Unions and flanges shall be provided where indicated and/or required for proper installation and maintenance of the system. They shall conform to the respective schedule given hereunder.

Flanges shall have bolt holes drilled and raised faced and fitted with black mild steel bolts, nuts and washers.

If equipment has different flanges to the type specified then mating flanges must be supplied of the same rating to connect to this equipment.

Extend flange bolts through nut at least four full threads when made up.

5-02.2.2 Union Schedule

No.	Services	Size	Description
a)	All services using black steel pipe	All sizes	150 lb malleable iron screwed, conical seat type Additional treatment of 02 coats of epoxy resin coating, 02 coats of rust & fungus preventive paint shall also be applied to outdoor pipes.
b)	All services using galvanized steel pipe	All sizes	150 lb malleable iron, galvanized screwed, conical seat type. Additional treatment of 02 coats of epoxy resin coating, 02 coats of rust & fungus preventive paint shall also be applied to outdoor pipes.

5-02.2.3 Flange Schedule

No.	Services	Size	Description
a)	Services using black steel pipe	All sizes	ANSI 150 lb weld-neck or slip-on as indicated or required. Additional treatment of 02 coats of epoxy resin coating, 02 coats of rust & fungus preventive paint shall also be applied to outdoor pipes.
b)	All services using galvanized steel	All sizes	ANSI 125 lb galvanized cast iron screwed pipe

	pipe		Additional treatment of 02 coats of epoxy resin coating, 02 coats of rust & fungus preventive paint shall also be applied to outdoor pipes.

5-02.4 Pipe Supports and Anchors

All supports for steel piping shall be ferrous. Brackets or supports shall be set out so that they do not obstruct the access to valves, flanges or other fittings requiring maintenance.

All pipework shall be supported by means of approved clips or hangers at centres as specified. In the event of two or more pipes being carried by a single support the spacing shall be for the shorter interval.

All vertical drops shall be supported so as to prevent sagging or swinging. Unless otherwise indicated, pipe hangers are to be spaced as follows:

Nominal Pipe Size (Inches)	Maximum Span (Feet)	Minimum Rod Diameter (Inch)
1 and smaller	6	3/8
1 ¼ - 1 ½	8	3/8
2 – 2 ½	10	3/8
3	10	1/2
4	12	1/2
5	14	5/8
6	16	5/8
8	20	7/8
10	20	7/8
12	20	7/8
14	20	1
18	20	1

Piping at all equipment, and control valves shall be supported to prevent strains or distortions in the connected equipment, valves and control valves. Piping shall be supported to allow for removal of equipment valves and accessories with a minimum of dismantling and without requiring additional supports after these items are removed.

All channels, angles, plates, clamps etc. necessary for the fastening hangers shall be furnished by Contractor. All hangers shall be properly sized for the pipe to be supported. Oversized hangers shall not be permitted, without Engineer's approval.

All hangers shall be provided with lock nuts and have provisions for vertical adjustment of pipes.

Individual horizontal piping shall be supported by hangers consisting of malleable split rings with malleable iron sockets, or steel clevis type hangers, or roller hangers as directed by the Engineer.

Pipe stands with base flanges and adjustable type yokes shall be used for pipes supported from the floor.

Vertical piping shall have heavy wrought iron or steel clamps securely bolted on the piping with the end extensions bearing on the structure of the building.

Piping shall be anchored where required to localize expansion to prevent undue strain on piping and branches. Anchors shall be entirely separate from hangers and shall be heavy forged or welded construction of approved design.

Hangers for cold piping shall have hardwood inserts or high density insulation capable of withstanding the compression and allowing the hanger to support the pipe without any metal contact.

Upper ends of iron rods shall be welded to angles attached to ceiling (concrete slab) by anchor screws and heavy iron washers.

5-02.5 Pipe Sleeves

All pipe penetrating through walls, partitions and slabs shall have sleeves having an internal diameter at least 1" larger than the outside diameter of the pipe or of the insulation passing through the sleeves.

Pipes passing through interior masonry or concrete floor shall be provided with sleeves of galvanized standard wrought steel pipe flush with walls and ceilings and extending 1" beyond external surface of wall or above finished floor.

On the exposed pipes, passing through floors, wall, partitions plaster furrings, split type nickel plated circular steel plates, 3" larger in outside diameter than the outside diameter of the pipe or pipe covering, shall be provided.

5-02.6 Flashing Sleeves

Flashing sleeves are to be provided where pipes pass through water proof membranes. Flashing sleeves details are to be submitted to the Engineer for approval but generally they shall be provided with an integral flange set into the membrane. The associated pipe shall also have a flange and sealed with approved mastic.

5-03 VALVES & SPECIALITIES

5-03.1 General

Valve and piping specialties shown on drawing are only schematic and all required valves and specialties are not necessarily shown on drawings.

The Contractor shall furnish all shut-off valves, check valves, drain cocks, dirt traps, automatic vents, manual vents, relief valves, strainers and other specialties as are required for proper operation of the whole system.

All valves up to 2" shall be of bronze body with threaded connection.

All valves of sizes from 2.5" up to 8" shall have cast iron body and renewable bronze seat rings and self -packing feature so that they can be packed while open

and under pressure.

All valves larger than 8" shall be of ductile iron body Pressure Rating for all Threaded valves shall not be less than PN20

Pressure Rating for all Flanged valves shall not be less than PN16 or Class 125.

All valves shall be of design and construction to conform the valves body testing at 1.5 times (during manufacturing) & valve seats testing at 1.1 times of valve rating as per BS EN 12266-1:2003.

5-03.2 Plug Valves

Plug valves shall be used for drain cocks and stop cocks at air vents.

5-03.3 Pressure Reducing Valves

Pressure reducing valves shall be used where shown on the drawings.

5-03.4 Balancing Valves/Circuit Setter

Circuit setter type valves as specified hereunder shall be used for balancing purpose where shown on drawings.

Shut-off valves shall be installed on both sides of all equipment. Balancing valves shall be installed where required for flow balancing. Make of valves shall be subject to Engineer's approval.

These valves shall be calibrated and with bronze, EPDM or PTFE seat rings equipped with readout valves. Each readout valve shall be fitted with an integral check valve designed to protect the user from being wetted when setting up to monitor flow. An integral pointer shall register degree of valve opening. Each balancing valve shall be constructed with internal seals to prevent leakage around rotating elements.

The Contractor shall arrange for the Read-out kit specified by the manufacturer for balancing flow through the valves without any additional cost.

DN65 & Above: Flange Type

- Flange to Flange: EN558-1(1) comply to EN13789
- Body & Bonnet Material: Cast Iron, Bolted Bonnet Type
- Disc & Disc Rings: Cast Iron Disc, PTFE or Bronze Disc Rings, or complete Bronze
- O Ring: EPDM or PTFE Teflon
- Indicator: ABS / PVC
- Bushing: Bronze
- Painting: Epoxy Painting

5-03.5 GATE VALVES

DN65 & Above: Flange Type

- Hand wheel Operation: Rising Stem or Non Rising Stem, (as specified)
- Valve Standard: EN558-1(3), EN1171, BS 5150, API 600, JIS 16K
- Body & Bonnet Material: Cast Iron, Bolted Bonnet Type
- Seats & Stems Material: Renewable in Bronze
- Painting: Epoxy Painting

DN50 & Below: Threaded Type

- End to End: EN 12288-1, BS 5154 or equal
- Body & Bonnet Material: Bronze

5-03.6 Relief Valves

Relief valves shall be provided for over-pressure protection. Valves shall have flanged-end connections except for valves 1" and smaller.

5-03.7 Globe Valves

GLOBE valves SHALL BE USED FOR BALANCING PURPOSE WHERE SHOWN ON DRAWINGS.

DN65 & Above: Flange Type

- Type: Rising Type OS&Y
- Valve Standard : EN558-1(1) comply to EN13789
- Body & Bonnet Material: Cast Iron, Bolted Bonnet Type
- Seats & Stems Material: Renewable in Bronze
- Painting: Epoxy Painting

DN50 & Below: Threaded Type

- End to End: BS 5154 or equal
- Body & Bonnet Material: Bronze CC491K

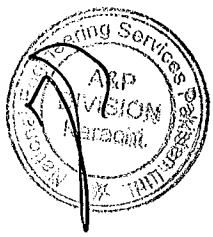
5-03.9 Non-Return/Check Valves

Non-return/check valves shall be non-slam check valves, spring loaded with stainless steel torsion spring. The valves body shall be lapped bronze seat, and spring loaded twin balanced flappers of bronze. The flappers shall open and close at low differential pressures to prevent damaging effects of water hammer created on pump shut-down.

DN65 & Above: Flange Type

- Valve Standard: EN558-1(10) comply to EN12334, ANSI 16.10
- Body & Bonnet Material: Cast Iron, Bolted Bonnet Type
- Disc Seat Rings Material: Renewable rings in Bronze
- Painting: Epoxy Painting

DN50 & Below: Threaded Type



- End to End: BS 5154 or equal
- Body & Bonnet Material: Bronze

5-03.10 Strainers

Approved strainers shall be fitted in the suction line of pumps, at make-up connections and at each automatic control valve of all apparatus of an automatic character whose proper functioning would be interfered by dirt on the seat, or by scoring of the seat. All strainers shall be pressure tested at works.

All strainers shall be of ample strength for the pressure to which they shall be subjected and with suitable flanges or tapings to connect with the piping they serve.

Strainer basket screens shall be stainless steel and shall be of ample strength to prevent collapsing the basket under shock loading. Perforations shall be in accordance with the following table:

Pipe Size	Perforation Size (Inches)	Number of Perforations (Per Square Inches)
All Sizes	3/64	225

Valve dirt blow-out connection suitably piped to the nearest floor drain.

DN65 & Above: Flange Type

- Flange to Flange: EN558-1(1) comply to EN13789
- Body & Bonnet Material: Cast Iron, Bolted Bonnet Type
- Perforated Mesh: Stainless Steel 304
- Painting: Epoxy Painting

DN50 & Below: Threaded Type

- End to End: BS 5154 or equal
- Body & Bonnet Material: Bronze
- Perforated Mesh: Stainless Steel 304 - Stainless Steel 316

5-03.11 Air Vents

Wherever possible, all water pipe work systems shall have manual venting at all high points in the system. Where this is not possible an automatic air vent shall be fitted and connected to the nearest drain. Air vents shall be of the flat type, and of appropriate sizes and working pressures. They shall be fitted with a suitably sized gate type lock shield valve. Manual vents shall be fitted with hose-nozzles.

DN50 & Below: Threaded Type

- Pressure Rating: Minimum PN16 equal to (360 Psi)
- Body & Bonnet Material: Forged DZR Brass or Bronze

- O-Ring: NBR Rubber
- Internal Float Polythene

5-03.12 Flexible Pipe Connectors

Flexible connectors shall be provided wherever pipes cross building expansion joints, at suction and discharge side of each pump and at connections to chillers, and/or wherever shown on the Drawings. These connectors shall be such that the working pressure, temperature and movement encountered will not be more than 75% of that allowable for the joint. One side of joints must have all piping and/or adjacent equipment adequately anchored. The other side must be supported, aligned and guided so as to allow free movement without imposing unnecessary stresses on the joints.

Connectors shall have integral duck and rubber flanges. They shall have individual solid steel ring reinforced with a carcass of highest grade woven cotton or acceptable synthetic fiber. Joints shall be constructed to pipeline size and to meet working pressures, conditions and face measurements as designated. They shall be of archetype construction with the number of arches (corrugations) dependent of the projected movement. All joints must be finish- coated with suitable paint to prevent ozone attack. Split back-up (or retaining) rings shall be furnished and fitted.

DN65 & Above: Flange Type

- Body: Neoprene Rubber with Steel Wires
- Internal Layer Nylon / Fiber
- Flanges: Steel (Galvanized) or Black Epoxy Painted

DN50 & Below: Threaded Type

- End to End: Neoprene Rubber with Steel Wires
- Union End: Galvanized

5-03.13 THERMAL EXPANSION JOINTS

Thermal expansion joint bellows shall be fully annealed type 321 stainless steel sheet stock rolled into a tube and seam welded with latest technology in forming the corrugations. The bellows shall be designed to take linear thermal expansion as well as axial load.

The end connections will be fixed flanged type and shall be of stainless steel conforming to ANSI dimensions welded directly to the integral ends of the bellows.

The thermal expansion bellows shall be designed to absorb the thermal expansion of at least +50 mm and working pressure of 16 bars.

SECTION 6 – INSULATION

6-01 GENERAL

6-01.1 The Contractor shall provide insulation for the services and equipment specified hereafter. Insulation shall be as per following Insulation Schedule.

6-01.2 Insulation material shall be complete with vapor barrier protection covering and jacketing (where specified), adhesives, insulation tape, duct sealer and/or sealing tape, fastening material, and jacketing for outdoor ducting and piping.

6-01.3 Identification bands shall be painted on insulation at frequent intervals. Lettering shall be agreed with the Engineer.

All exposed insulation in the plant room is to be painted to approve colors with one undercoat and one finishing coat of enamel paint. All steel pipe work and other steel equipment specified to be insulated shall be thoroughly wire brushed to the satisfaction of the Engineer and painted with one coat black cold asphalt paint before insulation is applied.

6-02 Insulation Schedule

No.	Services	Thickness (Inches)	Insulation Type	Vapor Barrier	Protection
a)	Indoor supply/return duct				
i)	Concealed to vision outdoor-air duct passing through conditioned space	1	Glass fiber blanket	Reinforced aluminum foil	8-Oz canvas
ii)	Exposed to vision and plant rooms	2	Glass fiber blanket	Reinforced aluminum foil	4-Oz canvas with water proof paint. Galvanized iron sheet metal jacketing. Additional treatment of 02 coats of epoxy resin coating, 02 coats of rust

					& fungus preventive paint shall also be applied to outdoor pipes.
iii)	AHU rooms	2	Glass fiber blanket	Reinforced aluminum foil	4-Oz canvas with water proof paint.
b)	Supply ducts, up to 10 feet from fan discharge and sheet metal air plenums	1	Acoustic liner applied inside with outside insulation as Item 6-02 (a)	Same as 6.02 (a)	
c)	Chilled/hot water piping, fitting valves & specialties				
i)	Indoor	See 6-02(g)	Glass fiber blanket	Reinforced aluminum foil	4-Oz canvas
ii)	AHU rooms	See 6-02(g)	Glass fiber blanket	Reinforced aluminum foil	4-Oz canvas with water proof paint.
iii)	Central plant room and outdoor	See 6-02(g)	Glass fiber blanket	Reinforced aluminum foil	4-Oz canvas with water proof paint. G.I. sheet metal jacketing. Additional treatment of 02 coats of

					epoxy resin coating, 02 coats of rust & fungus preventive paint shall also be applied to outdoor pipes.
d)	Cooling coil condensate drain piping	2	Closed Cell Foam	Reinforced aluminum foil	Additional treatment of 02 coats of epoxy resin coating, 02 coats of rust & fungus preventive paint shall also be applied to outdoor pipes.
e)	Chiller	As per Recommendation of Chiller or Hot Water Generator's Manufacturer			
f)	Expansion tank and air separator	1	Glass fiber blanket	Reinforced aluminum foil	1/2" thick 8 Oz canvas water proof paint metal jacketing.
g)	Insulation thickness if not specified above shall be as under:				
i)	Water pipe UP TO 2" 2-1/2" TO 5" 6 AND ABOVE	 1 2 2-1/2	 Glass Fiber Glass Fiber Glass Fiber	-	-
ii)	Valves and other	Thickness shall be same as			-

	specialties	applied to connected pipes			
h)	Flue stack / breaching	2	Mineral fiber	-	1" thick reinforced magnesia further with G.I sheet metal jacket. Additional treatment of 02 coats of epoxy resin coating, 02 coats of rust & fungus preventive paint shall also be applied to outdoor pipes.

6-03 INSULATION MATERIALS

6-03.1 Duct Insulation

Insulation material for ducts and sheet metal air plenums shall be flexible glass fiber, 1.0 lbs/cu.ft. Density and maximum conductivity of 0.27 Btu/hr.sq.ft./inch at 75 deg F.

6-03.2 Piping Insulation

Piping insulation shall be sectional glass fiber as specified above in Insulation Schedule, bounded to conform to the pipe. All glass fiber pipe insulation shall have a density at least 4 lb/cu.ft. and maximum conductivity of 0.27 Btu/hr.sq.ft.°F/inch at 75 Deg F.

6-03.3 Vapour Barrier for Duct and Pipe Insulation

Vapour barrier when specified shall be factory applied flame retardant reinforced aluminum foil, 0.02 mils thick.

6-03.4 Acoustic Liner Material

Acoustic liner shall be 1.5 lbs/cu.ft. Density fiber-glass with neoprene scrim on inside surface and thermal conductivity value shall not exceeding 0.27 Btu/hr.sft °F /inch at 75 Deg F. Material shall conform to TIMA Standard AHC-101-1975 with latest revisions.

6-03.5 Cooling Coil Condensate Pipe Insulation

Shall be 1" thick pipe insulation as mentioned above with aluminum foil self

adhesive tape 3" wide.

6-03.6 Chiller-Heater Insulation shall be as per recommendation of Chiller-Heater Manufacturer.

6-03.7 Expansion Tank and Air Separator Insulation

Shall be glass fiber, at least 3 lbs/cu.ft. density or closed cell foam type at least 3.5 lbu/cu.ft.

6.03.8 Insulation for Breaching/Flue Stack

Shall be spun mineral fiber with thermal conductivity not exceeding 0.56 BTU/(hr)(Sq.ft.)(F)/inch at 600 deg.F. Insulation shall have wire netting jacket on one side and copper clad or brass wire mesh jacket on the other side.

6-03.9 Insulation Protection Material and Accessories

6-03.9.1 Canvas

4 Oz or 8 Oz per square yard as specified in Insulation Schedule.

6-03.9.2 Jacket

26 gauge (US) galvanized steel sheet or aluminum sheet.

6-03.9.3 Water & Rat Proof Paint

As approved by the Engineer.

6-03.9.4 Wire Netting

1" hexagonal mesh, 20 gauge (US), galvanized.

6-03.9.5 Metal Lathe

Expanded metal lathe with 1/2 inch diamond mesh.

6-03.9.6 Banding

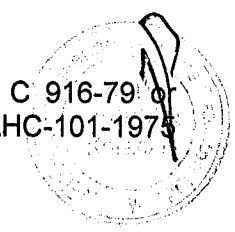
1/2" x 1/48" galvanized steel or aluminum bands.

6-03.9.7 Insulation Tape

Insulation tape for joints shall be of aluminum foil type, 2 inch wide, equivalent to Scotch No.473.

6-03.9.8 Adhesive

Adhesive for thermal insulation shall comply with ASTM Standard C 916-79 or equivalent. Adhesive for acoustic liner shall comply TIMA Standard AHC-101-1975 or equivalent.



6-03.9.9 Duct Sealer

Sealer for duct joints shall be butyl rubber caulking, weather proof and water resistant, conforming to U.S. Federal Specification TT-S-001657 Type 1, as manufactured by Woodmont Products, INC, USA, or approved equal.

6-03.9.10 Duct Sealing Tape

Duct sealing tape shall be 3 inch wide self-adhesive vinyl cloth tape.

6-04 INSULATION APPLICATION

6-04.1 General

All Thermal and acoustic insulating materials shall be installed as specified hereinafter.

Insulation shall be installed in a smooth, clean, workmanlike manner and joints shall be tight and finished smooth.

All surfaces to be insulated shall be dry and free from loose scale, dirt, oil or water when insulation is applied. Insulation shall be applied in such a manner that there will be no air circulation within the insulation or between the insulation and the surface to which it is applied.

Surface imperfections in the insulation such as clipped edges, small joints or cracks and small voids, or holes not over 1 inch square shall be filled with like insulating material.

Where a vapor barrier is fixed on site it shall be fixed in such a manner as to obviate the possibility of moisture penetration. It shall be fixed where required by means of an approved type bituminous compound or approved equal for tightness.

Insulation for all services shall only be applied until after testing and approval for tightness obtained from the Engineer, unless otherwise instructed in writing by the Engineer.

Insulation for all services shall be continued through sleeves. The insulation on exposed risers shall extend through the floor. Where insulated pipes are indicated on drawings as embedded in the thickness of walls, the insulation thickness may be reduced to 1 inch only.

Insulation is to be applied where indicated on the drawings or called for in these specifications.

6-04.2 Duct Insulation

Before applying insulation, either sealing tape or duct sealer shall be applied on all corners of traverse joints for air tightness.

The insulation shall be fixed on ducts with a suitable adhesive as specified. Adhesive shall be applied on at least 75% surface area. In addition to the fixing by adhesives, insulation on the underside of ducts exceeding 18 inch width must have mechanical fasteners of an approved pattern to prevent insulation sagging, or

alternatively bands as specified above shall be used at intervals not exceeding 4 feet.

All joints on the insulation shall be sealed with 2 inch aluminum foil tape. The tape shall only be fixed to the vapor seal and not to the bare insulation and, therefore, joints in the insulation shall not occur longitudinally at corners of ducts. If it is unavoidable to have joints at longitudinal corners then the insulation must be cut back and the vapor seal folded over the bare edge of the insulation so that the tape adheres only to the vapor seal.

6-04.3 Duct Insulation Protection

Indoor Exposed Duct: Insulation shall be covered over the vapor seal with a single layer of canvas with generous overlaps. The canvas shall be fixed with an approved adhesive.

6-04.4 Piping and Accessories Insulation

All pipes, fittings, valves and equipment requiring insulation in accordance with Insulation Schedule, shall be insulated with material specified under "Insulation Materials".

Longitudinal joints of pipe insulation shall be sealed with an overlap of vapor seal firmly fixed with an approved/specified adhesive.

Circumferential joints shall be sealed with insulation tape.

6-04.5 Pipe Insulation Protection

(a) Indoor Pipe Exposed

This finishing shall be used where the insulation is exposed to view.

The 8 Oz canvas wrapped around insulation shall be wrapped and fixed with approved adhesive.

The canvas shall be finished with three coats of Benjamin Foster's "Selfas" or other equal and approved.

(b) Outdoor Exposed Piping and Plant room piping

The insulation shall be covered with stout gauge, epoxy coated G.I. sheet metal jacketing. This finish shall be over the 8 Oz canvas applied as specified in (a) above.

6-04.6 Insulation for Equipment having Renewable Heads

Insulation which is applied to equipment having renewable heads and/or access plates shall be applied in a manner which will permit easy removal and replacement of the insulation. In general this shall be accomplished by encasing the insulation in sheet metal boxes which shall be bolted together.

6-04.7 Condensate Drain Piping

Self adhesive pipe insulation tape, as specified above, shall be spiral-wrapped around pipe, with 50% overlap. The insulation shall be covered with protective covering against rusty, salty or harsh environment for outdoor application.

6-04.8 Expansion Tank Insulation/Air Separators Insulation

Glass fiber insulation fixed with adhesive shall be finished with canvas jacket applied and saturated with adhesive. Insulation shall be further held with metal bands. Canvas shall be covered with approved gauge G.I./Aluminum sheet metal jacketing.

6-04.10 Insulation for Breaching/Flue Stack

Breaching and flue ducts shall be protected with one layer of magnesia, reinforced with wire netting. Outdoor flue ducts shall have G.I. powder coated sheet jacketing over magnesia.

6-05 PIPE INSULATION PROTECTION SHIELDS

Insulation shields shall be used at all hangers supporting insulated pipe to protect the insulation wherever fiberglass pipe insulation is installed. Where hangers and insulation shields are installed the insulation shields shall bear only an insulation material which is of such density that it will not compress, crush or deform. Density at these points shall not be less than 6 lb/cu.ft. Thickness and k- factor shall be at least equal to general run of insulation. Insulation manufacturer shall confirm suitability of insulation support without any visible compression.

Shields shall consist of 10 gauge galvanized steel plate. The plate shall be curved to fit the contour of the insulation and shall cover the lower 180 degree of the surface. Shields shall be secured to the insulation by means of galvanized steel or aluminum bands, and shall not be less than 10" in length.

SECTION 7 - ELECTRICAL EQUIPMENT & CONTROLS

7-01 SCOPE

a) The Contractor shall supply all panel boards, starting equipment, circuit breakers, busses, isolators, conducting cables, wiring, conduits, earth conductors, etc., for the entire HVAC system.

b) The earthing system shall consist of supply and installation of earth continuity conductor and running earth conductor all along the cable length. All material such as earth continuity conductors, earth connecting points, including the installation material and accessories shall be supplied and installed by the Contractor as specified.

c) For further details refer to Clause 7-02, "Distribution and Control Scheme".

7-02 DISTRIBUTION & CONTROL SCHEME

HVAC Contractor shall furnish and install one main electrical panel (MCC-1) to be located in HVAC central plant room.

All electrical works downstream of MCC-1 (including MCC-1, Power Factor Panel & ACPs) shall be in the scope of HVAC Contractor.

Electrical Works for the Data Center for HVAC Works is not included in the HVAC Contractror's Scope.

7-03 GENERAL

All electrically operated equipment shall comply in all respects with the relevant B.S Standards including dimensional standards where these exist, except in so far as this Specification is at variance therewith.

All electrically operated equipment shall be so designed that it will continue to function without damage to itself or otherwise, if the voltage and/or frequency vary within the following tolerances.

- Voltage plus or minus TEN percent.
- Frequency plus or minus SIX percent.

The entire installation shall be in accordance with the requirements and to the entire approval of the Electricity Department of the Government and the approval of the Engineer.

In general, all electrically operated equipment shall be suitable for continuous and prolonged operation in an ambient temperature of 40°C. This temperature makes no allowance for local rises in air temperatures due to the operation of the equipment itself or of heat produced in or by adjacent equipment such as compressors, condensers or heaters. The maximum operating temperature in standards specified shall be observed. Allowance for local high ambient temperature shall be made by reducing the permitted rises of temperature above ambient.

7-04 ELECTRICAL MOTORS

Unless otherwise indicated in these Specifications or in the Schedules, all motors which are not factory supplied by equipment manufacturer shall be totally enclosed fan cooled, of squirrel cage construction and of approved manufacturer. All such local manufactured motors shall be of Siemens make or approved by the Engineer.

Insulation on all motors shall be equal to Class F (IP 55). The efficiency of motors shall not be less than IE3. All motors shall be designed for continuous operation in the ambient temperature as mentioned in the respective equipment schedule or specifications. All Motors shall be properly de-rated for operation in an ambient temperature of 113°F (50 °C).

All motors and accessories such as protection and control devices etc. shall comply in all respects with NEMA, current B.S. Standards and I.E.E. Regulations. Single phase motors shall be capacitor-start induction run construction, unless otherwise indicated or specified.

All motors shall be quiet operating guaranteed to fulfill specified requirements without producing any sound audible outside of plant rooms. All belt- driven motors shall have adjustable bases and set screws to maintain proper belt tension, with proper belt guards. Motors installed in the building should be super silent sleeve bearing type.

The starting current of all motors above 10 hp. shall not exceed twice its rated full load current. For motors of rating 10 hp. and below the starting current shall not exceed 7 times its rated full load current or one hundred amps, per line, whichever is larger.

7-05 MOTOR STARTERS AND ISOLATION

Each three phase motor shall be provided with a protective automatic starter to disconnect the supply in case of:

Failure of the supply
Serious drop in voltage
Flow of excess current
Failure of any phase (single phasing)

All starters shall be properly de-rated for operation in an ambient temperature of 113°F (50°C).

Manual starters may be used for motors 1/2 hp and less and shall include thermal overload protection and disconnect switch. These should only be used when no automatic switching is intended.

DOL starters shall be used only on motors of 10 HP and less.

All motors, control gear and ancillary equipment shall be protected by H.R.C. fuses or circuit breakers in addition to the protective starter mentioned above. Such fuses shall be part of the control gear. The isolator shall be integral with control gear.

Single phase motors shall be protected by circuit breakers with overload

protection. Where several starters are mounted in a panel rack or bank, each starter shall have separate H.R.C. fuses or circuit breaker isolator. Manual starters for single phase motors should only be used when no automatic switching is intended.

Where starter operating circuits and ancillary apparatus are energized by an auxiliary supply other than the main power circuit to the motor the isolator shall incorporate auxiliary contacts to effectively isolate all poles of phases of such auxiliary supplies. Where necessary, two isolators shall be used.

All starters not in a central panel shall have a sheet metal enclosure with a removable lid and cover and necessary brackets for mounting on panel or wall. A clear schematic diagram of the starter circuit shall be fixed inside the cover of each starter.

All magnetic starters subject to manual start shall have momentary contact start and stop buttons built into cover. All magnetic starters subject to electrical interlock or automatic control shall have hand-off automatic switches built into cover.

All coils, cores, insulation, contacts and trippers to starters and relays and all parts subject to wear and arcing shall be renewable.

7-06 POWER AND CONTROL WIRING

All power wiring from the point of supply as described in previous sections to each equipment shall be carried out by the HVAC Contractor. All control wiring from each equipment to applicable control panels and Control System shall also in scope of HVAC contractor.

All conduits supplied by the Contractor for power and control wiring shall be of heavy gauge 16 SWG steel, manufactured and tested in accordance with BS 31.

The conduit shall be protected by two base coats of red oxide antirust paint and finished in first quality black enamel paint.

The conduit accessories, such as sockets, elbows, bushings, bends, etc., required for installation of conduit shall be furnished by the Contractor. The accessories shall conform to the same quality and specifications as for the conduits. All outlet boxes, inspection boxes, junction boxes, saddles, clamps etc., wherever required shall be provided by the Contractor.

Flexible steel conduits shall be installed at termination to equipment which is subjected to vibration. The flexible conduit shall consist of single-strip galvanized steel which shall be spirally wound, dust tight, mechanically continuous and strong. Where necessary, flexible conduit shall be adequately supported. All accessories for installation of flexible metal conduit shall be provided with an overall rubber covering. At all terminations, the conduit shall be held firmly in position by approved type of glands.

All LT cables for power and control system shall be copper conductor, PVC insulated for single core and PVC insulated PVC sheathed for multicore. All cables shall be of specified voltage grade complying with BS 6346 and/or BS 6004. The PVC insulation shall comply with BS 6746. Conductor shall be stranded or solid high conductivity soft annealed copper complying with BS 6360.

All multicore and single core sheathed cables for circuits operating up to 250 volts shall be 300/500 volts grade. All single core unsheathed cables shall be of 450/750 volt grade.

All power cables for main feeders, main to sub-main feeders, power equipment, etc., shall be multi-core copper conductor, armored or unarmored and shall be of 600/1000-volt grade.

All cables shall have phase identification colours on insulation of each core. The colour code for three phase circuits shall be red, yellow and blue for phase conductors and black for neutral conductor. Where insulated earth conductor is installed, it shall have green or green and yellow insulation.

While cable selection for the specified project, the power factor is required to be considered as 0.8.

Single-phase circuits shall have red for phase and black for neutral conductor.

All DC circuits shall have red for positive and black for negative conductor.

7-07 CABLE TRAYS

The Contractor shall discuss the layout with the Engineer and co-ordinate at Site with other services for exact route, location and position of the cable trays for electrical lines. It must be noted that the extent of works shown on the drawing does not indicate the exact position of cable trays. The Contractor shall ensure exact location and route of cable trays in coordination with other services drawings, as per site requirements and as directed by the Engineer.

7-07.01 Applicable Standards/Codes

Latest editions of the following standards / codes shall be applicable for the materials in scope of this Section:

BS 729 Hot dip galvanized coating on iron and steel articles

7-07.02 Products

The cable tray system shall be of one manufacturer and shall include factory-made trays, tray fittings, connectors and necessary accessories and supports to form a complete cable support system.

The cable tray system shall include the following factory - made tray elements:

a) Straight cable trays and ladders
b) Fittings as horizontal and vertical bends of various angles, crosses, tees, wyes, reducers, vertical riser elements
c) Connectors
d) All necessary fixing accessories.

Manufacturer's standard accessories shall be used and site fabrication shall not be permitted.

Horizontal run of cables laid on cable tray and exposed to direct sunlight shall be provided with covering at higher level to allow for ventilation

7-07.03 Materials

The whole of the tray work, trays, fittings, supports shall be of mild steel hot dipped galvanized after manufacture to BS 729. The thickness of the protective sheath on any element shall not be less than 55 microns.

Cable trays shall be constructed from mild steel hot dip galvanized and of minimum thickness of 1.5mm.

Insert elements, bolts, screws, pins, etc., shall be mild steel cadmium plated.

Tray work shall have oval perforations. Ladder type trays shall be used for vertical runs as approved by the Engineer.

All trays (straight and fittings) shall be welded construction and be a heavy duty returned-flanged, perforated type, unless specified otherwise. The minimum thickness of heavy duty returned flanged cable trays shall be 1.5mm.

Tray components shall be accurately rolled or formed to close tolerances and all edges rounded. Flanges shall have full round smooth edges.

Ladder racks shall be of similar construction. The rungs shall be spaced at maximum 300 mm. The system shall allow for installing additional rungs and for replacement of rungs.

For all trays, flanges shall be a minimum of 50 mm deep, unless otherwise specified.

Cable tray width and radius of curved sections shall be selected to suit the number of cables as shown on drawings and to the approval of the Engineer

Cable trays and accessories installed in hazardous and extremely corrosive environments shall be heavy duty GRP or 316 S31 grade stainless steel.

7-07 APPARATUS CONTROL PANELS (ACPs)

The panel shall be of sufficient size and dimensions to house various equipment for the installation. The panel shall be provided with lock and double set of keys. The panel shall be minimum of 14-gauge steel painted with powder coating inflammable paint. It shall be of the unit construction single fronted or double fronted type. It will be constructed such that doors are interlocked, preventing access to the devices installed inside without switching off the Main Circuit Breaker on incoming line.

This panel will contain the following equipment (but not limited to)

Circuit breaker on incoming line.
Circuit breakers, one for each outgoing line.
Starters with thermal overload protection for equipment which does not have factory supplied and/or equipment-mounted starter.
Relays, toggle switches, push button stations, hand-off-auto (HOA) switches - Labels on all components.
Terminal strip.
Relays and other devices for Temperature and Automatic Controls furnished by

Controls Manufacturer for field installation.
Pilot lights, one for each starter, red for equipment operating.

All internal wiring and accessories clipped individually to the panel and arranged parallel or at right angles.

All indications shall be visible from the front of the panel. Prior to installation, the contractor shall submit for approval of the Engineer the electrical diagram of the whole installation and the suggested electric panel layout showing samples of instruments and components.

7-08 LOCAL ISOLATING SWITCHES (LIS)

The Contractor shall provide local isolating switches moulded-case type enclosed in metal boxes for disconnecting all power to the equipment in emergency and during maintenance, for all equipment controlled by remote MCC or ACP. These switches shall be installed near the equipment within visual range and shall be weather proof for outdoor installation.

7-09 COMPONENTS

The HVAC panels shall be provided with all components as specified and as necessary for the satisfactory operation of the HVAC system. Typical specifications are given hereunder:

7-09.1 Bus Bars

The bus bars shall be made of high conductivity electrolytic copper and shall be completely isolated and mechanically braced for the specified fault level. The phase identification of bus bars shall be by colours applied on full length of bus bars and these shall be red, yellow and blue for phases and black for neutral. The earth bus bar shall be green.

The bus bars shall be triple pole. The neutral and earth shall be of appropriate size to meet the electrical and mechanical requirements of the system. The temperature rise shall not exceed 45 degrees centigrade at rated current.

7-09.2 Circuit Breakers

The circuit breaker shall be triple pole, moulded case, manually operated type with front drive grip handle. ON-TRIP-OFF indication shall be provided on all circuit breakers. The circuit breakers shall have the following protections and setting range unless otherwise shown on the drawings:

- Adjustable three poles, manual reset thermal overload release of setting range 80 to 100% of rated current.
- Magnetic triple pole short circuit release having range according to manufacturer's standard range.
- The incoming circuit breakers shall have two numbers each of potential free normally open and closed auxiliary contacts rated for 2 Amp, 230 VAC. The incoming circuit breaker shall also have ON, TRIP and OFF indicating lamps. The circuit breaker shall have specified rupturing capacity, without the use of

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back-up fuses. Auxiliary release and trip coils shall be provided for desired operation and/or interlocking as required.

7-09.3 Push Buttons

Push Buttons shall be momentary make/brake contact type (normally open/normally close). These shall be suitable for flush mounting. Push Buttons shall have round/square head. These shall have red and green colors for 'ON' 'OFF' switching operation respectively.

7-09.4 Energy Analyzers

Energy Analyzers & metering system shall be microprocessor digital based system consisting of energy analyzer, serial communication ports, data loggers / converters and any other hardware required to interface with BMS System.

The energy analyzer shall be of at least 96 x 96 mm and accuracy class 1 for active power and reactive power class 2.

The data from energy meters shall be read for real time views and recording / analyzing by third party BMS.

The energy analyzer shall be able to produce at least following:

1. Current present and maximum values
2. Active, reactive, apparent power present and maximum values
3. Voltage (Line to Line, Line to Ground and Line to Neutral)
4. Power Factor total and per phase
5. Frequency

The energy analyzer shall be able to cater communication systems which includes RS-485 Interface (MODBUS RTU) and Ethernet.

7-09.6 Air Break Contactors

The contactor shall be air break, triple pole, 400V AC suitable for the type of duty to be performed. The main contacts shall be silver tipped, butt type with double break per pole. Each contactor shall be provided with 230 VAC single phase operating coil, and minimum two normally open and two normally closed auxiliary contacts wired up to terminals. The number of working auxiliary contacts shall be provided according to the system requirements.

7-09.7 Indicating Lamps

Indicating lamps shall be suitable for flush mounting, complete with base, 230 volt incandescent lamp and shall have rosettes of suitable color (green for ON, Red for OFF and Amber for TRIP).

7-09.8 Line up Terminals

Line up terminals wherever provided for control or power circuits shall be suitable for voltage and size of conductors.

The line-up terminals for controls shall be suitable for channel mounting. All

necessary accessories such as end-plates, fixing clips, transparent label holder caps and label sheets with marking shall be provided.

7-09.9 Current Transformers

Air cooled, ring type current transformers shall be provided having transformation ratio as required. The current transformers shall be of suitable burden having accuracy class 1.0 and have 5 amps secondary.

7-09.10 Load Break Switches

Triple pole rotary 500 Volts AC on-load isolating switches of current rating as specified shall be provided complete with front drive grip handle and front plate.

7-09.11 HRC Fuses

HRC fuses shall be provided complete with fuse bases, fuse etc. The fuses shall have a fusing factor as specified for class QI.

7-09.12 Control Selector Switches

The selector switches for lights and other controls shall be rotary cam type, having required number of positions, complete with knob and front plate with position indication.

7-09.13 Frequency Converters (Inverter)

See specifications given under section-8 "HVAC Control System".

7-09.14 Labels

Each equipment on the panel shall be identified by a nameplate. Metallic nameplate with 6mm high etched letters shall be attached to the panel or integral with it. Lettering shall be cut into the plate to a depth of not less than 0.4 mm and shall show a contrasting colour produced by filling with enamel or lacquer. Painting of lettering directly on the surface of the plate or panel will not be permitted.

7-09.15 Outdoor Installation

All ACPs mounted outdoor or on roof shall be of weather proof construction minimum IP 54 rated suitable for operation at 50°C ambient temperature condition.

7-10 EARTHING

7-10.1 General

For scope of work refer to clauses 7-01 and 7-02.

All HVAC equipment with electricity connection and all ACPs and LISs panels shall have their frames, carcasses and all metal parts not normally carrying current, effectively and continually connected to the general mass of the earth. Each equipment and panel shall be separately connected to a main earth continuity conductor.

7-10.2 Earth Continuity Conductors

Earth continuity conductor shall be round, hard drawn, bare electrolytic copper wire of appropriate sizes as approved by the Engineer. All fixing accessories, earthing clips, sweating sockets, lugs, thimbles, etc., shall be provided for a complete earthing installation.

7-11 CONDUITS & CONDUIT ACCESSORIES

7-11.1 Material Description

The conduit for wiring shall be of polyvinyl-chloride material for use in concealed to vision locations and G.I. pipe in exposed locations including vertical shafts. All other accessories shall be subject to Engineer's Approval.

7-11.2 Application of PVC Conduit

Manufactured smooth bends shall be used where conduit changes direction. Bending of conduit by heating or otherwise shall be allowed at special situation only, for which approval of Engineer shall be necessarily required. The use of sharp 90 degree bend and tees shall not be allowed. The bends shall have enlarged end to receive conduit without any reduction in the internal diameter at joint. Round Junction Boxes shall be provided with one piece PVC Cover plate which shall be installed on the box by means of galvanized screws. Pull box shall be installed in conduit runs, wherever required to limit the pulling length of cables. Pull Boxes should be installed in conduit runs to limit the pulling lengths as required. The rectangular inspection or pull boxes shall be 16 S.W.G. thick sheet steel having nipples to receive PVC conduit with force fit. The sheet steel box shall be painted inside and outside with black enamel paint over a base coat of red oxide antirust paint, as approved by Engineer. The minimum length of inspection box shall not be less than four times the cables manufacturer's recommended bending radius of the cable. Bushes shall be used at pipe terminations and PVC solution for jointing of pipes.

The PVC conduit used inside the walls and concrete shall be of Class-D and the conduit being used in open space and ceilings shall be of Class-B.

7-11.3 Application of G.I. Conduit

Application of G.I. conduit shall be similar to PVC conduit as specified above, except that pipes shall have threaded socket connections. Pipes and fittings shall be as specified in Piping Section, finished with 2 coats of aluminum paint.

7-12 MOTOR CONTROL CENTRE

The Contractor shall supply and install the Motor Control Center (MCC) as shown on the Drawings and as specified including components for outgoing lines of future chiller. The panel shall be of sufficient size and dimensions to house the various starting and control equipment for the installation. The panel shall be provided with lock and double set of keys. The Motor Control Centre shall be suitable for operating at the voltage and frequency specified. It shall be of the unit construction single fronted or double fronted type with a common set of bus bars. It shall be made up of any number of steel plate cubicles with turned edges mounted side by side sub-divided into compartments to suit the control gear items, all bolted

together to form a self contained switchboard. It shall be constructed such that all doors are interlocked, preventing access to the starter until the corresponding isolating switch is in the "off" position. All equipment shall be inspected or maintained from the front of the switchboard, the main cables to the motor control centre and all outgoing cables from it may enter from top, bottom, or rear, depending on the location and convenience with provisions of steel removable panels covering the cable compartment.

Components shall be mounted in a logical order based on the sequence of operation, all components requiring frequent inspection shall be mounted between 2 ft. and 6 ft. above floor level.

This panel will contain the following equipment (but not limited to):

- Circuit Breaker on incoming line
- Copper busbars with suitable porcelain isolators.
- Circuit breakers, one on each outgoing line.
- Push button stations, one for each starter.
- Pilot lights, one for each incoming main lead, red, yellow and blue to indicate live phases.
- Pilot lights, one for each starter, red for equipment operating.
- Ammeters, one for each main incoming lead and one for each starter.
- Starters with thermal overload protection.
- Voltmeter with commutator.
- Toggle switches, labels.
- Control relay
- Electrical voltage protection relays for under/over voltage, phase failure and phase reversal.

All internal wiring and accessories for the interlocking of the various components, clipped individually to the panel, and arranged parallel or at right angles.

All indications shall be visible from front of the panel. Prior to installation, the Contractor shall submit for approval to the Engineer the electrical diagram of the whole installation and the suggested panel layout showing the arrangement of electric components with samples of instruments and components.

7-13 POWER FACTOR IMPROVEMENT PANEL (PFI)

The Power factor Improvement Plant shall be used for improving the system power factor to keep the same within the limits as prescribed by WAPDA.

The complete enclosures for the Power Factor Improvement Plant shall be fabricated with 14 SWG sheet steel.

The complete sheet steel metal work of the Power Factor Improvement Plant shall be:

- cleaned down to bare shining metal
- de-rusted and de-greased
- painted with two base coats of anti-corrosive RED oxide paint
- Two coats of weather proof powder paint in approved colour.

7.13.1 Components

The Power Factor Improvement Plant shall be provided with components as specified in these specifications, mentioned in the Bill of Quantities, as shown on the Drawings required for the satisfactory operation of the Power Factor Improvement Plant and of the electrical system.

Typical component specifications are given below:

7.13.1.1 Bus Bars

The bus bars shall be made of high conductivity electrolytic copper and shall be completely isolated and mechanically braced for the specified fault level. The phase identification of bus bars shall be by colours applied on bus bars and these shall be red, yellow and blue for phases and white for neutral. The earth bus bar shall be painted green.

The bus bars shall be triple pole and neutral and shall be of appropriate size to meet the electrical and mechanical requirements of the system. The temperature rise shall not exceed 45 degrees centigrade at rated current.

7.13.1.2 Insulators

The insulators for mounting of bus bars shall be suitable for 3 Phase, 4 wire, 415 Volt AC operation as shown on the drawings.

7.13.1.3 Insulating supports

The insulating supports for mounting of bus bars inside the sheet steel enclosure shall be of suitable material and thickness to provide the required insulation. These shall also be suitable to withstand the physical weights of the bus bars.

7.13.1.4 Nuts, Bolts and Washers

The nuts, bolts and washers for the Bus Tie Duct shall be made of galvanized steel suitable for long life operation.

7.13.1.5 Power Factor Regulator

The Power Factor Regulator shall be suitable for sensing power factor in a Three Phase unbalanced load network. The Power Factor meter shall be digital. The regulator shall have provision for Automatic cum Manual operation. The operating voltage shall be same as that for the associated LV switchboard.

The Power Factor Regulator shall be microprocessor controlled for fast computer programming at site. It shall have provisions for sensing connection errors.

SECTION 8 - AIR INLETS AND OUTLETS

8-01 GENERAL

Before placing orders for these items, the Contractor shall check that all items to be supplied by the manufacturer comply for spread, throw, drop and noise, with capacities and characteristics as indicated on the drawings and schedules. All outlets shall be specifically selected for their particular application and designed for quite operation. All items are to be approved by the Engineer.

All air inlets/outlets shall be of material as indicated on the Drawings and Schedules, and/or as specified.

Colour and finish shall be subject to Engineer's approval. Ceiling diffuser face and margin sizes and styles shall be coordinated with false ceiling/boxing type. All devices shall have substantial approved gaskets to completely prevent streaking on walls or ceilings due to leakage.

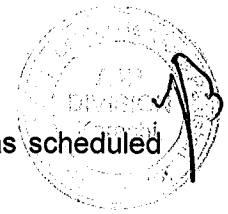
Where ceiling panels and ceiling diffusers are of different size, ceiling diffuser shall be centered in ceiling panel. Duct routing may slightly be adjusted, if necessary, for this purpose or duct drops for diffuser necks may be offset upto a max. of 30 degrees. or diffuser locations having requirement of greater than 30 degrees offset, flexible round insulated duct connection shall be used.

All wooden frames for wall inlets/outlets (where not mounted directly on the duct) shall be 3/4" thick set permanently in the walls. These frames shall be provided by the Contractor. The Contractor shall be responsible for all cuttings of walls, fixing of wooden frames in walls and repair of masonry/plaster required for fixing side-wall inlets/outlets. The Contractor shall furnish wooden frames for wall inlets/outlets to those responsible for civil construction for installation at locations indicated on shop drawings prepared by the Contractor for this purpose.

Ceiling inlets/outlets shall not be supplied on false-ceiling. Cutting of false ceiling (tiles) shall be the responsibility of the HVAC Contractor.

Manufacturer's certified free area for each type and size of grille, register, linear/square diffuser and louver shall also be provided for the purpose of air balancing.

8-02 GRILLES/REGISTERS



All side wall outlets and inlets shall be of sizes and characteristics as scheduled and shown on the Drawings.

Double deflection type grilles shall have vertical front bars and horizontal back bars. Double deflection adjustable bars type registers shall have vertical front bars and horizontal back bars.

All supply outlets shall have opposed blade dampers, finished in black paint, fixed to the outlet and shall be operatable with a removable key inserted from front of the grille.

All return and/or exhaust inlets shall have similar dampers if scheduled.

8-03 CEILING DIFFUSERS

Ceiling diffusers shall be of the sizes and characteristics as scheduled and shown on the Drawings.

Ceiling diffusers shall be furnished with volume dampers as furnished by the diffuser manufacturer, finished in black paint.

Volume control for these diffusers shall be accessible through the diffuser from below the ceiling and shall maintain their setting when adjusted. Each diffuser shall be provided with sponge rubber or felt gasket. Return diffusers shall be similar to supply diffusers unless otherwise indicated. Inner core shall be removable and shall be mounted on outer frame. (Throw pattern for supply diffusers shall be as shown on Drawings by arrows or as shown in schedule).

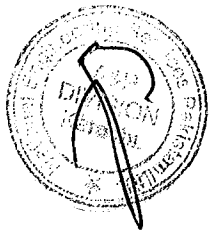
Ceiling diffusers intended for use with flexible round insulated duct shall have suitable inlet box.

8-04 TRANSFER GRILLES

Transfer grilles shall be of the type and characteristics as scheduled. These shall be installed on both sides of wall where no false ceiling is provided, or, where transfer grille is installed below false ceiling level unless otherwise scheduled. Transfer grilles shall be sight-tight where indicated.

8-05 EA/OA LOUVERS

All louvers shall be of approved construction as per AMCA standard 500-74. All louvers shall be fitted with aluminum mesh bird and anti vermin screens. The design of the OA inlet louver blades shall be suitable to arrest rainwater, sand and dust from incoming outdoor air. Sizes are to be as given on the Drawings. Louvers shall be complete in all respects with mounting accessories. Louvers shall be of Scheduled material and finish. Design of OA and EA louvers shall be similar. All EA louvers shall have back draft dampers upstream of louvers.



SECTION 9 - INSTRUMENTS AND GAUGES

9-01 GENERAL

All necessary gauges, and pipeline thermometers and other indicating and measuring instruments as required, specified and shown shall be furnished and installed by the Contractor. All gauges and thermometers shall have labels indicating their function.

Instruments shall include but not limited to:

Pressure gauges.
Thermometers for water piping
Gas flow meter
Testing and Maintenance instruments

These instruments shall be installed as shown on Drawings. Portable testing and maintenance instruments shall be supplied in carrying cases.

9-02 PRESSURE GAUGES

Pressure gauges shall be of the Bourdon tube type.
Working parts shall be of corrosion resisting metals.

Dial diameter shall be 4.5" and shall permit easy reading from floor with black numerals on white background.

Range shall place operating pressure at or near the middle of scale. Dial face shall be calibrated in psi and KPa in suitable increments with a range not less than one and half times the maximum operating pressure. Pressure gauges shall be complete with shut- off cock and necessary tubing with socket adapter.

When gauges are mounted on a panel board they shall be flush mounted.

9-03 THERMOMETERS

Thermometers for water line shall be mercury in steel with metal guard steel bulb and separable sockets screwed 3/4" dia., 9" length. Thermometers shall be complete with well for piping.

Calibrations shall be in degrees Fahrenheit with suitable increments. Range shall place operating temperature at or near the middle of scale. Range shall not be less than one and half times the maximum operating temperature.

9-04 GAS FLOW METER

Gas flow meter shall be of digital direct display type suitable to be operated in gas line of the project. It shall be completed in all respect with all accessories. Calibration shall be directly readable from LCD screen.

9-05 TESTING AND MAINTENANCE INSTRUMENTS

The Contractor shall supply following testing and maintenance instruments

1. 1 No. Digital meter with probes for measuring of air velocity, static pressure and relative humidity at duct, filters and grilles.

2. 1 No. Tachometer

3. 6 Nos. Insertion type duct thermometer

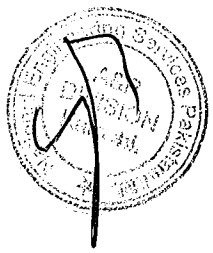
4. 2 Nos. Dry bulb and wet bulb measuring Sling thermometer

5. 1 No. Clamp-on Ammeter

6. 1 No. Water flow meter suitable for measuring water flow rates use with balancing valve (Direct Flow Display).

7. 1 No. Digital Sound level measuring meter

Details of these instruments with catalogues shall be submitted to the Engineer for approval.



SECTION 10 - PAINTING & EQUIPMENT IDENTIFICATION

10-01 GENERAL

All material and labor for painting and identification of services shall be provided by the Contractor, as specified hereunder:

10-02 PAINTING

All steel work in connection with supports for pipes ductwork etc. exposed to the elements is to be painted with two coats of an approved rust preventive paint.

All exposed metal surface of hangers, brackets, etc. must be painted with two under-coats and two finishing coats of enamel paint of approved color. G.I. sheet is not to be painted. However, all non insulated pipe work and valves are to be painted as stated above.

All exposed ducts and or pipes without insulation shall be painted with two initial coats of approved rust preventive coating suitable for salt range envorinments, two under coats of red oxide primer and two finishing coats of enamel paint of approved color. However, all non insulated pipe work and valves are to be painted as stated above.

All machinery and equipment which have been painted in factory to the satisfaction of the Engineer shall have a finishing coat of paint before Final Acceptance if the factory paint is damaged during transportation, storage or installation.

Identification bands shall be painted on non insulated ducting, piping or on insulation at frequent intervals. Lettering shall be agreed with the Engineer

All exposed insulation in the plant room is to be painted by approved colors with one undercoat and one finishing coat of enamel paint. All steel pipe work and other steel equipment specified to be insulated shall be thoroughly wire brushed to the satisfaction of the Engineer and painted with one coat black cold asphalt paint before insulation is applied.

Internal surfaces of grilles, diffusers and register boxes and connections visible to occupants of rooms, shall be painted by Air Distribution Contractor with two coats of dull black paint or other colour as directed by the Engineer.

All pipe and duct hangers in concealed locations shall be given one coat of black asphalt paint before being concealed.

All steel pipe, cradles, vibration isolation rails that will be covered, partially covered, set in cement or fill, or not accessible when the installation is completed, shall be given two coats of black asphalt paint.

10-03 MANUFACTURER'S NAMEPLATES

Each unit or equipment shall be identified by a permanently attached nameplate made of brass or other corrosion resistant material. Plates shall not be less in size than 1.5 inch x 3 inch Plates shall bear information pertaining to unit as follows:

System and unit designation from Schedule of Equipment.

Manufacturer's name and address (only distributor's or agent's name and address will not be accepted).
Rated capacity.
Temperature, pressure or other limitations.
Electrical Data

10-04 VALVE TAGS, CHARTS AND NAMEPLATES

Valve Tags, dampers and controls shall be designated by distinguishing numbers in English on the charts or diagrams. The Contractor shall provide stamped brass tags for all designated items with numbers corresponding to those on the charts.

The tags shall be not less in size than 1-1/2 inch in diameter with depressed black numbers of ½ inch height.

The Contractor shall provide separate lists designating the location and function of each valve, dampers and control.

The charts, diagrams and lists shall be of sizes, type and character as approved.

SECTION 11- INSPECTION TESTING AND COMMISSIONING

11-01 GENERAL

11-01.1 The whole of the works supplied under this Contract shall be subject to inspection and tests by the Employer and/or Engineer should he so require, during manufacturing erection and after completion. The inspection and tests shall include, but not be limited to, the requirements of this Section of the Specifications.

11-01.2 For this purpose the Engineer shall, at all reasonable times, be allowed free and ready access to the Contractor's shop and the shops of his suppliers for the purpose of inspecting the specified equipment components, or any other parts, and obtaining information as to the progress of the work. Failure on the part of the Engineer at this or any other time, to discover or reject materials or work which do not meet specified requirements shall not be deemed an acceptance thereof nor a waiver of defects therein.

11-01.3 Specific tests required by the various items of the Plant, Parts, materials and equipment shall be treated in accordance with the specifications of the corresponding clauses of the Specifications.

11-01.4 The Contractor shall submit to the Engineer, one month prior to the date of commencement of the balancing and performance tests, six (06) copies of the complete test procedure. The procedure, method and points of measurement as well as the method of calculation shall be approved by the Engineer before any test is carried. Six (06) copies of the test results shall be furnished to the Engineer for his approval.

11-01.5 The Contractor shall supply all necessary testing and balancing instruments, which shall include, (but not limited to) the instruments listed in Section 10, INSTRUMENTS AND GAUGES, and carryout any test of any kind on a piece of equipment, apparatus part of system or on a complete system if the Engineer requests such a test for determining specified or guaranteed data, as given in the Specifications or in the Schedule of Equipment. Necessary skilled staff shall be provided by Contractor.

11-01.6 Any damage resulting from the test shall be repaired and/or damaged material replaced with intimation to the Engineer, all to the satisfaction of the Engineer, and at no extra cost to the Employer. Skilled staff shall again be provided by the Contractor.

11-01.7 In the event of any repair or any adjustment having to be made, other than normal running adjustment, the tests shall be void and shall be recommenced after the adjustment or repairs have been completed.

11-01.8 All testing, balancing and final adjustment shall be in accordance with the provision of the applicable ASHRAE Standards, or other approved relevant standards.

11-01.9 The Contractor shall test a piece of equipment, apparatus, parts of system or a complete system in accordance with method and Schedule of Tests provided by the Engineer to determine Specified or Guaranteed data, given in the Specifications, Schedule of Equipment and Contractor's Data Sheets.

11-01.10 The contractor shall be responsible for carrying out tests on the

material/equipment/installation furnished by him.

11-02 PRELIMINARY INSPECTION & TESTS

11-02.1 General

All equipment shall be inspected and tested to determine the completeness and general conformance to specified requirements, when operated independent of overall HVAC System, for noise, vibration, electrical data.

11-02.2 Piping System

Pressure tests on part or whole of piping network shall be applied only before connection of equipment and appliances.

In no case shall piping, equipment or appliances be subjected to the pressure exceeding their rating.

Tests shall be completed and approved before any insulation is applied on pipes, valves and fittings, and before these are concealed. Tests shall be performed in the presence of and to the satisfaction of the Engineer or his representative. Any leaks or defects discovered by the tests shall be repaired and the system retested as above, all at no additional cost to the Employer.

The prescribed pressure shall be maintained for four (04) hours.

11-02.3 Ductwork

Inspection on ductwork shall be carried out by Contractor's supervisor in the presence of Engineer's representative to the satisfaction of the Engineer.

All joints in ducts and at outlets shall be physically inspected for air leakage. All dampers shall be tested for proper operation.

Ducts, plenums and casing shall be inspected and made substantially air tight before covering with insulation or concealing in the masonry. The terms substantially airtight shall be construed to mean that no air leakage will be noticeable through the senses of feeling or hearing.

11-02.4 Equipment

All HVAC equipment shall be inspected for visible damage, operation of moving parts, noise and vibration. Tests shall be carried out with readings of RPM, ampere, voltage, etc. to verify the name plate data.

11-02.5 Electrical Equipment

All electrical panels shall be cleaned and adjusted on site before application of power. The following tests shall be carried out:

1) Wire and cable continuity tests.

2) Insulation resistance tests, phase to phase and phase to earth, on all circuits and equipment, using 500 volts megger. The megger reading shall

not be less than one meg.ohm.

3) Earth resistance between metallic conduit systems and earth must not exceed half (1/2) ohm.

4) Phasing out and phase rotation tests.

5) Operating tests on all protective relays to prove their correct operation before energizing the main equipment.

6) Operating tests on all starters, circuit breakers, etc.

11-03 BALANCING AND COMMISSIONING

11-03.1 Air and Water Balancing

All air handling and ventilating equipment, ductwork air inlet and outlets, air volume control dampers, and water valves shall be adjusted and balanced to deliver within 10% of the specified quantities indicated on the Drawings. Where the equipment or systems depend upon controls for proper operation, functioning and performance, the Engineer may ask the Contractor that the later shall be operated simultaneously with the equipment or system during tests.

If the air quantities cannot be delivered without exceeding the speed range of the sheaves or the available horsepower, the Engineer shall be notified before proceeding with the balancing of air distribution system.

Any addition/replacements required to meet the specified flow rates shall be the responsibility of the Contractor at his own cost.

The balancing and commissioning work will be done by a specialized firm/approved by the Engineer, having working experience of more than five (05) years along with working experience of at least five (05) projects of similar nature.

11-03.2 Commissioning

Upon completion of air and water balancing and when the whole or part of HVAC System is substantially complete and ready for operation as specified, the Contractor shall carry out Commissioning. Appropriate Seasons are not necessary and the purpose of the commissioning is to start-up the whole or part of HVAC System with manual and/or automatic controls and to put the whole or part of HVAC plant in operation to make it ready to provide cooling and/or heating.

The Commissioning shall be considered completed when complete HVAC plant put into operation and made ready to provide either cooling or heating as directed by the Engineer. The Engineer may direct the Contractor to commission part of central plant along with part of AHUs, FCUs and distribution network. This will be considered as partial commissioning.

11-04 PERFORMANCE TESTS

Each equipment of HVAC plant shall be tested for performance after successful completion of Commissioning of that equipment to determine the Specified and Guaranteed Data at Specified Operating Conditions as shown in Equipment

Schedule and Specifications. These tests shall be carried out in appropriate seasons.

The test data shall not deviate by more than five percent (5%) from the Guaranteed capacity data.

Should any part of the apparatus or system fail to meet the specification requirements, it shall be adjusted, repaired or replaced to the satisfaction of the Engineer by the Contractor at his own cost. The complete Performance Test shall than be repeated.

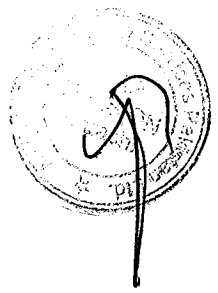
11-05 RELIABILITY TRIAL TEST

After completing the above Preliminary Tests, adjustments, Commissioning and Performance Tests, the Contractor shall carry out Reliability Trial Tests for the whole or part of system.

The trial tests, both for summer and winter, shall last for a period of 14 consecutive days during which time the whole or part of the system, as the case may be, shall operate continuously without major adjustment or repair to the satisfaction of the Engineer.

Should any part of the apparatus or system fail to operate continuously as specified, it shall be adjusted, repaired or replaced to the satisfaction of the Engineer and the Reliability Trial Tests shall be repeated for another 14 consecutive days for continuous operation without major adjustment or repair.

Reliability Trial Tests should be carried out during appropriate seasons in Defects Liability Period.



SECTION 12 - MEASUREMENTS AND PAYMENTS

12-01 GENERAL

Unless expressly excluded, the cost of all materials, equipment and works required by Special Provisions and Technical Provisions of Specifications, acceptably furnished, installed and tested as Specified, shall be considered to be included in the amounts tendered against the item listed in the Schedule of Prices for the Building Code 01.

12-02 SOP ITEM NO. 1 (a), 2 (a), 3 (a), 4 (a through m), 5 (a through f), 6 (a through e), 7 (a & b), 8, 9, 10 (a through d), 11, 12, 13, 14, 22 (a-1 through j-5), 24 (a), 27, 28 & 32

12-02.1 Measurement

Measurement will be made of each item and all associated accessories and work acceptably furnished, installed and tested as individual units.

12-02.2 Payment

Payment of these items will be made at the Contract Unit Rates for these items entered in Schedule of Prices.

12-03 SOP ITEM NO. 1 (b), 2 (b), 3 (b), 4 (n), 5 (g), 6 (f), 7 (c & d), 10 (e), 19 (b), 22 (i-1 through i-5), 24 (b), 25, 29, 30 & 31

12-03.1 Measurement

No measurement will be made of the items mentioned above.

12-03.2 Payment

Payment will be made at a Contract Lump sum Price entered for the respective item in Schedule of Prices.

12-04 SOP ITEM NO. 16 & 20

12-04.1 Measurement

Measurement will be made for surface area of installed sheet metal ducting and plenums and grease exhaust duct for different gauges. No measurement will be made for wastage, bracing flanges, hangers and supports, fasteners, anchor bolts air-turning vanes, splitter dampers, and grease exhaust duct protection.

12-04.2 Payment

Payment will be made for the number of units measured as provided above at the Contract Unit Rates as entered in SOP.

12-05 SOP ITEM NO. 23 (a through e)

12-05.1 Measurement

Measurement will be made of the area of sheet metal to which the acoustic Liner or insulation is applied. No measurement will be made for accessories and adhesive.

12-05.2 Payment

Payment or deduction will be made for the number of units measured as above at the Contract Unit Rates entered in SOP.

12-06 SOP ITEM NO. 15, 17, 18 & 26

12-06.1 Measurement

Measurement will be made of the core area of the respective item acceptably furnished, installed and tested. No measurement will be made of accessories and attachments.

12-06.2 Payment

Payment will be made for the number of units measured as provided above at the Contract Unit Rates as entered in SOP.

12-07 SOP ITEM NO. 19 (a), 21

12-07.1 Measurement

Measurement will be made of the length of pipe/flex. Round duct/ flex. Duct connection route at centre line of pipe/ duct, for the piping/ ducting, fittings and accessories, acceptably furnished, installed and tested. No measurement will be made for fittings, accessories, attachments, hangers, nuts and bolts.

12-07.2 Payment

Payment will be made for the number of units measured as provided above at the Contract Unit Rates as entered in SOP.

12-08 SOP ITEM NO. 23 (f-1 through h-5)

12-08.1 Measurement

Measurement will be made of the length of piping at center line, to which the insulation is applied. No measurement will be made for accessories, adhesive, etc.

12-08.2 Payment

Payment will be made for the number of units measured as above at the Contract Unit Rates entered in SOP.

LIFT WORKS

HOME DEPARTMENT – GOVERNMENT OF SINDH

EVIDENCE BLOCK
AT FORENSIC SCIENCE LABORATORY, KARACHI

ELEVATOR WORKS

SPECIFICATIONS

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SECTION-I

SPECIAL PROVISIONS

1.1. SCOPE OF WORK

The scope of work given in relevant sections of equipment shall include but not necessarily be limited to the following:

i. Preparation of all relevant installation/ erection drawings, coordinated shop drawings, obtaining Government and/ or Employer approvals and/ or certificates, fabrication, transportation to site, storage, installation, testing, commissioning, operation and maintenance thereafter for the stipulated period of equipment including training of Employer's staff.

ii. All wiring and controls including necessary material and accessories beyond the power supply point.

iii. All other miscellaneous equipment and/ or work required to render the equipment ready for continuous, safe and efficient operation.

iv. All relevant civil works as per BOQ/ SOP, Cutting, patching and repairing of damaged civil works required during installation of new equipment. Repairing of damaged civil works and architectural finishes are also included in the scope of work.

v. Inspection of already constructed related civil works immediately after award of work and confirmation of its suitability for the equipment.

vi. Regular operation (17 hours/ day, 6 days/ week and 300 days/ year) & Maintenance and periodic servicing of equipment during defects liability period (i.e.; 365 days) including greasing, oiling, cleaning etc. of parts as recommended by the manufacturer. Full time operational staff (trained experienced operator cum technician) is required.

vii. Provide all required installation, operation and maintenance manuals, spares lists, drawings and diagrams, inspection test certificates and submission of miscellaneous requisite documentation.

viii. Providing training to Employer's Staff at site regarding operation and maintenance of the equipment.

1.2. CODES AND STANDARDS

All equipment & materials under this works shall be furnished in conformity with latest edition of applicable standards of ANSI, ASME, BS/ EN, AWS, NFPA, ASTM, NEMA, IEE, etc. and applicable Government and Local Codes governing the same. In case of conflict, the strict requirements shown/ specified shall govern. All equipment shall be rated and tested as per relevant standard (latest edition).

Where possible, the same codes and standards shall be used throughout a particular facility. However, the final decision on which codes and standards shall be applied shall remain with the Engineer.

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Abbreviation for codes and standards referred to in the contract are as under:

- EN European Norms
- ANSI American National Standard Institute, USA
- ASME American Society of Mechanical Engineers, USA
- AWS American Welding Society
- NFPA National Fire Protection Association
- ASTM American Society for Testing and Materials, USA
- NEMA National Electrical Manufacturer's Association
- IEE Institute of Electrical Engineers, London

1.3. ORIGIN OF SUPPLY AND PREQUALIFICATION REQUIREMENT

Complete equipment, to be supplied under the Contract, shall be of imported origin and can be provided by any one of the following manufacturers or approved equivalent subject to meeting the specification requirement (models fully complied and certified with latest EN 81 Standards only):

- DOPPLER (WEST EUROPE)
- HYUNDAI (KOREA, CHINA)
- KOHLER (WEST EUROPE)
- KONE (WEST EUROPE, CHINA)
- MITSUBISHI (JAPAN)
- SHANGHAI MITSUBISHI (CHINA)
- ORONA (WEST EUROPE)
- OTIS (WEST EUROPE, CHINA)
- SCHINDLER (WEST EUROPE, CHINA)
- SIGMA BY OTIS (KOREA, CHINA)
- THYSSEN KRUPP (WEST EUROPE, CHINA)

OR APPROVED EQUIVALENT

All major elevator components shall be manufactured/ assembled in the manufacturers authorized factories/plants and shall be quoted only from authorized agents of manufacturer in Pakistan. All brands mentioned above and approved equal brand shall minimum comply the pre-qualification criteria as below.

1. Successful experience of at least twenty (20) elevators of a nature and complexity comparable to the works within the last five (05) years in Pakistan. This

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experience should include Supply, Installation, Testing, Commissioning and Operation & Maintenance of elevator works.

2. Authorized distributor of the proposed brand for minimum Five (05) years in Pakistan.

3. Successful experience of proposed brand's elevator manufacturing for minimum thirty (30) years in international market.

4. Paragraph wise compliance statement of technical specification from the equipment manufacturer.

5. Comparison of each part/ system of proposed brand with one of the brands provided in suggested manufacturer's list along with the test reports.

6. Approved equal brand shall clearly be mentioned in the technical bid along with above said information.

1.4. QUALITY STANDARD

To guarantee a high-quality standard in the field of designing, fabricating, installing and maintaining the said equipment, only manufacturers with a proven record of similar experience will be considered in Bid Evaluation. To verify the manufacturer's experience, a reference list with completed projects should, therefore, accompany the Bidding documents.

1.5. PRODUCT HANDLING AND STORAGE

It will be the Contractor's entire responsibility to ensure that all necessary precautions are taken during transportation to avoid damage to any of the equipment.

The Contractor must arrange with the supplier of mechanical equipment, well in advance, that there is sufficient clear and load bearing passage at site to be used for shipping the equipment to the installation place. The Contractor shall also liaise with the equipment supplier with regard to adequate openings and lifting points.

Specific handling or storage requirements will be dealt with in the relevant parts of the specifications, where necessary.

1.6. INSPECTION AND CONTROL

1.6.1. General

The Contractor shall ensure that the manufacturer continuously conducts his own thorough inspections of all equipment during manufacturing, assembling and installation.

The Engineer shall have the power at any time to inspect, examine and test any part of the works, or any materials or plant intended to be used in the works, either on the site or at any factory or workshop where such parts, materials or plant are being constructed, manufactured or from which they are being obtained.

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1.6.2. Pre-shipment Inspection

All equipment to be supplied under this Contract shall be subject to inspection and testing by one representative of the Employer and one representative of Engineer along with one Contractor's representative at its point of original manufacture or final shop assembly before its dispatch to site. The Contractor shall make necessary arrangements and provide all the facilities required for the representatives of Employer/ Engineer for conducting such inspection, at Contractor's cost. The cost of travel including overseas travel, arranging of Visas, boarding and lodging of Employer's and Engineer's representatives shall be the responsibility of the Contractor.

In addition, for foreign travel the Contractor shall provide (for two persons) daily allowance in US$ for out of pocket expenses, at $ 150 per day per person. The number of days shall be actual days spent in travel calculated from the dates of travel from and to the hometown of the concerned representative nominated for inspection, but not less than five (05) days. The US$ in cash shall be provided before start of travel from hometown.

The Contractor shall submit tests procedures for approval of Engineer well in advance to the set date of pre-shipment inspection. The Contractor shall give at least three (03) weeks' notice to the Employer/ Engineer for attending such inspections/ tests.

1.6.3. Inspection at Karachi Port/ Dry Port

All major imported equipment will be inspected at Karachi port/ Dry port The Contractor shall make necessary arrangements and provide all the facilities required for such inspection. The cost of travel, boarding and lodging of Employer, his authorized representative and the Engineer shall be the responsibility of the Contractor. In case of non-availability of such inspection, Engineer reserves the right to deduct suitable amount from Contractor's payment and subsequent inspection at dry port will be additional responsibility of the Contractor up to Engineer's satisfaction.

1.6.4. Inspection at Site Works

All equipment/ materials supplied by the Contractor shall be inspected by the Engineer after delivery of the same at site to assess any damage or short of quantities and any other requirements of the specifications. The Engineer will issue an inspection certificate if the supplied items of equipment and material are found to be satisfactory.

The Engineer shall inspect the works in progress as and when considered necessary by the Engineer and the Contractor shall provide full access and assistance to the Engineer for carrying out inspection to verify the conformity of works as shown on Drawings and as specified. Such inspection if made shall not relieve the Contractor from any obligations under the Contract.

1.6.5. Damages, During Transportation, Storage & Installation

The Contractor shall be responsible for any damage of the Equipment/ material during transportation to site, storage and installation until satisfactory handing over the works

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to the Employer. The Contractor shall replace any damaged equipment/ materials at his own cost.

1.7. DRAWINGS AND SUBMITTALS

In general, the following submittals are required for the works covered under this Section. However, the final decision with regard to what should be submitted, to what extent and at which time of the Contract period shall remain entirely with the Engineer.

1.7.1. Technical Data Sheets/Technical Submittal

Information submitted with the Bid is for reference only. Final model and details will be selected as per Technical Submittal submitted after the award of work. Technical data/ submittal shall comprise of the following at the minimum, which shall be submitted within one (01) week from award of work:

i. Data Sheet as per Specifications

ii. Catalogues/ Brochures in Original

iii. Compliance Statement for Technical Provision (paragraph-wise)

iv. Outline drawings

v. Structure drawings from Manufacturer

vi. Installation drawings from Manufacturer

vii. Full EN 81 Compliance Statement from Manufacturer

viii. Warranty Statement from Manufacturer

1.7.2. Design Drawings/ Shop Drawings

The Contractor shall submit Design Drawings/ Shop Drawings within two (02) weeks from acceptance of Bid to the Engineer for approval.

The drawings must show in reasonable detail installation and design features such as:

i. Final arrangement of equipment keeping in view the dimensions provided in architectural drawings for civil construction of the Equipment.

ii. Maximum dynamic and static loads imposed on civil structure.

iii. Dimensions and locations of all services, openings in floors and walls, location of embedded parts and location of Employer's furnished electrical connection.

iv. The Contractor shall review the civil construction drawings related to the equipment and identify any major shortcomings/ rectifications essentially required for equipment installation within above stipulated time period. Minor civil rectification and adjustment works are included in Contractor's Scope of Work.

v. Wiring and control logic diagrams.

vi. All other relevant information required by the Engineer.

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Approval given by the Engineer is to be understood as an approval to proceed with the works. The approval does not in any way release the Contractor from his Contractual obligation to supply, install and maintain the equipment supplied by him as laid down in the Specifications.

1.7.3. As-Built Drawings

The Contractor will furnish As-Built Drawings separately. Such drawings, diagrams and schedules as well, in the opinion of the Engineer, provide an adequate record of the work "as installed" shall be submitted to the Engineer for approval before the issuance of Taking-Over Certificate.

The drawings shall include particulars of all items of equipment, including wiring diagrams, etc. As-installed drawings shall be submitted to the Engineer at least thirty (30) days before issuance of Taking-Over Certificate.

The size of the drawings shall be minimum A2 size. Every item and dimensions in drawings must be legible.

1.7.4. Installation, Operation and Maintenance Manuals

Two (02) sets of installation manual for the equipment shall be supplied by the Contractor prior to commencement of installation of equipment.

At least thirty (30) days prior to the scheduled date of practical completion, the Contractor shall supply a complete set of operating and maintenance manuals to the Engineer for approval. Once approved, the Contractor shall proceed to prepare and hand to the Engineer three (03) sets of the approved operating and maintenance manuals.

The manuals shall be neatly bound and provided with a suitably captioned hard cover. The contents shall be generally arranged in the following manner unless otherwise specified/ required.

i. Index

ii. General description of the complete facility.

iii. Operating instruction of the complete facility.

iv. Emergency directions of the complete facility.

v. Safety control adjustment and settings of all safety protection equipment.

vi. List of equipment giving manufacturers and agents' name, and name plate data together with all data sheets published by the equipment manufacturer.

vii. Installation, operating and maintenance instructions for each item of equipment (including lubricating charts).

viii. Proforma for Operational log of equipment as per manufacturer recommendation or Engineer's approval.

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ix. List of spare parts for each item of equipment as recommended by the manufacturer for at least five (05) years operation.

x. List of essential tools recommended by the manufacturer for Operation and Maintenance.

xi. As-built drawings.

All above submission shall be signed and stamped by the Contractor prior to submission and all submission shall be in English. The approval by the Engineer of the above submission shall not be held to relieve the Contractor of any part of his responsibility to meet all of the requirements of this Contract.

1.8. QUALITY ASSURANCE

The Contractor shall submit with this Bid a written assurance that the materials and workmanship of the equipment installed will be according to recognized international standards and will conform to all contractual requirements of this specification.

1.9. OPERATION AND MAINTENANCE

1.9.1. Operation and Maintenance during Defects Liability Period

The Contractor shall include the operation, maintenance and guarantees of the whole of the Contract Works as laid down in the General and Special Conditions. During this term, the Contractor shall remedy and/ or replace all defective parts or items and correct any omissions certified by the Engineer.

The Contractor will also be held liable for any costs of dismantling or re-erection which may have to be undertaken in order to replace defective parts.

Continuous service operators shall be provided on a routine daily basis for 16 hours/day, 6 days/ week and 300 days/ year for one (01) year.

Services shall be performed by skilled personnel (operator cum technician) under the supervision of experienced supervisors.

The Operation & maintenance shall include operators for continuous operation, provision of spare parts by the Contractor during Defects Liability Period, inspection of all equipment, lubrication of all bearings, the supply of all necessary oil and grease, cotton waste, running adjustments and keeping the installation and equipment in a clean condition unless otherwise specified/ required by the Engineer.

1.9.2. Register of Service, Operation and Maintenance

The Contractor shall provide a register of service, operation and maintenance for the installation. Where such requirements are specially required by any regulation of authorities having relevant jurisdiction over this contract work this shall be complied with strictly.

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The Contractor shall also provide and maintain a record of all services, maintenance and repair work carried out in detail. Such record shall be prepared in duplicate and should be in the form of maintenance/ repair sheet with one copy to be retained by the Engineer upon the execution of such services.

All registers and records shall be kept by competent persons in the employment of the Contractor during the period for which he is responsible for maintaining the installation.

1.9.3. Operation and Maintenance Staff during Defects Liability Period

The Contractor shall provide operators in elevators in different shifts to operate the system continuously for 10 hours, 6 days/ week and 300 days/ year during Defects Liability Period of one (01) year. Operating personnel for complete system shall have at least five (05) years' experience in operation and maintenance of similar works. The remaining staff list shall be provided to the Engineer for approval. The staff Nos, skills and experience shall be as per approval of Engineer. The Contractor shall also arrange to provide proper training to Employer staff to operate the system to complete satisfaction of the Employer. All cost incidental to provide operating staff including staff salaries shall be deemed to be included in relevant item of Schedule of Prices. No separate payment shall be made to the Contractor for fulfillment of his obligations under this Clause.

1.10. TOOLS & INSTRUMENTS FOR TESTING, SERVICING, OPERATION AND MAINTENANCE

The Contractor shall supply and deliver to site a complete set of essential tools, test equipment, and other instruments necessary for proper testing, servicing, operation and maintenance of the equipment. Tools shall include special tools and instruments, which are necessary for maintenance repair and overhauls of the equipment. The Contractor will not use these tools for erection purpose, etc.

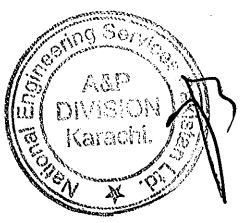
1.10.1. Spare Parts

All essential spare parts during Defects Liability Period of one (01) year shall be provided by the Contractor and their cost shall be included in the Bid.

Also, the recommended spare parts list shall be provided along with prices which remain valid for two (02) years beyond Defects Liability Period. The following shall be included in recommended parts list:

1.10.1.1. Consumables

The Bidder shall provide with the Bid recommended list of consumable spares for a period of one (01) year of operational duties. The list shall contain all consumable items, overhaul kits, fast moving spare e.g., fuses, bulbs, bulb covers, gaskets, oil filters and a full set of at least two spares for all lamps. All items to be separately listed and priced.



1.10.1.2. Normal Spare Parts

The Bidder shall provide with the Bid a recommended list of spares and components, which shall be required to maintain each equipment/part beyond period of one (01) year of operational duties during Defects Liability.

The Bidder shall also confirm in Bid his ability to provide a full range of spare parts and major components for the offered equipment. The Bidder shall provide a guarantee period of at least 25 years for the serviceability of equipment and supply of spare parts and indicate the same in his Bid.

1.11. PAINTING & FINISHES

All equipment, machinery, gears, controls, exposed and unexposed steel work shall be thoroughly cleaned, freed from oil, grease and other foreign substances detrimental to good finishing.

Apply approved primer, undercoats and finishing coats on a properly prepared surface in accordance with the paint manufacturer's recommendation and in accordance with recognized international standards.

The type and shade of paints, particularly of the finishing coat shall be subject to the Employer's/ Engineer's approval.

Enamel shall also be applied according to the manufacturer's recommendation. Stainless steel finish shall be No.4 finish or equivalent, unless specified otherwise in the specification. If field touch-ups of abraded and damaged surfaces become necessary, the same type of paint used in the factory shall be employed.

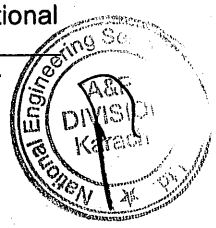
1.12. TESTING AND COMMISSIONING

On the completion of the Work substantially in accordance with the Contract, the Contractor shall give the Engineer notice in writing thereof and before making the "Testing and Commissioning" shall give the Engineer and the local authority seven (07) days' notice in writing of the date on which he will make the said tests of the work in accordance with relevant codes and in the manner prescribed by the Specification.

Unless otherwise agreed, the Contractor shall commence such tests upon the date and shall carry out the same, in the presence of the Engineer or his authorized representative, whose name shall previously have been communicated in writing to the Contractor and the local authority.

If any portion of the works fails under the tests to fulfill the Contract conditions, the Contractor shall inform the Engineer thereof in writing, and tests of the faulty portions shall, if required by the Engineer be repeated within a reasonable time upon the same terms and conditions.

If the "Testing and Commissioning" is not successfully made by the Contractor within one (01) week after the date fixed by the Contractor for the completion for operational



use or for the testing of the works, the Engineer may in writing call upon the Contractor under seven days' notice to make such tests, and on the expiry of such notice such tests shall forthwith be made by some other agency appointed by the Engineer at the expense of Contractor.

The Contractor shall supply all necessary utilities, labour, apparatus and instruments necessary for the prescribed tests. The accuracy of the Contractor's instruments shall be demonstrated if required.

The Contractor shall make for payment of all or any fees charged by the local authorities for the above.

The installation will be under the charge of the Contractor during this period, at which time the Contractor shall instruct the Employer's personnel on the maintenance, servicing and trouble shooting of the various plants and system.

Should any failure occur due to, or arising from, faulty materials or workmanship or otherwise, sufficient to prevent the operational use of the installation, the reliability test period of one (01) year shall recommence after the Contractor has remedied the cause of failure to the satisfaction of the Engineer.

1.13. TEST CERTIFICATES AND REPORTS

The Contractor shall provide copies of all test certificates/reports including the following:

i. Test Certificates of critical materials

ii. Factory test reports

iii. Pre-shipment test report

iv. Report of testing & commissioning of equipment

1.14. TRAINING

On completion of all works, but prior to final taking-over, the Contractor shall arrange for free training and instruction to be provided to the Employer's maintenance staff and operators. This training shall cover all aspects of the operation and maintenance of the plant/equipment and shall ensure that the trainee is provided with at least the necessary fundamentals required for the safe and efficient operation of the plant/equipment in question. The instructor(s) must be competent and experienced personnel, well acquainted with the task of lecturing. The schedule of offered training highlighting the details of syllabus indicating number of hours for training and field instruction subject to be taught and no. of Employer's staff strength to be trained shall be enclosed with each Bid so as to allow for an evaluation by the Engineer.

1.15. MANUFACTURER WARRANTEE

The Contractor shall submit two (02) copies of written warrantee from the manufacturer under his cover warrantee that the material and workmanship of the equipment installed is according to recognized international standards and conform to all contractual

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requirements of this specification that he will make good without extra cost any defects not due to ordinary wear and tear or improper use, which may develop within two (02) years from date of the installation being handed over to the Employer.

During the last month of the warrantee period, the Contractor shall demonstrate to the Engineer that all equipment and accessories are operating to the required specifications.

The manufacturer warrantee period shall be two (02) years after final commissioning.

In case if equipment remains out of order for more than ten (10) days or more, warrantee/ maintenance period will be extended accordingly.

1.16. MEASUREMENT AND PAYMENT

No measurement and payment shall be made for the works involved within the scope of this section of specifications unless otherwise specifically stated in the schedule of prices or herein. The cost thereof shall be deemed to have been included in the quoted unit rate price of other items of the schedule of prices.

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SECTION-II

TECHNICAL PROVISIONS

2.1 GENERAL

This section shall cover Elevators where indicated on the drawings and specified herein. Any conflicts between the requirements in this specification and the codes, drawings, standards and specifications referred to herein shall be brought immediately to the attention of the Engineer for resolution. The Bidder shall submit technical data sheets, outline drawing and printed technical literature to fully elaborate offered equipment. The Bidder is advised to visit the site to check the available elevator shaft, pit depth and machine room etc. to ensure that offered equipment will suit to existing conditions.

2.2 SCOPE OF WORK

Following elevator works are required for Evidence Block at Sindh Forensic Science Laboratory Site, Karachi;

i. Supply of One (01) No. Brand new 1000 kg in Evidence Block; Elevator fully-EN certified heavy duty MRL (Machine Room Less) Type with Simplex control serving Basement + Ground floor + First floor only. Design to operate 10 hours/ day, 6 days/ week and 300 days/ year.

ii. All associated civil, architectural and electrical works necessarily required for installation of elevator in the shaft.

iii. Making good any damage done to the civil works including supply and installation of matching paint, floor tiles, granite / marble wall finish etc., whichever is applicable as per site conditions and/ or as directed by Engineer.

iv. Supply and installation of exhaust fan propeller type of size 800 CFM (SP 0.2 inch of WG) are required for each Machine Room/shaft respectively including complete electrical work.

v. Supply and installation of Electric Distribution Board and related electrical works at elevator control panel on last floor and cables for elevator power supply and other electrical accessories required for proper installation of the elevator.

vi. Supply and installation of split air conditioner with Hydrophilic blue/black fin having cooling capacity of 2 tons of refrigeration (TR) heavy duty (10 hours operation), high ambient (0~40°C compatible) for Machine rooms/Shaft (for MRL) of elevator.

The scope of work shall cover design, supply, installation, testing & commissioning, operation and maintenance of entire elevator equipment including hoisting machinery, sheaves and girders, controller, car, ropes, counterweights, supports, brackets and guides for car & counterweights, car & landing doors, door operator, switches & control, safety devices, signals, governor, safety gears, buffers, pit screens, well trimming girders, trap door and such related accessories complete in all respects as specified herein. The Contractor shall also furnish all labor, erection equipment, (i.e., winches, scaffolding etc.), erection tools, appurtenances, embedded parts and materials, etc.

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necessary to supply, install, test and commission the elevator all in perfect operating condition in accordance with these Specifications and Drawings.

The Contractor shall submit design drawings/ shop drawings within two weeks after award of work for approval of Engineer. The drawings must show final arrangement of equipment, dynamic & static loads imposed on the building, openings, location of embedded parts etc. wiring and control logic diagrams.

The Contractor shall be responsible to make good any damage done to the civil works for erection or other purposes without cost to the Employer.

The Contractor shall also provide and install, from designated electrical power supply point, all required cabling, distribution boards and accessories without cost to the Employer.

The Contractor shall maintain the works during Defects Liability Period. In addition to routine periodic maintenance, the Contractor shall execute all such work of repair, rectification, parts replacement and making good defects occurring during this period. Design of equipment to be supplied by the Contractor shall also be the responsibility of the Contractor and/ or his suppliers.

The Contractor shall also provide training to the staff of Employer regarding operation and maintenance of the equipment.

Prior to completion date, the Contractor shall submit Three (03) copies of Operating and Maintenance Manuals to the Employer/ Engineer.

2.3 DESIGN REQUIREMENTS

2.3.1 Elevator System General Requirements:

i. Elevators shall be designed specifically for the operation; loading and environmental conditions encountered in specialized forensic building and shall have a minimum design life of 25 years.

ii. The final assembly of all components shall not pose hazardous conditions to the public or maintenance personnel. Surface irregularities, sharp edges, or protrusions in public or maintenance areas shall not be permitted.

iii. Provide convenient and safe equipment access for inspection, cleaning, maintenance, repair, and replacement.

iv. All gaps and running openings within regulatory tolerances shall be properly closed by the use of appropriate sealant or another approved means installed in accordance with the manufacturer's instructions.

v. For parts and equipment subject to wear and requiring periodic replacement, the Contractor shall furnish key and seat, nut, screws, or other removable and replaceable type mechanical fasteners. Such replacements shall not diminish original structural integrity. Use of rivets or similar type fasteners requiring physical deformation during field positioning will not be permitted.

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vi. The elevator equipment shall be quiet and smooth running and shall not exceed the following maximum noise output levels during all phases of operation:

- 70 dBA measured in the elevator car
- 70 dBA measured at the elevator hoist way entrances

vii. Fire Protection: Contractor shall provide non-combustible materials for components including Halogen-free cables.

2.3.2 Seismic Criteria:

i. Installation and equipment designed for static and for seismic conditions shall be provided in accordance with regulatory requirements.

ii. Provide hardware necessary to protect motors, drives, and door operators

iii. Seismic design shall be based on the assumption that structures and equipment will be subjected to a maximum horizontal ground acceleration of 0.7g (70 percent of gravity).

2.3.3 Power:

The main elevator power shall be 400 V, three phase, 50 Hertz.

2.3.4 Elevator Controller:

i. The controller for Elevators shall be a field programmable microprocessor based, collective selective control, automatic operation with open loop, variable voltage, and variable frequency control.

ii. Elevator operation shall be by means of Push Buttons in the car, numbered to correspond to landings served, by push buttons Call at terminal landings, and by UP and DOWN Push buttons at intermediate landings.

iii. All options or parameters shall be field programmable without the need for external devices. Programmable settings shall be stored in non-volatile memory.

2.3.5 Elevator Door and Hoist way Door Operation:

2.3.5.1 Hoist way doors and car doors shall:

i. Open automatically and simultaneously when the car arrives at the destination landing.

ii. Be equipped for readily and independently adjustable door hold open times when car stops for a car or hall call. Main floor door hold times shall be adjustable independently of other floors.

iii. Close after hold open time interval has elapsed and no obstruction has been detected, or when the car is called or dispatched to another landing, or when either the car door close button or a car call is pushed.

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2.3.5.2 Activation of the door close button in the car shall cancel door timer and close the doors provided there is no obstruction

2.3.5.3 All closing times shall be adjustable from 5 seconds to 30 seconds without exceeding closing force specified herein.

2.4 MATERIALS & WORKMANSHIP

2.4.1 Materials

All materials shall be of the highest grade, free from defects and imperfections, of recent manufacture and unused, and of the classification and grades designated, conforming to the requirements of the latest issue of the appropriate specifications and standards. All materials, supplies, and articles not fabricated by the Manufacturer shall be the products of recognized reputable manufacturers.

All materials including electrical wirings shall be weather proof.

2.4.2 Workmanship

All work shall be performed and completed in a thorough workmanlike manner and shall follow the best modern practice in the manufacture of high-grade machinery, notwithstanding any omissions from the Bid Documents. All work shall be performed by mechanics skilled in their various trades. All parts shall be made accurately to American Standard or other approved gage, where possible, so as to facilitate replacement and repairs. All bolts, nuts, screws, rivets, threads, pipes, gages and gears shall conform to applicable American or other approved standards.

2.4.3 Structural Metal Work (NOT USED)

2.5 PRODUCT DESCRIPTION

2.5.1 General

Elevators shall be installed by the Contractor in the shaft at location shown on the drawing. The dimensions of respective elevator wells and pits are also shown on the drawings.

The Contractor is recommended to visit the site to examine the existing structures and details to verify and confirm suitability of the existing structure for the installation of the equipment.

Any changes in the above planned elevators shaft and pit floor structure or other design details due to particular equipment requirement shall be submitted by the Contractor to the Employer/Engineer for approval within fifteen (15) days from the date of Award of the Contract. All such approved amendments shall be made by the Contractor without any additional cost to the Employer. Similarly, the elevator contractor must coordinate the installation with the other trades.

The elevator contractor shall also provide opening in Elevator well for suitable ventilation and for escape of gases and smoke in case of fire.

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The control cabinet/ panel of MR type elevator shall be located in machine room and control cabinet/ panel of MRL elevator shall be located at the last serving floor. The dimensions/ location shall be given by the elevator Manufacturer.

The location of drive machinery and control cabinet shall suit the elevator orientation to allow easy access and sufficient space for maintenance work and to provide a good-looking architectural outlook.

The Contractor shall acoustically insulate the elevator shaft and shall appropriately isolate the equipment to prevent disturbances in the surroundings area due to operating machinery.

i. Sound reducing materials to isolate motor set from civil structure, balance rotating parts to eliminate vibrations and flexible electrical conduits shall be provided. The operation of elevator car and doors shall be completely free from all abnormal jerks, vibrations and sound. The maximum sound level within the car must be within comfortable limits defined in relevant standards/codes.

ii. The elevator Contractor must schedule his installation work in accordance with civil construction schedule.

The characteristic details of the elevator to be supplied under this contract are listed under para 2.6. The construction and functional details are given hereunder:

2.5.2 Civil Construction

2.5.2.1 Elevator Well

The elevator shall be installed in the completed elevator wells of dimensions as available on site.

The top of the well shall be enclosed and watertight.

The Contractor shall be responsible to carry out minor correction for the purpose of installation of guides in perfect plumb and other equipment to ensure perfect installation and operation of the elevators without any cost to the Employer.

2.5.2.2 Pit Access Ladder

A rugged steel ladder for easy access to the pit shall be provided by the elevator Contractor. The pit access ladder shall be attached with a safety switch inside the pit.

2.5.2.3 Pit Screen

A suitable rigid screen shall be provided and fixed by the Elevator Contractor at the bottom of the elevator well where the counterweight comes down to its buffers and between elevators if required. The screen shall have a minimum height of 7 ft. as per code requirements.

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2.5.3 Elevator Car

2.5.3.1 Car Frame & Platform

The car frame, consisting of upper yoke with cross yoke side braces and bottom frame shall be made of welded or bolted steel channel sections, sufficiently rigid to withstand the operation of the safety-gear without permanent deformation of the car frame. The elevator car, platform, door operating mechanism, safety doors, etc. shall be mounted on car frame.

The deflection of the members carrying the platform shall not exceed 1/1000 of their span under static conditions with the contract load evenly distributed over the platform.

Roller guides, mounted on car frame, shall have individual suspension to cushion jolts and minimize noise and vibration.

The platform shall be of fabricated frame of formed and structural steel shapes gusseted and rigidly welded, with provision for a floor covering as specified with the car body work. Rubber pads of sufficient size shall be provided between the car frame and the platform to provide sound and vibration isolation. The underside of the platform will be covered with sheet steel to provide adequate fire resistance.

An aluminum sill grooved to suit door spuds shall be fitted to the platform together with a toe-guard.

The car bodywork shall be carried on the platform with the top fixing to the car frame being suitably isolated.

All auxiliary equipment shall be mounted and supported from the car frame.

2.5.3.2 Car Body Work

The car bodywork shall be of steel construction with provision for interchangeability of décor finishes and ceiling designs. The roof shall be constructed to withstand the weight of two men without deformation.

One side of the car shall have vision panel. Vision Panels shall be installed in such a way that vision panels on car and hoist way shall be aligned.

The car top shall have provision for emergency communication and roof trap door with micro-switch. A3 pin socket outlet shall be fitted on top of the Elevator car, besides two outdoor protected type lights one each at the bottom and top of the car operated through an MCB.

2.5.3.3 Finish

The car enclosure shall have either decorative stainless steel hairline or Back painted glass finish as mentioned in Technical Data as approved by the client/employer. The floor shall be provided with granite flooring.

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Ceiling shall be of removable type with modular LED light fittings.

Handrails on two side walls shall be provided with satin finish standard stainless steel hollow section. Fixing brackets shall also be in stainless steel.

The design and finish of car interior together with suspended ceiling, light fittings, floor covering and other fittings shall be to the Engineer's approval. The Contractor shall offer various options of car finish with his bid.

2.5.3.4 Telephone

A telephone compartment shall be provided in each car in the front return panel above the car operating buttons. The compartment shall be provided with hinged door flush with the panel. The entire compartment and door shall be of stainless steel.

The Contractor shall also provide a telephone set in the compartment which shall be connected to the central control center. The intercom connection work with the Central Control Center included in elevator contractor scope of work.

2.5.3.5 Recessed Motion Sensing Unit

The motion sensor unit shall be recessed into the ceiling. Provide a mounting bracket flush to the ceiling for the motion detector unit. The motion detector shall be located and adjusted so that movement of the doors does not generate a false occupancy. Provide the 120 Vac-power supply to the power pack unit of the motion detector.

Programmed Operation: If after a programmable length of time, an elevator car call has not been activated and the sensor detects elevator car occupancy, the car shall be programmable to proceed with either one of two courses of action. The choice of action shall be selectable by the motion detector switch in the service panel on the Car Operating Panel. The logic and circuitry of this alarm shall be incorporated into the controller circuit. Any auxiliary relay contact required to accomplish this feature shall be provided. This circuit shall be depicted in the schematic diagram of the controller. All occupancies, regardless of operation, shall be reported to the Communication Room.

Automatic Car Call Mode: Upon occupancy detection, the elevator shall automatically generate a car call to the opposite floor if a car call is not activated within an adjustable time of 5 to 30 seconds.

Nuisance Occupancy Mode: If occupancy is detected without a car call for an adjustable time of 5 to 30 seconds, then the doors shall reopen and remain open with audible alarm until a car call or hall call is generated or the car is vacated.

2.5.3.6 Camera

A 360° camera shall be mounted in the ceiling corner on the front wall opposite of the side of the Car Operating Panel. The camera shall be adjusted to observe patrons inside the Car. The camera shall be housed in a vandal resistant enclosure. The display of the camera shall be available in the control room. All necessary hardware till control

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room and software shall be provided by the Contractor. The connection work with the central control room included in elevator contractor scope of work

2.5.4 Doors

2.5.4.1 Landing Doors

Each landing shall be provided with center/side opening doors as shown on drawings. The doors, frames and architrave shall be made of stainless steel in satin finish. The door panels shall have a fire resistance rating of at least one hour. The panels shall be interconnected by maintenance - free self-tensioning synchronizing wire rope.

Each landing shall be equipped with a toe-guard apron at the hoist way entrance side. The toe-guard apron shall be of sheet steel not less than 16 gauge thick, and shall extend not less than 50mm beyond the entrance jamb at each side. Toe-guard apron shall be approximately 2 feet deep, adequately fastened and braced; the lower edge turned inward.

The frames shall be of 14 SWG (min.) and panel's fascia, toe-guards, dust and hanger covers shall be of 16 SWG. All other features not covered above shall be similar to that specified under Car Doors.

Each landing entrance shall be equipped with an approved type factory tested interlock as required by the code. The interlock shall be designed to prevent moving of the car away from the landing until the doors are locked in the closed position as defined by code and shall prevent opening of the doors at any landing from the corridor side unless the car is at rest at that landing or is in the leveling zone and stopping at that landing.

Landing door unlocking device as specified by the ANSI A17.I or B.S. 5655: part 1 Code shall be provided to permit authorized persons to gain access to hoist way when Elevator car is away from the landing.

Each Landing door or door panel shall be furnished with sheave type two-point suspension hangers and tracks complete in all respects. The sheaves shall have polyurethane tires with ball bearings sealed and lubricated for life. Hangers shall be provided with an adjustable slide to take the up-thrust of the doors. Tracks shall be of cold drawn steel shapes with smooth surface and shaped to conform to the hanger sheaves. Tracks shall be removable for replacement.

2.5.4.2 Car Doors

The car doors shall be center/side-opening type as shown on drawings. The door-gear shall operate by a fractional kilowatt AC motor with VF drive. The door gear shall be built-in unit with the car door top track support, mounted on the car entrance column extensions.

A retractable car door coupling shall be provided to connect the car and landing doors to eliminate any backlash and ensure complete door synchronization.

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The car doors, frame and front shall be of stainless steel (brush finish) with panel construction and other features such as fire rating, etc. similar to the Landing Doors.

The door panels shall be suspended from sheave hangers with polyurethane tires and sheaves running on a polished steel track, and guided at the bottom by non-metallic shoes sliding in an extruded aluminum threshold groove.

If the car is stationary at floor level with the doors closed, it shall be possible to open the car doors from inside the car by pushing the car door in the opening direction. To open the doors from the landings, the triangular key must be used.

2.5.4.3 Door Safety Devices

2.5.4.3.1 Full Width Light Curtain:

The car doors shall be fitted with light barrier system extending from 25mm above floor level up to a height of 1600 mm, operating between car and landing doors. The barrier system shall comprise of a transmitter and a receiver strip containing several pairs of transmitters & receivers generating a large number of invisible light rays. In case if any one of these rays is interrupted, the control unit immediately reverses the door motion. The light curtain shall recalibrate itself at regular interval to update its scanning cycle.

In addition to above, the car doors shall be provided with an additional safety such as Door closing force limiting device or photoelectric beam etc. to maintain operational safety in case of failure of the main light barrier system.

2.5.4.3.2 Door Open Timing Feature:

The door operation shall also have door open timing feature operation in conjunction with light rays to provide adjustable, reduced, hold open time once rays are broken and re-established. In the event rays are broken beyond an adjustable time, a buzzer shall sound and doors to close at reduced speed.

2.5.4.4 Door Operator

A variable frequency controlled variable speed door operating unit capable of opening and closing car and landing doors simultaneously shall be mounted on the car frame independent of the car bodywork. The mechanism shall be designed to achieve smooth acceleration and retardation of doors without the use of dashpots. All pivot and bearing points shall be of steel and nylon or bronze bushed pins, ball or roller bearings suitably lubricated shall be fitted.

The driving mechanism shall be designed such that:

The closing force applied to the doors shall meet the requirements of B.S. 5655: Part I.

The car doors can be opened by hand in the event of a mains failure.

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The motion of the doors will be reversed if they meet an obstruction. An AC motor with VF drive to provide variable speed shall be provided to obtain the performance required by the control system.

Mechanical Control Station, carrying controls and equipment as specified in B.S. 5655 shall be fitted on the top of the operator.

2.5.5 Hoisting Equipment

2.5.5.1 General

The elevator shall be MRL (Machine Room Less) type. The complete drive machinery and convertor shall be installed in the overhead of the shaft for MRL type and in machine rooms for MR type or as indicated in drawings. The Contractor shall provide exact location of Drive Machinery and other equipment so as to allow sufficient access and space for maintenance work within fifteen (15) days after award of the contract.

Anchor bolts, templates, inserts, signal boxes, and sleeves for installation shall be furnished by the Contractor. Additional structural members such as steel angle, steel beam supports for governors, motors, controller, and rope guards shall also be supplied by the Contractor.

Each hoisting machine and corresponding controller shall be numbered with 100mm high numerals giving elevator numbers.

Sound reducing buffers of elastic material shall be provided under the base of the hoisting machines to isolate sound and vibrations from the building structure. The rotating parts shall be dynamically balanced to eliminate vibration.

2.5.5.2 Hoisting Machines

2.5.5.2.1 Gearless Traction Type:

The hoisting machine shall be of the permanent magnet gearless drive with motor, brake and other integral parts mounted as one assembly on steel bed plates so that proper alignment of these parts is maintained under all conditions.

Means shall be provided on all elevator machines to enable the elevator cars to be raised or lowered in an emergency by manual operation. The direction of winding corresponding to the raising and lowering of the elevator car shall be clearly indicated.

Manual operation shall be by a smooth-rimmed detachable, spoke less wheel fitted to the shaft.

2.5.5.2.2 Brakes:

The brake shall be spring actuated, electrically released and of adequate proportions for the duty involved and fitted with two self-aligning shoes actuated by compression springs.

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The brake shall be instantly and automatically applied in the event of interruption of the power supply.

The brake shall be capable of bringing the car to rest smoothly, under maximum conditions of load and speed, and capable of sustaining static load of 150% of the contract load.

2.5.5.2.3 Motor:

The variable voltage variable frequency (VVVF), motor specially designed to meet all elevator duty requirements shall have a duty cycle rating of a minimum of 180 starts per hour. The motor speed shall have controls to allow smooth transition between acceleration and deceleration phase. The motor shall be capable of stable operation at all speeds up to the stated maximum and no abrupt speed change shall be permitted. It shall have a drip proof enclosure and may be force ventilated.

The drive motor shall be rated to provide sufficient power to accelerate the elevator to full speed in the shortest period while maintaining passenger comfort.

The power system shall incorporate solid state equipment controlling the speed of the elevator motor. Smooth performance with steeples acceleration and deceleration is to be provided with a leveling accuracy of ± 0.25" and the final stop at floor level is to be achieved dynamically after which the machine brake shall be applied to hold the elevator car stationary.

2.5.6 Hoist-way Equipment

2.5.6.1 Suspension Ropes/Belts

Suspension ropes of high-grade steel specially designed for elevator duty shall be provided in conformity with the requirements of B.S. 329. The material of the rope shall conform to B.S. 2763. It shall be free from loose wires, distorted strands or other irregularities. All rope terminals shall comply with B.S. 461. Independent adjustment shall be provided for each rope. All suspension ropes material and strength shall comply the requirements of latest EN 81-20 & EN 81-50 standards.

The length of each rope shall be so adjusted that it loses traction with sheave when the counterweight touches its buffers.

An automatic device shall be provided for equalizing the tensions of suspension ropes at least at one of their ends.

Suspension belts as per International Standards may be provided as an alternative to suspension ropes. However, Contractor will ensure trouble/ jerk free operation in suspension belt due to power break down problem.

All necessary equipment/ material shall be provided for trouble free operation. Manufacturer certificate on letter head for the same is required with use of suspension belts.

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2.5.6.2 Guides, Fixings and Inserts

The guides shall consist of high quality 'T' section steel of adequate strength and dimensions suitable for travel, car weight, speed and capacity of elevator. Guiding surfaces shall be accurately machined. The joints shall be spigotted and joined by machined steel finish plates.

Guides shall be of sufficient length to prevent any of the car or counterweight shoes from running off the guides.

All guides are to be securely fixed to the walls of the elevator well by steel brackets bolted to metal inserts or by other approved means. Rag bolts shall not be permitted. All metal inserts, fixings, guide rails, anchor bolts etc. shall be provided by the elevator Contractor.

Guides shall be so jointed and fixed to their brackets that they do not deflect by more than 3mm under normal operation.

Guides and their fixing shall withstand the application of the safety-gear without permanent deformation when stopping a fully laden car or the counterweight.

2.5.6.3 Guide Shoes

The sliding guide shoe shall comprise three slide elements, wherein each slide elements forms a respective. The arrangement shall be suitable for an oil-free mode of operation. Three fastening grooves each for preferably (with respect to the direction of insertion or longitudinal direction) mechanically positive reception of a respective slide element shall be provided in the support element. Support element shall comprise at least one bearing pin formed, preferably monolithically, at the support element. The guide shoe housing shall have a cut-out, which is complementary with the bearing pin.

The sliding guide shoe shall comprise a preferably separate protective element for protecting the slide surfaces from contaminations. The protective element in that case be positioned at the holding element on an inner side facing at least one slide element. In completely assembled position the protective element shall bear against the slide element or slide elements shall seal protects these.

2.5.6.4 Counterweight

A counterweight equal in weight to the car plus 40% to 50% of the specified load shall be provided to each elevator. Structural Steel frame shall support requisite number of cast iron weights. It shall be fitted with guide shoes and suspension arrangements and accessories suitable for specified elevator capacity.

2.5.6.5 Safety Gear and Governor

A friction type progressive safety gear actuated by centrifugal over speed governor shall be securely bolted to the car frame under the car platform.

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The governor wire rope operating the safety gear mechanism shall not be less than 6mm diameter.

The tension weight fitted with an electrical safety device shall be provided to cause the hoist motor to stop should the governor rope break or slacken.

The governor shall be fitted with a direct driven unit to relay to the control system both the speed and position of the elevator in shaft.

The governor shall be equipped with two electrical switches, preset to operate progressively in case of over speeding to reduce the elevator speed in the first stage and if the elevator speed is not brought under control, operate to cut of power supply to the hoist machine and apply brakes.

If the car continues to travel downwards at excessive over speed, the mechanical trip shall operate causing the governor jaws to grip the rope to bring the safety gear mechanism into operation causing the jaws to grip the guide rails equally through self-aligning friction shoes thus bringing the car to rest gradually and smoothly. The governor and safety gear shall be released by raising the car.

In case of elevator pit have another floor under it or access to public there must be second Safety Governor with safety gears attached with counter weight frame and operation will be same as stated above for Safety Governor attached with the Car.

The governor and safety gear shall be adjusted to operate as specified by B.S. 5655.

2.5.6.6 Buffers

Oil buffers of spring-return type or as mentioned in EN standards shall be supplied and installed in pit under car and counterweight for each Elevator. The minimum total stroke of the buffer shall be based on the retardation of 32 feet/sec^2 based on 115% contract speed. The maximum rate of retardation of the oil buffers based on 115% contract speed shall be 80.5 feet/sec^2 excluding any transient declarations having duration not exceeding 0.04 sec.

The buffers shall be mounted on continuous channels securely anchored to the pit floor and fastened to the guide rails. The channels, anchors and any additional supports required for buffers shall be provided by the Contractor.

The buffers shall be fitted with means of ascertaining the correct amount of oil in the buffers.

Each buffer shall be permanently and legibly marked to indicate the type and quantity of oil to be used within the buffer.

The buffers shall be self-setting type fitted with safety device to ensure its return to their normal position after operation.

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2.5.6.7 Final Limit Switches

The elevators shall be equipped with an automatic device arranged to bring the car to a stop at the terminal landings independent of the regular operating devices in the car. Final limit switches should stop the car and prevent normal operation should it travel beyond the normal stopping device.

Separate control devices for normal stopping and final limit switches shall conform to the requirements of BS 5655: Part I.

2.5.7 Controller & Control System

2.5.7.1 Controller

The controller shall be floor mounted, upright type enclosed in enamel finish steel cabinet with either hinged doors at the front and removable panels at back or hinged door both at front and back.

The control system shall be microprocessor based and fitted with all safety devices to protect equipment and motors from damage in the event of overload or other malfunction. Protection against phase reversal shall provide as per code.

The driving unit control module, comprising of power and command module, shall control drive performance parameters. The controller unit shall control acceleration & deceleration, speed and the jerk rates during change in acceleration or deceleration to provide stepless speed variation for maximum passenger comfort. The jerk rates shall be individually adjustable to user's satisfaction. Upon receiving signal to perform journey, the command module shall evolve optimum speed profile for each journey and trigger power module for AC/DC and DC/AC conversion for necessary drive current and voltage to obtain desired motor torque.

The controller shall control car motion on feedback from motor-mounted tachometer and operate the brakes of hoisting motor through the signals received from micro switches and load weighing devices.

The controller shall be arranged to cut off the power supply, apply the brake and bring the car to rest upon failure of operation of any of the electrical safety devices.

2.5.7.2 Control System

2.5.7.2.1 General:

The design of control system shall be based on functionally arranged section modules featuring high degree of efficiency, economy of operation, adaptability to changing operating conditions, safety and reliability in operation through maintenance free electronic circuitry.

The control equipment shall be microprocessor based electronic solid state. The total system shall be designed to operate in normal machine room ambience and incorporate full protection against noise and electrical interference generated within the power

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section, controller and switchgear. The system design shall allow the control algorithm to be reprogrammed by software changes.

The Controller shall be state-of-art microprocessor-based controller capable of high-speed data transmission and analysis for optimization of traffic control.

All modules shall be tested at the manufacturer's works prior to installation. System component shall be subjected to environmental endurance, thermal shocks and salt spray in test chambers.

Following is a list of parameters which shall be monitored and recorded for each Elevator and can be control with building controller through dry contacts. The list is indicative only and shall be finalized according to Client/Project requirements:

i. Operating status of Elevator (Running, Out of Service, or Maintenance mode).

ii. Elevator Running Up/Down

iii. Elevator Error/Fault Detail

iv. Emergency Stop

v. Mains Power Failure

2.5.7.2.2 Supervisory Operational Mode:

The operational mode of the Elevator shall be automatic control as specified in para 2.6. with special operation features, viz emergency operation and fireman switch.

The control system shall be provided with a parking feature, which returns the car to the main floor when there are no calls in the system.

The elevator shall be provided with individual landing station and operated from interconnected landing buttons including two operating devices in the car. Single touch buttons shall be mounted at each terminal landing.

On touching car or landing buttons, (other than those for landing at which car is standing) shall start the car provided interlock circuits are established and causes car to start traveling in the direction of registered call. Car shall stop at the designated landings for which calls are registered with stops made in order in which landings are reached, irrespective of sequence in which calls are registered, provided call for a given landing is registered sufficiently in advance of arrival of car at that landing to permit stop to be made.

If there are no car calls and car start up in response to outside landing calls, car shall proceed first to the highest down call and then reverses to collect other down calls. Up landing calls shall be collected similarly when car starts down in response to such calls. If car stops for a landing call and a car call is registered within a predetermined interval after stop for a landing corresponding to direction car was travelling, car shall proceed in the same direction regardless of other landing calls registered.

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If DOWN landing buttons are touched while car is travelling up, car shall not stop at these landings, but calls remain registered. After highest car and landing calls have been answered and door interlock circuit is established, car shall reverse automatically and respond to down car and landing calls. When travelling down, car shall not respond to up landing calls, but calls shall remain registered and answered on next up trip. No double door operation shall be permitted.

2.5.7.2.3 Load weighing:

Means shall be provided for weighing passenger load. Control system shall be designed to provide dispatching in advance of normal intervals and to provide landing call by-pass when the car is filled to approximately 80% of full capacity load.

Settings shall be individually adjustable. A buzzer shall be provided to indicate overload in elevator.

2.5.7.2.4 Door Operation:

Doors shall open automatically when a car arrives at a terminal to permit egress of passengers. When another car is at the terminal and is loading for departure or upon expiration of a timed interval, the doors shall close until car is designated for loading. In the event a passenger has entered the elevator, the doors shall reopen upon registration of call on the car button or by pressing the door open button. If no other car is at the terminal, an arriving car shall have its doors open until the car is dispatched or expiration of a timed interval with no demand.

2.5.7.2.5 Automatic leveling:

An automatic 2-way leveling device shall be provided, designed to govern the leveling of the car to within 6mm above or below the landing sill. The leveling operation shall avoid over-travel, under-travel, of the car and maintain the leveling accuracy regardless of the load in the car, direction of travel, rope slippage or stretch in ropes.

2.5.7.2.6 Independent Operation:

Controls shall be provided for operation of the elevator from car buttons only. A key operated switch shall be provided in each car.

2.5.7.2.7 Emergency Features:

i. Emergency operation: The Elevator shall be equipped with control system to operate and recall the cars in fire or other emergency conditions and to allow the elevator to run on emergency power supply.

ii. The operation of elevator on emergency service shall be as follows:

- The Elevator shall be operable only by a person in the car.
- Elevator shall not respond to Elevator corridor calls.
- The Elevator will stop at the next level.

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iii. The opening of power operated doors shall be controlled only by buttons or switches. If the switch or button is released prior to the doors reaching the fully open position, the doors shall automatically re-close. Open doors shall be closed by either the registration of a car call or by "door close" switch or button.

iv. Elevators shall be removed from emergency service by moving the emergency service key-operated switch in the car to the 'off' position with the car at the main floor.

v. Emergency Lighting and Emergency alarm unit: An emergency light shall be included for each elevator car. An automatic change over switch shall be provided in the controller so that upon normal supply failure Emergency power supply shall be available for the light fixture, exhaust fan, and alarm unit.

vi. The Contractor shall supply a suitable button in the car control wired to a terminal box fixed in the elevator shaft near the bottom floor served. A suitable alarm bell shall be provided and fixed including all necessary wiring connecting up to the terminal box.

vii. The power for the emergency lighting, exhaust fan and alarm bell shall be from the same emergency supply consisting of rechargeable nickel cadmium battery unit with trickle charger and 10 years minimum life expectancy.

viii. Emergency power transfer: In the event of normal power failure, adequate power will be supplied through Employer furnished stand-by generator to run the Elevator.

ix. Operation under Standby Power: A control signal from the generator shall be provided to the elevator controller or elevator group to place the elevator or group of elevators in emergency power mode, which will cause the elevators to return to the designated floor and remain there with the doors open. If there are a group of elevators, power shall be provided to only one elevator at a time and automatically switch to the remaining elevators until all elevators have returned to the designated floor with the doors open.

x. Intercom: The Contractor shall install for each elevator, an intercom facility with control room or at location designated by Employer for 24 hours communication. All necessary cabling and conduiting is included in contractor's scope of works.

xi. Earthquake control: In the event of an earthquake, the elevator facility shall be provided with a seismic detector which will bring all cars to stop at the next floor and open the doors.

xii. Emergency Rescue Device (ERD): In the event of a power break down, the elevator shall be provided with ERD which will bring all cars to stop at the next floor till the power is resumed.

xiii. Manual Brake Release Lever: In case of a power break down and fault in ERD, the elevator shall also be provided with a manual brake release lever to manually evacuate the passengers. And it shall be fixed inside the control panel to be used only by the designated person.

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2.5.8 Signals & Fixtures

Contractor shall provide fixtures and signals as follows, test complete system, correct any deficiencies in wiring and function and make complete system fully functional. Location and arrangement of fixtures and signs shall comply with the ADA and other code requirements.

2.5.8.1 Integrated Hall Indicator

An integrated hall indicator consisting of digital car position indicator (revealing floor position of car) and illuminated arrows indicating the arrival and departing direction, as determined by the control system shall be installed above each individual elevator and at each landing. A two-tone electronic gong shall also be provided for audible announcement of the arrival of the elevator car.

The digital car position indicator shall be either of 2-character 7/8 segment type with character height of 35-40mm.

The direction arrows shall be of acrylic and protrude from the faceplate for lateral visibility.

The integrated hall indicator shall be of horizontal configuration. The stainless-steel face plate, min. 2mm thick, of satin finish containing the digital car position indicator and direction arrows. The hall indicator shall operate on 24 V D.C. supply.

2.5.8.2 Landing Call Station

Landing call station fitted with push button Panels shall be installed at each landing. It shall be designed for mounting on the landing door frame or on adjacent side wall, subject to Engineers' approval.

The push button Call Panels shall be of flush type, constructed of stainless-steel panel suitable for long arduous duty. The translucent surround of the push button Call Panels shall illuminate to indicate acceptance of call signal.

The push button Call Panels of each landing station shall be inter-linked such that with the pressing of call button of any elevator, call buttons of elevators in the same direction shall light up and record the call.

2.5.8.3 Car Station

The car station shall be integral/aligned with the front return of the car and constructed from stainless-steel push-button Panels.

The hinged full height front panel of the car station shall carry the controls and indicators. The panel shall be fitted with a secret release, which can only be opened from the back of the trough. When the hinged panel is opened an isolate/ normal switch shall be available. The car operating panel shall be recessed in the wall of lift cabin and edges of car operating panel shall be flushed with the wall of lift cabin.

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The car-operating panel shall contain at least the following controls with push button Call Panels:

i. Alarm button

ii. One floor button for each floor served

iii. Open door button/hold on button

iv. Key operated car independent service switch

v. Key operated fan switch

vi. Digital car position indicator and direction arrows

vii. Intercom

viii. Speaker for position announcement

All push button Panels shall be set flush with the panel surface for maximum resistance against abuse. When operated, a LED illuminated halo shall highlight the screen thereby informing that the call has been registered. The push button Panels shall be made of stainless steel with the appropriate floor marking.

The digital car position indicator and direction arrows shall be positioned above the floor marking.

Separate Car Operating Panel for wheel chairs user shall be provided in the car lift with all necessary features.

2.5.9 Power Supply & Electrical Installations

2.5.9.1 General

The power supply at load break switch will be available in the Elevator machine room. All further wiring, controls and providing proper distribution boards, along with necessary material and accessories beyond the power supply points shall be supplied and installed by the Contractor. The electrical installation and appliances shall comply with B.S. 5655: Part I.

2.5.9.2 Wiring Installation

All wiring shall be carried out in accordance with the IEE regulation, NEC standard and B.S.S. wherever applicable.

All cables shall be PVC insulated, and if required PVC sheathed also, single or multicore having tinned copper conductors. Cables for different voltage circuits which are run together must have the insulation rating, suitable for the highest voltage present. Wherever cables are subjected to high temperature such as termination to car light, it shall be protected by suitable heat resistant sleeve. At all terminations, cable

ends shall have numbered ferrule to match with the mark on respective component and control drawings. All wiring shall be continuous between terminations.

Travelling cables between the elevators well and elevator car terminal boxes shall be suspended by looping over reels or by suitable clamps. The connections in the terminal boxes shall be marked for identification purposes.

Travelling flexible cables shall be fire resistant and shall comply with B.S. 6977

2.5.9.3 Trunking and Conduits

All wiring from machine room to motor controls at each floor and to other circuits shall either be run in 16 SWG galvanized steel conduit or trunking, the selection and route of which shall depend on the number of cables and ease of installation and maintenance. If trunking is installed it shall have removable covers, and the trunking finished in dark grey enamel as per B.S. 381C. Fixing arrangements of conduit of trunking shall be vibration proof suitable for the existing conditions. All connections from trunking or conduits to motors or other equipment subjected to vibration shall be with flexible galvanized steel conduit. All trunking and conduit shall be continuous through out the length to ensure good earth continuity.

2.5.9.4 Earthing

Earthing of all equipment and metal work which can be subjected to dangerous voltage under normal operating and fault conditions shall be earthed in accordance with NEC Standard. One PVC insulated earth conductor of suitable size having yellow colour with green tracer shall be run along the trunking or conduit as main earth. All branch circuits in conduit or trunking and other metal work shall have branch earthing cable connected to main earth. All length of trunking shall also be bonded to main earth.

2.5.9.5 Testing

Testing of electrical installations shall be carried out to the satisfaction of the Engineer in accordance with standard practice and recognized international standards/codes.

2.5.10 Fire Protection

All precautions will be taken to eliminate the potential sources of fire and smoke sources and prevent flame propagation. In particular:

i. Halogen-free cables will be used,

ii. Oil, grease and dust will be collected,

iii. No plastic materials shall be used in these systems.

Each elevator will be equipped with a fire and smoke detection unit and linked to the fire detection system.

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2.5.11 Local Materials

2.5.11.1 Pit Screen

A suitable rigid steel screen shall be provided and fixed by the Elevator Contractor at the bottom of the elevator well where the counter-weight comes down on its buffers and between elevators. The screen shall have a minimum height of 7 ft. as per code requirements.

2.5.11.2 Separator Beams & Well Trimming Girders

Properly designed separator beams and trimming girders shall be supplied and installed at proper location in Elevator well by the elevator contractor to suit fixing requirement of offered elevator. The separator beams and trimming girders installed in elevator shall be of at least 200mm rolled I-beams of prime quality structural steel (ASTM A-36 or equivalent).

2.5.11.3 Trap Door

The Contractor shall provide and install the trap doors of rugged construction in the machine rooms at location shown on relevant drawing to enable access of the hoisting machinery into the machine rooms. The trap door shall be strong enough to temporarily withstand/support heavy machinery. It shall be installed flush with the finished floor when closed and be lockable only from inside the machine room.

The Contractor shall include the above items in his bid price for the elevators.

2.6 TECHNICAL DATA

2.6.1 Evidence Block Elevator Schedule-Quantity One (01) No.

Sr. No.	Description	Minimum Requirement
01	Type	Machine Room Less Type (MRL) heavy duty VVVF Passenger Elevator fully complied with EN 81-20, EN 81-50 and EN81-70 standards.
02	Capacity	1000 Kg
03	Elevator Speed	1 m/sec
04	Travel Height	As per BOQ/SOP
05	No of Stops/Openings	Basement + Ground floor + First Floor (03 stops/03 openings)
06	Internal Car Sizes (w x d) x h	(1100 mm x 2100 mm) x 2300 mm
07	Machine Type	VVVF AC gearless drive

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08	Car & Counterweight Guide Shoes	Sliding guide shoes
09	Drive Location	Above in shaft (MRL Type)
10	Control System	Simplex control
11	Architraves	Full width of Stainless-Steel satin finish at all floors as approved by the Client/Employer at all floors.
12	Elevator Shaft Size (w x d)	As per layout drawing attached
13	Pit Depth	As per layout drawing attached
14	Head Room	As per layout drawing attached
15	Buffers	Oil buffers of spring return type (Energy Dissipation type) or as recommended by EN 81 Standards
16	Door Size	900mm x 2100mm
17	Door Operation & Type	VVVF control, Power operated, 2-Panel Side opening stainless steel panel construction and fire rating of 2 hr
18	Indicators	- Digital car position indicator on each landing with direction arrows. - Digital position indicator inside car with direction arrows. - Two tone electronic gong announcing arrival of car.
19	Landing Call Station	- Push buttons type or as approved by the engineer with call acceptance illuminated indications.
20	Car Station (02 Nos stations each elevator) (One for wheelchair users as per EN 81-70)	- Integral with the front return of the car and constructed of Stainless Steel/glass and recessed/flushed with wall. Including separate handicapped car operating panel push button type or as approved by the engineer - It shall include alarm buttons, floor call buttons, door open/hold button, key-operated attendant switch, fan switch, intercom, all buttons shall be of push button type or as approved by the engineer (connection with building safety/security system is included in Contractor's scope).
21	Car Design	- Stainless Steel Hairline at all floors as approved by the client/employer. - Front return and car door of stainless steel (hairline finish) construction or as approved by the client/employer.

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		- Full width half height mirror on rear wall or as per manufacturer design. - Ceiling removable type full extended poly carbonate diffuser with modular light fittings as approved by engineer - Ventilation Blower (Pre-Installed) - Handrails on two side - Granite Floor - Inter Telecommunication system - Emergency exit - Load measuring device with overload buzzer and inter-lock till overload is removed. - LED Lighting
22	Door Safety Devices	- Full height Light curtain protection (2D) - Door opening timing feature
23	Special Features	- Attendant control - Emergency operation and fireman switch. - Emergency lighting & alarm unit. - Earthquake control system - Voice guidance system - Connected with building control - Suitability for 0~40°C ambient temperature - Phase reversal failure indication & interlock - Manufacturer Security Cameras for surveillance (Connection with building safety/security is included in Contractor's scope) - ERD Device (Emergency Rescue Device with battery backup) - Manual Brake Release Lever - Halogen free cables
24	Interior Finish	Superior/Highest/Executive quality as per approval of engineer on submitted samples.
25	Minimum Functions	- Direct Leveling - Optimum travel curve - Re-running automatically when elevator is re-powered - Car location adjusted automatically - Load compensating - Travel Counter

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		- Over/Under voltage protection - Phase trip protection - Over current protection - Over heat protection - Encoder trip protection - Contact adhered protection - Bi-directional over speed protection - Reversal protection - Travel over time protection - Final terminal protection - Over load protection - Anti-door lock bridge - Automatic by-pass hall call while full load - Level for self-helping - Travel to next floor when open door trip - Emergency illumination in car - Emergency alarm - Automatic car fan - Automatic car lighting - Fire return feedback - Settable landing number - Automatic parking, parking floor - Car calls cancelable - Parking key switch, landing - Fire return (Phase I), Main landing - Hoist way lighting - Car door button
26	Trips/hour	180 minimum
27	Power Supply	- 3 Phase / 400V / 50 Hz. - 1Phase/230V/50 Hz. (for lighting)
28	Ambient Condition for Motor/control safeties for shafts etc	0°C to 40°C
29	Inspection & Test Language	English
30	Elevator Mode	Two Mode: - Normal Mode: From the car or from the landing. - Maintenance Mode: Low speed (inspection running).
31	Design Life	25 Years

NOTES:

i. Bidder is advised to visit the site to check as built dimensions of elevator shafts, overhead and pit and confirm in his bid that offered elevators will suit to as built dimensions.

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ii. All leaflets properly signed/stamped in original to be submitted with the bids for the equipment including drive, controls, car design, doors & architrave, indicators landing and car station, safety devices etc. being offered.

iii. Model Number and Technical Specifications mentioned in Technical Bid are considered for reference only. The Bidder/Contractor will submit Technical

iv. Submittal of the proposed model after award of work with full compliance of Bidding Documents for the Engineer's review and approval. No reference model and technical specifications accompanied with the Bid are supposed to be final until Engineer's approval of the Technical Submittal.

v. Any variation in the technical aspects of the offered model by the Bidder, against the above data, due to manufacturer's standards will be subject to Engineer's approval.

2.7 INSTALLATION

2.7.1 General

The installation of elevator equipment including its electrical installations shall comply with applicable standards, manufacturers' instructions and recommendations. Electrical work required during installation shall comply with NFPA 70 or approved equivalent.

The scope of installation and civil works shall include the following:

i. Providing and/or cutting all necessary holes, chases and openings and making good after installation of equipment.

ii. Supplying and fixing all supports, beams, ladders etc. necessary for the installation of the machinery, guide brackets, doors, buffers etc.

iii. Furnishing all necessary cement and/or concrete for 'grouting-in' brackets, bolts, etc.

iv. Providing and fixing suitable scaffolding and protection of work in progress.

2.7.2 Welded Construction

Welded construction shall be provided for installation of Elevators wherever bolted connections are not required for subsequent removal or for normal operation, adjustment, inspection, maintenance, or replacement of worn parts. Welding workmanship and qualification of welding operators shall comply with American Welding Society (AWS) standards or approved equivalent.

2.7.3 Sound Isolation

Rotating and vibrating Elevator equipment and components shall be mounted on vibration - absorption mounts designed to effectively prevent the transmission of vibrations of the structure, and thereby eliminate the sources of structure - borne noise.

2.7.4 Lubrication

Operating parts of the system including ropes, guides, etc., shall be lubricated as per manufacturer's recommendation.

2.7.5 Alignment

Proper co-ordination of installation of hoist way entrances with the installation of elevators' guide rails shall be done for accurate alignment of entrances. Wherever possible the final adjustment of sills and doors shall be delayed until the car is operable in the shaft. The clearance shall be reduced to minimum, safe, workable dimensions at each landing.

2.7.6 Sills

Sill unit shall be set at each floor landing accurately aligned, slightly above structural floor, to suit level of scheduled floor finish.

2.7.7 Painting, Retouching & Re-finishing

After completion of installation and testing to the satisfaction of the Engineer-in-Charge, the Contractor shall carryout all finishing, retouching and refinishing operation on the entire equipment accessories and installation matching the original finish in an approved way. All auxiliary works carried out by the Contractor as the finished installation shall also be painted in the approved standard after applying anticorrosive base.

2.8 TESTING AND INSPECTION REQUIREMENTS

The Contractor shall submit separate list of shop tests, to be conducted prior to shipment and field tests after installation prior to commissioning.

The Contractor shall arrange pre-shipment inspection of the equipment as per requirements given in clause of Sec.8510.

Testing after installation shall be carried out for each elevator before it is put into normal service in accordance with B.S. 5655 Part 10 and appropriate certificate shall be completed. The tests shall include but be not limited to the following:

i. Functioning of all system and devices

ii. Operational test of all safeties

iii. Protection against false signals

iv. Earth fault test on cable/controller & switch gears

v. Insulation resistance test for cables

A thorough inspection of all equipment shall also be undertaken at this stage and appropriate certificate shall be completed.

Elevator shall be periodically re-examined during defect liability period and at the end of guarantee/defect liability period appropriate certificate shall be completed to assess operational performance.

All equipment and personnel required to complete testing and inspection shall be provided by the Contractor. All erection work and tests shall be performed by the Contractor's erectors who shall be suitably qualified and experienced persons to the satisfaction of the Engineer.

SECTION - 8460

INTERNAL GAS PIPE LINES (LOW PRESURE)

1. SCOPE OF WORK

The Contractor shall furnish all plant, labour, materials, equipment, tools, appurtenances, services, temporary work and storage and perform all operations necessary for the supply and installation of the gas supply piping alongwith necessary fittings in perfect operating condition in accordance with these specifications and Drawings and/or as directed by the Engineer.

The Contractor shall be responsible for the supply and installation of gas piping work (low pressure) within the building and outside upto gas regulator. Gas regulator, meter, control valves and piping work (high pressure) will be carried out by SSGC.

The Contractor shall execute all gas piping work through SSGC approved sub-contractor.

2. GENERAL

The Contractor shall design, provide and install gas piping to supply gas upto designated places mentioned in drawings. Operating pressure in gas pipeline shall be 8 inches of water column.

The layout of gas supply pipelines is tentative and for tender purposes only. Final layout of the gas supply pipelines shall be made by the Contractor after coordination with other services in accordance to the equipment layout. The final piping layout as prepared by the Contractor shall be submitted to the Engineer for approval prior to start of installation.

3. CODES AND STANDARDS

The Codes and Standards applicable to only a portion of the specified works are referred in the relevant parts or clauses.

Codes and Standards which are generally applicable to the works and services of this section are listed herein:

Latest editions shall be considered and applicable for all standards referred in this section.

National Fire Protection Association Standard

NFPA 54

ASA Standard

ASA Z 21.30

American Nation al Standards Institutes

ANSI Z 223.1

Other authoritative codes and standards which ensure equal or higher quality than those referred above may also be acceptable subject to satisfaction and approval of the Engineer.

Any conflict between the requirements of this specification and those on the figures herein or in codes and standards referred shall be brought to the attention of the Engineer for resolution whose decision will be final and binding.

4. EQUIPMENT AND MATERIALS

a. PIPE

All internal piping (low pressure piping) shall conform to BS 1387 medium grade or equivalent. The pipe shall be galvanised.

b. PIPE FITTINGS

Fittings shall be of malleable cast iron in accordance with BS 143. Fittings shall be galvanised and screwed.

c. BALL VALVES

The ball valves shall be of bronze body and shall provide quick cut off and shall meet the requirements of BS 6755.

d. PLUG VALVES

The Contractor shall supply and install where shown on the drawings, area isolation plug valves and service plug valves of taper plug type with provision for greasing which should withstand a test pressure of not less than 3.5 bar in closed position.

The plug valves shall be of steel body of 150 class pressure rating and shall be of locking type so that the gas supply can be locked off, if desired. All plug valves shall conform to API-615.

5. TRANSPORTATION, DELIVERY AND STORAGE

All transport handling, uncrating, unpacking, cleaning, degreasing, protective covering, inspection, etc., shall be included in the scope of work. Due diligence and care shall be exercised to prevent distortion and damage when unloading and moving the material to its location for installation.

6. INSTALLATION AND WORKMANSHIP

a. GENERAL

Installation work shall include all handling, assembling, aligning, supporting, setting, excavation and back filling, etc. necessary to install gas piping in locations shown on tender drawings. Special attention shall be paid to all installation notes on the drawings.

The supply and installation work shall be carried out in accordance with schedule to be submitted by the Contractor to the Engineer for approval, keeping in view the conditions and other works in the vicinity.

Each part of the piping systems shall be complete in all details and provided with all fittings, control valves and accessories necessary for satisfactory operation.

b. PROTECTION

Keep pipe and other openings closed to prevent entry of foreign matter. Cover all fixtures, equipment and apparatus and protect against dirt, water, chemical or mechanical damage, before and during the construction period. Restore to the original condition, any fixtures, apparatus or equipment damaged prior to obtaining completion of maintenance period certificate, including damaged shop coats of paint.

c. CUTTING, PATCHING AND REPAIRING

Required for proper installation and completion of work in this section, including masonry work, concrete work, carpentry work, painting and repainting shall be performed by skilled craftsmen in respective trades at expense of the Contractor. Cut construction only after obtaining written permission from the Engineer. No payment shall be made for such works and their cost shall be included in tendered cost.

d. PIPING UNDERGROUND

i) Clearances

Underground gas piping shall be installed with enough clearance from any other underground structure to avoid contact therewith, to allow proper maintenance and to protect against damage that might result from proximity to other structures.

All underground gas piping shall be located in a manner so as to be at least 12 inches away from other services.

ii) Protection Against Damage

Underground piping systems shall be installed with atleast 30 inches of cover. The cover may be reduced to 12 inches if external damage to the pipe is not likely to result. If a minimum of 12 inches of cover can not be maintained, the pipe shall be installed in conduit or bridged (shielded).

iii) Protection Against Corrosion

Gas piping in contact with earth or other material which may corrode the piping, shall be protected against corrosion in an approved manner as per Engineers' instructions. The piping shall be properly prepared i.e. scraped or wire brushed to remove mill scale, rust and cleaned with solvent to remove dirt, oil and grease before using bitumen and hessian cloth, fiber glass mat or PVC tapes as approved by the Engineer.

e. PIPING THROUGH FOUNDATION WALL

Underground gas piping, when installed below grade through the outer foundation or basement wall of a building shall be encased in a sleeve. The annular space between the gas piping and the sleeve shall be sealed at the foundation or basement wall to prevent entry of gas or water.

f. CONCEALED PIPING IN BUILDING

i) Minimum Size

No gas pipe smaller than standard ½ inch dia pipe shall be used in any concealed location.

ii) Piping in Partitions

Concealed gas piping shall not be located in solid partitions.

iii) Piping in Floors

Gas piping in solid floors such as concrete shall be laid in channels in the floor suitably covered to permit access to the piping with a minimum of damage to the building. When piping in floor channels may be exposed to excessive moisture or corrosive substances, it shall be suitably protected.
Gas piping may be embedded in concrete floors and passages with a minimum cover of 2inches.

iv) Connections in concealed locations

When installing gas piping which is to be concealed, unions, running threads, right and left couplings, bushings, and swing joints made by combination of fittings shall not be used.

g. BRANCH PIPE CONNECTION

All branch outlet pipes shall be taken from the top or sides of horizontal lines and not from the bottom.

h. PIPE THREADS

i) Specifications for Pipe Threads

Metallic pipe and fitting threads shall be taper pipe threads complying with the Standard for Pipe Threads BS.21-1985.

ii) Damaged Threads

Pipe with threads which are stripped, chipped, corroded, or otherwise damaged shall not be used.

iii) Number of Threads

Pipe shall be threaded in accordance with following table.

Pipe Size inches	Approximate Length threaded portion inches	Approximate No. of Threads to be Cut
½	¾	10
¾	¾	10
1	⅜	10
1¼	1	11
1½	1	11
2	1	11
2½	1½	12
3	1½	12

i. PIPE HANGERS, SUPPORTS AND ANCHORS

Pipe hangers and supports shall conform to the requirements of Standard Practice for Pipe Hangers and Supports-Materials Design and Manufacture, ANSI/MSS SP-58.

All supports for steel piping shall be ferrous. Brackets or supports shall be set out so that they do not obstruct the access to valves, flanges or other fittings requiring maintenance.

All pipework shall be supported by means of approved clips or hangers at centres. In the event of two or more pipes being carried by a single support the spacing shall be for the shorter interval.

All vertical drops shall be supported so as to prevent sagging or swinging. Unless otherwise indicated, pipe supports are to be spaced as follows:

Nominal Pipe Size (inches)	Max. Span (feet)
½	6.0
¾ to 1	8.0
1½ or larger (horizontal)	10.0
1½ larger (vertical)	every floor level

Piping at all equipment and control valves shall be supported to prevent strains or distortions in the connected equipment, valves and control valves. Piping shall be supported to allow for removal of equipment, valves and accessories with a minimum of dismantling and without requiring additional supports after these items are removed.

All channels, angles, plates, clamps etc. necessary for the fastening hangers shall be furnished and fitted by the Contractor. All hangers shall be properly sized for the pipe to be supported. Oversized hangers shall not be permitted without Engineer's approval.

Details of hangers and supports to be used by the Contractor shall be submitted to the Engineer for approval before fitting. All hangers shall be

provided with lock nuts and have provision for vertical adjustment of pipes.

Individual horizontal piping shall be supported by hangers consisting of malleable split rings with malleable iron sockets, or steel clevis type hangers, or roller hangers as directed by the Engineer.

Vertical piping shall have heavy wrought iron or steel clamps securely bolted on the piping with the end extensions bearing on the structure of the building.

j. UNIONS

Unions shall be installed at suitable locations and at all valves for easy dismantling of the piping system.

7.0 FINISHING

a. PAINTING

All hangers, brackets and other surfaces exposed to air shall be painted. All surfaces to be painted shall be prepared properly to receive prime coat of paint. Surfaces shall be scraped or wire brushed to remove mill scale, rust and cleaned with solvent to remove dirt, oil and grease. All surfaces shall be thoroughly dried before application of paint. Prime coat shall be suitable for subsequently applied finish coats. For prime coat, lead paint of an approved manufacturer shall be used.

Before finish coat is applied, all prime coated surfaces shall be properly touched up. The equipment and piping shall not be finish painted until they have been tested and approved. All succeeding coats shall be applied only when the undercoats are thoroughly dried.

All exposed metal surfaces of pipework, hangers, brackets, valves, etc. must be painted one under coat and two finishing coats of enamel paint of approved colour.

8.0 TESTING AND COMMISSIONING

a. GENERAL

At each stage of the work, the Contractor shall have the installation subjected to various tests, checks and detection techniques, as mentioned in NFPA-54, and obtain the approval of the Engineer. Any imperfections, defects, non-compliance with the specifications and above code, etc. shall be made good to the satisfaction of the Engineer at no extra cost.

In addition to the tests and checks specified earlier, the piping shall be subjected to pressure tests and operational test as specified herein.

b. PRESSURE TESTS

Prior to initial operation, piping shall be pneumatically tested to a pressure of not less than 3 psig for internal (low pressure) pipelines.

Test pressure shall be measured with a manometer or with a pressure measuring device designed and calibrated to read, record or indicate a pressure loss due to leakage during the pressure test period. The source of pressure shall be isolated before the pressure tests are made.

If repairs or additions are made following the pressure test, the affected piping shall be retested, except that in the case of minor repairs or additions, the Engineer may waive retest requirements. The pressure test shall be maintained for a sufficient time not less than one hour to determine if there are any leaks. Equipment which is not to be included in the test shall be either disconnected from the piping or isolated by the use of valves or blanks.

The Contractor shall inform the Engineer in writing of his readiness to carry out the pressure tests, atleast 4 days prior to the date the test is to be held, and shall perform the test in his presence. Records shall be made of the tests, including the test fluid, test pressure and shall bear the approval of the Engineer.

c. COMMISSIONING

After the piping system has been tested and determined to be free of leakage, all piping shall be fully purged in accordance with NFPA-54. Care shall be taken to ensure that under no circumstances the piping be purged into the combustion chamber of an appliance. After the piping has been sufficiently purged, all appliances shall be purged and pilots, if any, ignited.

Each burner shall be adjusted to its proper gas rate in accordance with the manufacturer's instructions. Over rating of the burners is prohibited. The burner gas rate can be checked with test hand on the meter. The gas rate shall be adjusted to the required rate by changing a fixed orifice. The primary air shall be adjusted for proper flame characteristics.

All protective devices furnished with the appliances shall be checked to ensure proper operation.

When an automatic pilot is provided, it shall be checked for proper operation and adjustment in accordance with the manufacturers' instructions.

At the time of commissioning new installations or extensions of gas piping work, consumer shall be instructed by demonstrations as to how to operate the appliance safely.

9.0 **SUBMITTALS**

a. MANUFACTURER'S DATA

The Contractor shall submit manufacturer's data for all material and equipment for approval of Engineer before the order is placed. Orders for material submitted for approval must be accompanied by relevant drawings, curves, technical data, catalogues and samples.

10.0 MEASUREMENT AND PAYMENT

a. GENERAL

Except otherwise specified herein or elsewhere in the Contract Documents, no separate measurement and payment will be made for the under mentioned works related to the relevant items of the Bills of Quantities but shall not be limited to the following. The cost thereof shall be deemed to have been included in the quoted unit rate of the respective items of Bills of Quantities.

i. Cutting, welding, joining and threading of steel pipes.

ii. Gaskets, supports, hangers, fittings and reducers for fixing the steel pipes in position.

iii. Painting systems of pipes aboveground and coating systems of pipes underground/buried.

iv. Testing and commissioning of gas pipelines.

v. Excavation, laying, backfilling, concreting, cutting, patching & repairing where necessary.

b. STEEL PIPES

i. Measurement

Measurement of acceptably completed works of supply, erection/ installation of steel pipes complete with fittings i.e. bends, tees, etc. will be made on basis of actual length in feet of steel pipes provided and installed in position as shown on the drawings or as directed by the Engineer.

ii. Payment

Payment will be made for acceptably measured quantity of supply, erection/installation of steel pipes complete with fittings i.e. bends, tees, etc. on the basis of unit rate per foot quoted in the Bills of Quantities and shall constitute full compensation for all the works related to the item.

c. APPURTENANCES

i. Measurement

Measurement of acceptably completed works of supply, installation and testing of appurtenances such as ball valves, plug valves, pressure regulators, residential meters, etc. will be made on the basis of actual number of equipment provided and installed in position as shown on the drawings or as directed by the Engineer.

ii. Payment

Payment will be made for acceptable measured quantity of supply, installation and testing of appurtenances such as ball valves, plug valves, pressure regulators, residential meters, etc. on the basis of unit rate per number bid quoted in the Bills of Quantities and shall constitute full compensation for all the works related to the item.